New York ISO
Independent System Operator

System & Resource Outlook Update

Economic Planning Department

Electric System Planning Working Group (ESPWG)

Friday April 1, 2022 – NYISO

Agenda

- **Outlook Study Status**
- **Policy Case Update**
  - Capacity Expansion Baseline Model Update
  - Preliminary Capacity Expansion Scenario Results
- **Next Steps**

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Outlook Study Status

- September – October 2021: Finalize reference case assumptions*
- November - December 2021: Conduct simulations and analysis*
- January, February, March, April 2022 : Conduct Policy case simulations and analysis, issue draft report*
- April-May 2022: Finalize draft report, seek Business Issues Committee and Management Committee review and approval
- July 2022: Seek Board of Directors review and approval

* Collaborate with ESPWG and seek stakeholder input

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Policy Case:
Capacity Expansion

Requests from last ESPWG

- Q: Load forecast posted for 3/24 net or gross? A: Gross load.

Updated “Baseline” Assumptions for Capacity Expansion

- Combine incremental changes as proposed at 3/24/22 ESPWG for ESR capital and fixed O&M costs, DEFR allowable build year, and LCRs for future transmission projects
  - Disable fossil and nuclear capacity builds
  - Allow DEFR capacity builds starting in 2030
  - Increase ESR zonal multipliers to 2021-2025 Demand Curve Reset based values
  - 10% reduction in Zone G-J LCR for AC Transmission projects
  - 650 MW reduction in Zone J & G-J LCR for Clean Path New York HVDC
- Updated version of Assumptions Matrix for Capacity Expansion Model posted here [fill in with link] with today’s meeting materials

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Summary of Preliminary Baseline Assumptions

- CLCPA Case load forecast from 2021 Gold Book, with adjustments to BTM-PV, energy storage, and electrification forecasts
  - BTM-PV is included in the load forecast and is not modeled as a candidate technology eligible for capacity expansion
- CLCPA targets enforced (see next slide for list of modeled constraints)
- UCAP equivalent of IRM and LCR requirements enforced, adjustments for future transmission
- Generation resource investment and operating costs as outlined in the capacity expansion assumptions matrix
  - Capital, fixed O&M and variable O&M costs assumed per 2021 EIA Energy Outlook
  - Fuel and emissions prices consistent with production cost database
  - DEFR capital, fuel, and operating costs informed by recent studies
- Delay start year of new builds of Dispatchable Emission Free Resource (DEFR) technology options
- Max capacity limitations of UPV, LBW, and OSW aligned with 2040 limits per Appendix G: Annex 1: Inputs and Assumptions Climate Action Council draft scoping plan
- Declining capacity value curves for UPV, LBW, OSW, and ESR generators to model declining capacity value of these generators as a function of installed capacity

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Summary of Baseline Assumptions (cont.)

- **Candidate technologies eligible for capacity expansion:**
  - Land based wind
  - Offshore wind
  - Utility PV
  - 4-hour battery storage
  - Dispatchable Emission Free Resource (DEFR)
- **CLCPA targets and other state policy mandates modeled:**
  - 6 GW BTM-PV by 2025
  - 70% renewable energy by 2030
  - 3 GW energy storage by 2030
  - 10 GW BTM-PV by 2030
  - 9 GW offshore wind by 2035
  - 100% CO_2 emission free by 2040

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Policy Case: Capacity Expansion Results

Capacity Expansion Scenarios with Updated Baseline

- **The load forecast scenarios presented at the 3/24/2022 ESPWG have been rerun with the updated baseline assumptions, as outlined on slide 6 of this presentation**
- **Given uncertainty of future policy, technology, and costs, scenarios depicted on the following slides are intended to examine a range of values for a single assumption change**
  - For example, multiple scenarios have been conducted on the load forecast to capture a range of potential future load conditions
  - Additional detail on the forecasted annual energy and peak for these load forecasts are included on the following slide

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Annual Energy & Peak Summaries for Load Forecasts

Annual Energy Forecasts - GWh

Year	Outlook CLCPA Case	Lower Load Case (2021 Gold Book)	Alternate Case (Draft Scoping Plan)
2025	144,704	146,170	150,047
2030	150,909	145,960	164,256
2035	172,566	151,250	204,702
2040	208,679	160,980	235,731

Summer Peak Forecasts - MW

Year	Outlook CLCPA Case	Lower Load Case (2021 Gold Book)	Alternate Case (Draft Scoping Plan)
2025	31,679	31,470	29,612
2030	34,416	31,453	30,070
2035	40,033	32,117	34,402
2040	48,253	32,812	38,332

