Draft Appendix: Production Cost Model Benchmark

Overview

The System and Resource Outlook model development process begins with the benchmarking of the latest version of the production cost database. Benchmarking is a process by which historical actual system operation data is utilized as inputs to the production cost model to validate key metrics by adjusting model parameters. This process allows the NYISO to examine and adjust the model according to the benchmark year real-time operations and to ensure model behavior aligns with reality. For the 2025-2044 System & Resource Outlook process, the NYISO selected the 2024 operating year for benchmarking.

Production Cost Model

The production cost model simulates the unit commitment and economic dispatch market software used in actual operations to dispatch generators in the most economically efficient way possible to meet load on an hourly basis. For the 2025-2044 Outlook, the NYISO used PLEXOS as the software to perform this optimization for each hour in 2024 for the benchmarking analysis. The scope of the production cost model consists of modeling the generators, hourly load, and the transmission network for the NYCA, PJM, ISO-NE, IESO, and scheduled flows with Hydro-Québec (HQ).

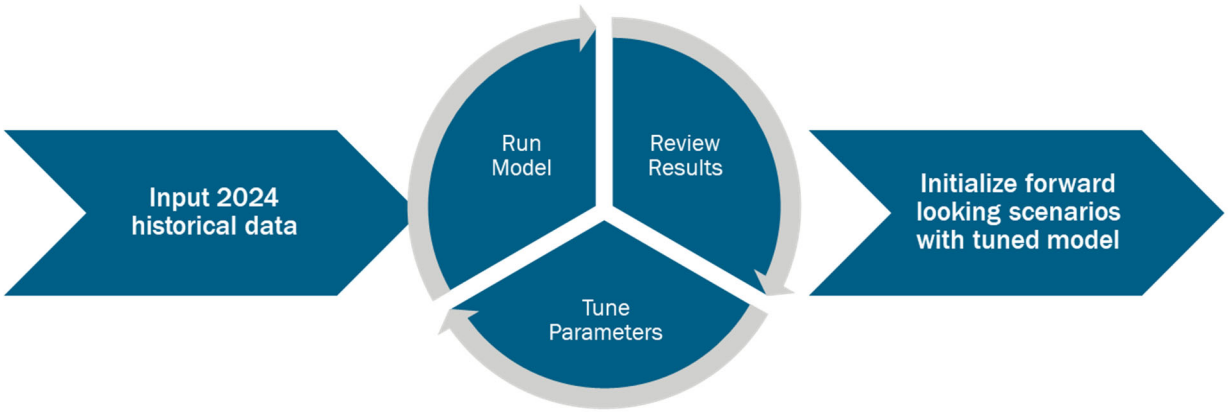
Model Software

[This section will be populated in future versions.]

Model Benchmark Process

The benchmarking process includes gathering actual historical system data as inputs to the production cost model. Multiple iterations of the production cost model simulations were run to converge a specific set of performance metrics to be within acceptable tolerances compared to actual values. These iterative runs include incremental updates to the production cost model database where the inputs are layered into the model to examine the effect of each step change. The iterative runs also include tuning model parameters to improve model output accuracy.

Figure A-1: Benchmark Process Diagram



Inputs

The production cost model utilizes input data from the historical benchmark year (2024), which includes hourly actual net load, fuel prices, emission prices, actual renewable energy output, scheduled tie line flows, and generation facility outages. The NYISO used a mix of public and proprietary sources to update historical loads for the four-pool system (i.e., NYISO, PJM, ISO-NE, and IESO).

The NYISO updated the emissions prices, which include RGGI CO_2, CSAPR Group 3 NO_x and Group 1 SO_2, and Massachusetts CO_2, to reflect historical 2024 prices. For fuel prices, daily natural gas prices were updated using S&P Global hub historic data. The annual uranium price and weekly oil and coal prices were updated using EIA historic data. Derates and outages for generators within the NYCA were included in the model. Hourly generation shapes were updated for renewable generators utilizing actual generation from 2024. Hourly shapes for scheduled flows with HQ and PJM through Neptune were updated based on publicly available data on the NYISO website. Outages for nuclear power plants external to the NYCA were included. The NYISO used year 2024 from the FERC 715 power flow case to represent the NYISO system topology for the benchmark analysis. Individual transmission outages were not included in the network topology due to modeling complexity. Lastly, the Central East interface dynamic limit nomogram was updated by capturing derates and line outages for associated generators, lines, and capacitor banks.

Data	Source
Emissions prices (RGGI CO_2, CSAPR Group 3 NO_x, Group 1 SO_2, MA CO_2)	Historical 2024 prices
Daily natural gas prices	S&P Global hub historic data
Annual uranium price	EIA historical data
Weekly oil and coal prices	EIA historical data
Generator derates and outages within NYCA	Actual historical data
Hourly generation shapes for renewable generators	Actual generation from 2024
Hourly shapes for scheduled flows with HQ and PJM via Neptune	NYISO website (publicly available data)
Outages for nuclear power plants external to NYCA	Actual historical data from Nuclear Regulatory Commision
NYISO system topology for benchmark analysis	FERC 715 power flow case (year 2024)
Central East interface dynamic limit nomogram	Updated to reflect derates due to outages for generators, lines, capacitors

Model Tuning

The NYISO updated the production cost model with the inputs described above in successive runs to test the directional impact of each modeling input. After all inputs were included, the NYISO compared the model metrics to the historical actuals for validation. Several parameters were adjusted to align the model metrics with actual historic values. One of the key parameters utilized for model tuning are hurdle rates. Hurdle rates are costs modeled in the production cost model to simulate the market-to-market friction charges for transactions between two control areas. The hurdle rates utilized for the 2024 benchmark, as well as the 2025-2044 System & Resource Outlook reference cases, are as shown in the figure below.

Figure A-2: Hurdle Rates

Commitment Hurdle Rate	Export (from NYCA)	Import (into NYCA)
PJM	$ 4.00	$ 5.75
Linden VFT	$ 3.50	$ 1.00
Neptune	$ 5.00	$ 6.00
HTP	$ 4.50	$ 6.50
ISONE	$ 0.10	$ 1.00
Cross Sound Cable	$ 0.10	$ 0.50
Northport Norwalk Cable	$ 2.50	$ 2.50
IESO	$ 10.00	$ 0.10

Benchmark Metrics

To benchmark the production cost model, the NYISO chose several metrics to evaluate model performance. The NYISO focuses its benchmarking on the following metrics:

- Generator Annual Generation (GWh)

- Transmission Constraint Congestion (Hours)
- Import/Export Energy (GWh)
- LBMPs ($/MW)

The final benchmark results are listed in Figure A-333 to

Figure A-122 below for the 2024 benchmark year.

Figure A-33: Zonal Load Payment Summary (nominal $M)

2024 Zonal Load Payment	Actual	Benchmark
West	506	450
Genesee	321	282
Central	525	471
North	187	169
Mohawk Valley	271	227
Capital	454	387
Hudson Valley	368	306
Millwood	114	92
Dunwoodie	230	187
New York City	2,069	1,636
Long Island	924	810
NYCA	5,968	5,016

Figure A-4: Zonal Generator Payment Summary (nominal $M)

2024 Zonal Generation Payment	Actual	Benchmark
West	545	521
Genesee	154	154
Central	1,035	899
North	284	294
Mohawk Valley	119	120
Capital	544	461
Hudson Valley	414	297
Millwood	