Winter Peak Forecasts - MW

Year	Outlook CLCPA Case	Lower Load Case (2021 Gold Book)	Alternate Case (Draft Scoping Plan)
2025	26,491	24,065	21,758
2030	31,717	25,252	25,892
2035	41,681	28,347	35,093
2040	57,144	32,668	42,301

*Annual Energy Forecasts for the *Outlook CLCPA Case* and *Lower Load Case* are representative of net load forecast (i.e., inclusive of impacts from Behind-the-Meter solar)

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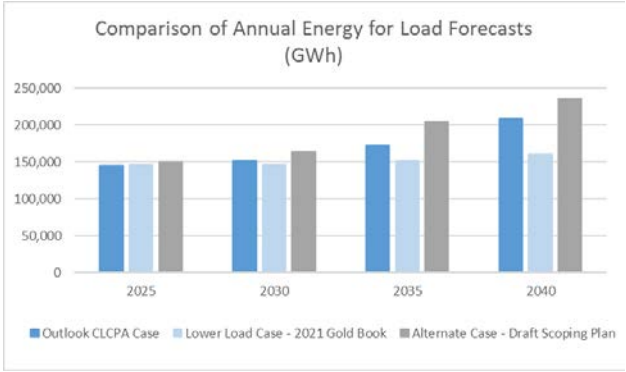
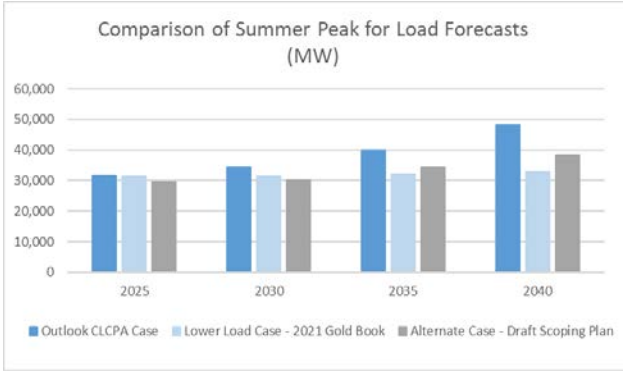
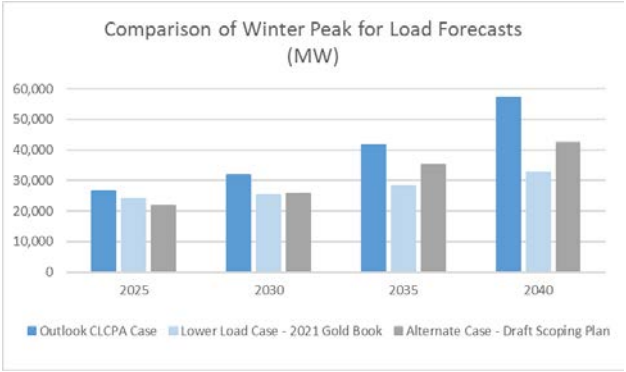
Annual Energy & Peak Summaries for Load Forecasts







*Annual Energy Forecasts for the *Outlook CLCPA Case* and *Lower Load Case* are representative of net load forecast (i.e., inclusive of impacts from Behind-the-Meter solar)

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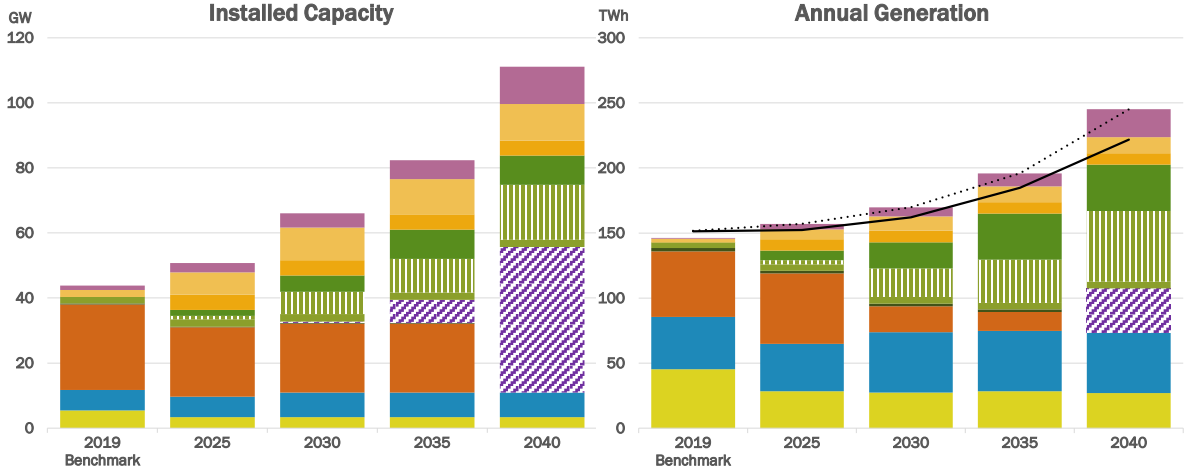
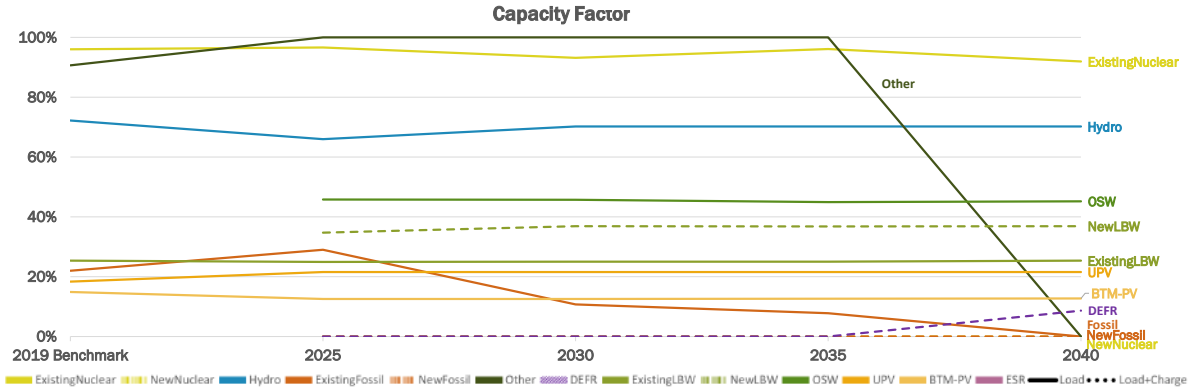
Updated Baseline





Installed Capacity (MW)					
	2019	2025	2030	2035	2040
Nuclear	5,400	3,346	3,364	3,364	3,364
Fossil	26,262	21,310	21,232	21,234	-
DEFR - HcLo	-	-	-	-	3,814
DEFR - McMo	-	-	-	-	-
DEFR - LcHo	-	-	420	7,053	40,937
Hydro	6,331	6,302	7,537	7,540	7,540
LBW	1,985	3,335	9,086	12,612	19,087
OSW	-	1,826	5,036	9,000	9,000
UPV	32	4,676	4,676	4,676	4,676
BTM-PV	2,116	6,834	10,055	10,828	11,198
Storage	1,405	2,910	4,410	5,793	11,448
Total	43,838	50,763	66,460	89,376	111,064

Generation (GWh)					
	2019	2025	2030	2035	2040
Nuclear	45,429	28,338	27,444	28,338	27,092
Fossil	50,520	54,174	19,987	14,516	-
DEFR - HcLo	-	-	-	-	33,504
DEFR - McMo	-	-	-	-	-
DEFR - LcHo	-	-	-	-	516
Hydro	40,034	36,418	46,342	46,392	46,377
LBW	4,416	8,189	26,971	38,297	59,362
OSW	-	7,331	20,186	35,460	35,647
UPV	51	8,817	8,816	8,817	8,819
BTM-PV	2,761	7,483	11,068	11,983	12,454
Storage	612	4,347	7,004	10,084	21,349
Total Generation	146,262	157,088	169,810	195,879	245,120
RE Generation	47,261	68,238	113,383	140,949	162,659
ZE Generation	93,301	100,922	147,831	179,371	245,120
Load	151,386	152,336	162,122	184,836	221,828
Load+Charge	151,773	157,089	169,811	195,879	245,120
% RE [RE/Load]	31%	45%	70%	76%	73%
% ZE [ZE/(Load+Charge)]	61%	64%	87%	92%	100%

Emissions (million tons)					
	2019	2025	2030	2035	2040
CO_2 Emissions	22.24	23.53	8.50	6.22	-

* Storage includes Pumped Storage Hydro and Batteries
* 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)

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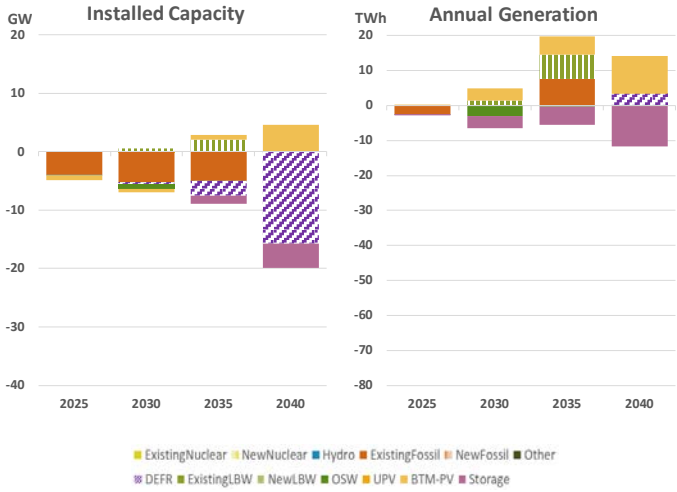
Updated Baseline with Alternate Load Forecast

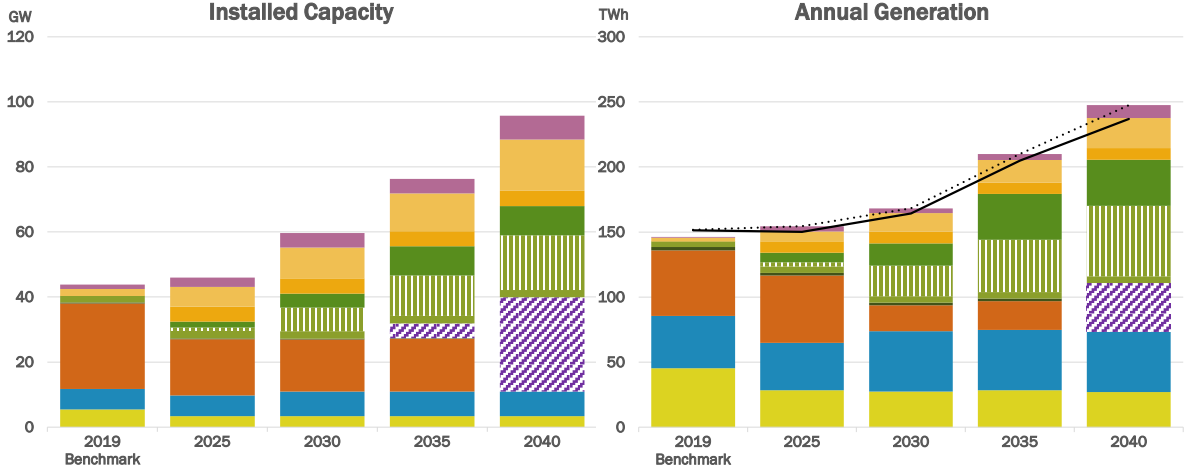
- **Input Assumptions Adjusted:**
  - Load forecast based on Draft Climate Action Council Scoping Plan Analysis Forecast
  - Forecast for BTM based on Draft Climate Action Council Scoping Plan Analysis Forecast
- **Caveats:**
  - Compared to other scenarios that have a single change in assumptions, the change to the load forecast captures many changes (zonal and NYCA wide load levels, BTM forecast, etc.) which impact many facets of the model
- **Observations:**
  - Significantly less DEFRs built by 2040, however, DEFRs have notably higher capacity factor in 2040
  - Higher BTM forecast (capacity and subsequent generation) offsets contributions from ESRs
  - Decreased fossil capacity (*i.e.*, primarily earlier retirements and no new builds) offset by earlier DEFR capacity additions
- **Deltas:**

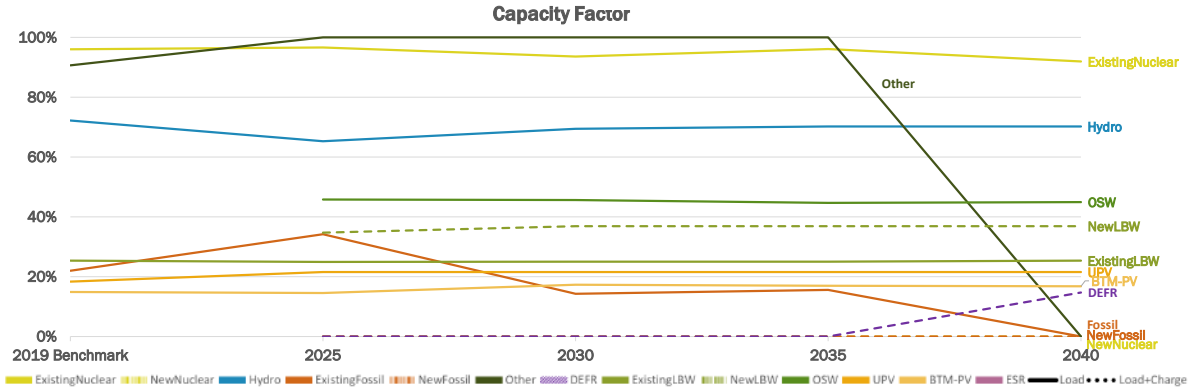


Installed Capacity (MW)	2025	2030	2035	2040
Nuclear	-	(17)	-	-
Fossil	(4,001)	(5,239)	(5,006)	-
Other	(7)	(8)	(7)	-
DEFR	-	(420)	(2,544)	(15,778)
Hydro	69	79	-	-
LBW	-	433	2,098	-
OSW	-	(720)	-	-
UPV	-	-	-	-
BTM-PV	(834)	(532)	773	4,566
Storage	-	-	(1,383)	(4,149)
Total	(4,773)	(6,424)	(6,068)	(15,362)

Generation (GWh)	2025	2030	2035	2040
Nuclear	-	-	-	-
Fossil	(2,356)	1	7,636	-
Other	(58)	(58)	(58)	-
DEFR	-	-	-	3,323
Hydro	-	-	-	14
LBW	-	1,437	6,875	-
OSW	-	(2,938)	(213)	(211)
UPV	-	-	-	-
BTM-PV	148	3,393	5,240	10,766
Storage	(382)	(3,426)	(5,349)	(11,528)
Total Generation	(2,648)	(1,591)	14,131	2,364

Updated Baseline with Alternate Load Forecast





Installed Capacity (MW)					
	2019	2025	2030	2035	2040
Nuclear	5,400	3,346	3,346	3,364	3,364
Fossil	26,262	17,308	15,993	16,228	-
DEFR - HcLo	-	-	-	-	4,251
DEFR - McMo	-	-	-	-	-
DEFR - LcHo	-	-	-	4,509	24,721
Hydro	6,331	6,370	7,616	7,540	7,540
LBW	1,985	3,335	9,519	14,710	19,087
OSW	-	1,826	4,316	9,000	9,000
UPV	32	4,676	4,676	4,676	4,676
BTM-PV	2,116	6,000	9,523	11,601	15,764
Storage	1,405	2,910	4,410	4,410	7,298
Total	43,838	45,989	59,617	80,765	95,702

Generation (GWh)					
	2019	2025	2030	2035	2040
Nuclear	45,429	28,338	27,444	28,338	27,092
Fossil	50,520	51,818	19,989	22,152	-
DEFR - HcLo	-	-	-	-	37,344
DEFR - McMo	-	-	-	-	-
DEFR - LcHo	-	-	-	-	-
Hydro	40,034	36,418	46,342	46,392	46,391
LBW	4,416	8,189	28,408	45,172	59,362
OSW	-	7,331	17,248	35,247	35,436
UPV	51	8,817	8,816	8,817	8,819
BTM-PV	2,761	7,631	14,461	17,223	23,220
Storage	612	3,960	3,573	4,730	9,821
Total Generation	146,262	154,435	168,215	210,005	247,485
RE Generation	47,261	68,386	115,276	152,851	173,228
ZE Generation	93,301	100,683	146,293	185,919	247,485
Load	151,386	150,047	164,255	204,813	236,882
Load+Charge	151,773	154,436	168,215	210,006	247,485
% RE [RE/Load]	31%	46%	70%	75%	73%
% ZE [ZE/(Load+Charge)]	61%	65%	87%	89%	100%

Emissions (million tons)					
	2019	2025	2030	2035	2040
CO_2 Emissions	22.24	22.21	8.26	9.19	-

* Storage includes Pumped Storage Hydro and Batteries
* 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 Captial Low Operating (HcLo)

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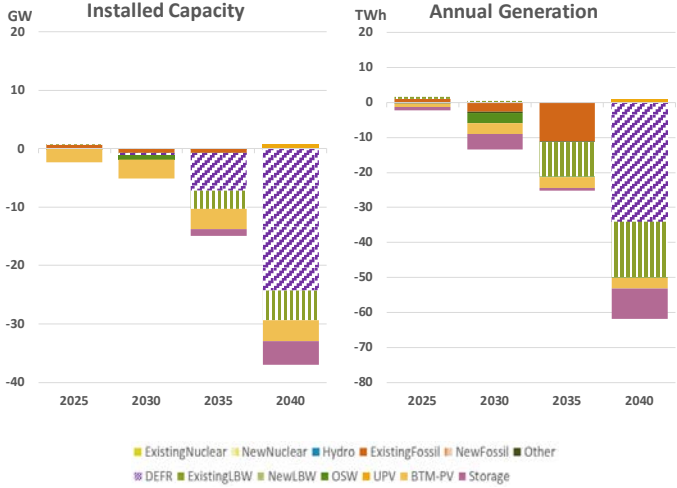
Updated Baseline with Lower Load Forecast

- **Input Assumptions Adjusted:**
  - Load forecast based on 2021 Gold Book (consistent with load forecast used in Base & Contract Cases for 2021 SRO)
  - Forecast for BTM based on 2021 Gold Book (consistent with BTM forecast used in Base & Contract Cases for 2021 SRO); note 6 GW BTM projected by 2030 as compared to 10 GW in "Baseline"
- **Caveats:**
  - Compared to other scenarios that have a single change in assumptions, the change to the load forecast captures many changes (zonal and NYCA wide load levels, BTM forecast, etc.) which impact many facets of the model
- **Observations:**
  - Significantly less DEFRs built by 2040, less LBW and ESR capacity built
  - Zero generation from DEFRs in 2040
  - Lower BTM capacity and generation due to lower forecast
- **Deltas:**



Installed Capacity (MW)	2025	2030	2035	2040
Nuclear	-	(17)	(18)	(18)
Fossil	649	(687)	(689)	-
Other	(27)	(28)	(28)	-
DEFR	-	(420)	(6,405)	(24,290)
Hydro	(13)	2	(0)	(1)
LBW	154	67	(3,129)	(5,008)
OSW	-	(720)	-	-
UPV	-	-	-	824
BTM-PV	(2,254)	(3,261)	(3,473)	(3,575)
Storage	-	-	(1,142)	(4,129)
Total	(1,491)	(5,065)	(14,885)	(36,198)

Generation (GWh)	2025	2030	2035	2040
Nuclear	-	-	-	-
Fossil	1,009	(2,724)	(11,093)	-
Other	(239)	(239)	(239)	-
DEFR	-	-	-	(34,020)
Hydro	(7)	(1)	(0)	13
LBW	505	391	(9,815)	(15,789)
OSW	-	(2,938)	(213)	(211)
UPV	-	-	-	1,073
BTM-PV	(1,048)	(3,057)	(3,013)	(3,079)
Storage	(1,044)	(4,504)	(791)	(8,736)
Total Generation	(824)	(13,072)	(25,164)	(60,749)

Updated Baseline with Lower Load Forecast

Installed Capacity (MW)	2019	2025	2030	2035	2040
Nuclear	5,400	3,346	3,346	3,346	3,346
Fossil	26,262	21,959	20,545	20,545	-
DEFR - HcLo	-	-	-	-	-
DEFR - McMo	-	-	-	-	-
DEFR - LcHo	-	-	-	648	20,461
Hydro	6,331	6,289	7,539	7,539	7,539
LBW	1,985	3,488	9,153	9,483	14,079
OSW	-	1,826	4,316	9,000	9,000
UPV	32	4,676	4,676	4,676	5,500
BTM-PV	2,116	4,580	6,794	7,355	7,623
Storage	1,405	2,910	4,410	4,650	7,318
Total	43,838	49,271	60,976	68,087	74,866

Generation (GWh)	2019	2025	2030	2035	2040
Nuclear	45,429	28,338	27,444	28,338	27,092
Fossil	50,520	55,183	17,263	3,423	-
DEFR - HcLo	-	-	-	-	-
DEFR - McMo	-	-	-	-	-
DEFR - LcHo	-	-	-	-	-
Hydro	40,034	36,410	46,341	46,392	46,391
LBW	4,416	8,694	27,363	28,482	43,572
OSW	-	7,331	17,248	35,247	35,436
UPV	51	8,817	8,816	8,817	9,891
BTM-PV	2,761	6,435	8,011	8,970	9,375
Storage	612	3,288	2,494	9,293	12,622
Total Generation	146,262	156,249	156,732	170,715	184,380
RE Generation	47,261	67,687	107,778	127,908	144,666
ZE Generation	93,301	99,313	137,716	165,538	184,380
Load	151,386	152,605	153,969	160,555	170,469
Load+Charge	151,773	156,250	156,733	170,715	184,380
% RE [RE/Load]	31%	44%	70%	80%	85%
% ZE [ZE/(Load+Charge)]	61%	64%	88%	97%	100%

Emissions (million tons)	2019	2025	2030	2035	2040
CO_2 Emissions	22.24	23.84	7.17	1.39	-

* Storage includes Pumped Storage Hydro and Batteries
* 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)

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Recommendation

- **Proceed with the following cases for production cost modeling:**
  - Case #1 – Baseline
  - Case #2 – Alternate Load Forecast Scenario

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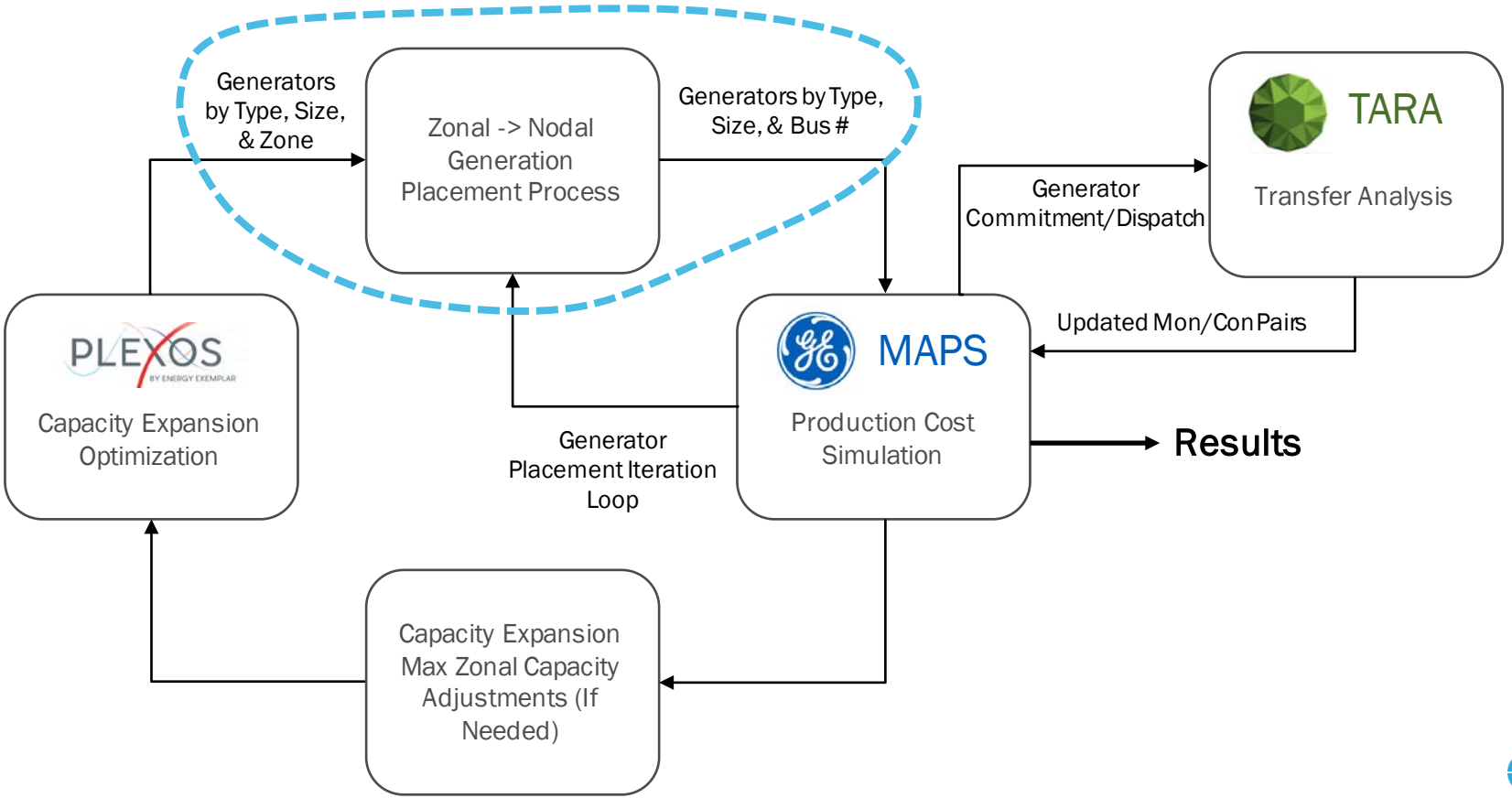
Policy Case:
Zonal to Nodal Generation Placement Process

Policy Case Simulation Framework



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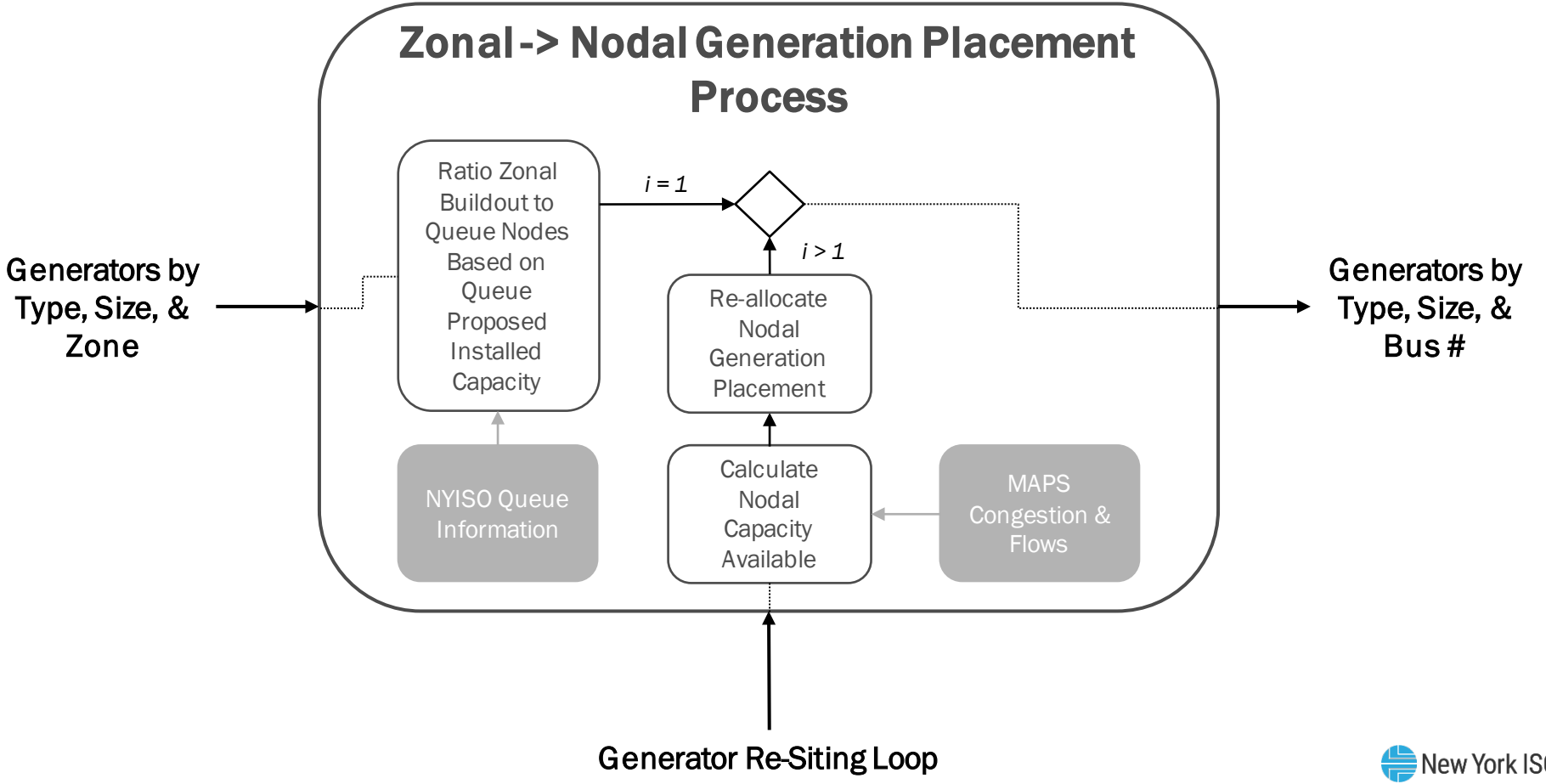
Zonal -> Nodal Generation Placement Process



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Next Steps

Next Steps

- Finalize Contract Case renewable pockets and energy deliverability calculations
- Begin zonal to nodal siting process with Baseline case
- 4/26 ESPWG
  - Contract Case renewable pocket map & metrics
  - Preliminary production cost results from Baseline

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Questions, Feedback, Comments?

- Email additional feedback to: JFrasier@nyiso.com

2021-2040 Outlook Data Catalog

ESPWG/TPAS Presentations

May 20, 2021
- Model Benchmark Results

September 22, 2021
- System & Resource Outlook Update

October 25, 2021
- Capacity Expansion Model Primer
- System & Resource Outlook Update

November 19, 2021
- System & Resource Outlook Update

December 19, 2021
- System & Resource Outlook Update

January 25, 2022
- System & Resource Outlook Update

February 9, 2022
- System & Resource Outlook Update
- Base & Contract Case Results

February 25, 2022
- System & Resource Outlook Update

March 8, 2022
- System & Resource Outlook Update

March 24, 2022
- System & Resource Outlook Update
- Contract Case Congestion Analysis

Final Reports

2022 Release

Data Posted to ESPWG

- Assumptions Matrix v1
- Capacity Expansion Assumptions Matrix v1
- Contract Case Renewable Projects
- Emissions Price Forecast
- Fuel Price Forecast
- Capacity Expansion Assumptions Matrix v2 (Redline)
- Capacity Expansion Assumptions Matrix v3 (Redline)
- Production Cost Assumptions Matrix v2 (Redline)
- Capacity Expansion Assumptions Matrix v4 (Redline)
- Capacity Expansion Assumptions Matrix v5 (Redline)
- Policy Case Hourly Load Forecasts
- Policy Case Zonal Capacity Expansion Preliminary Results

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Appendix

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. Curtailments will be reported as part of the Policy Case production cost model results.
- Ongoing work will continue to refine the methods, assumptions, and reporting in the years to come

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Capacity Expansion Model Caveats

- The capacity expansion model is a projection of the future system mix and not an endorsement of outcomes under any specific set of assumptions. It is intended to inform NYISO studies and stakeholders of potential future generation buildouts under a multitude of scenarios
- 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

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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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Questions?

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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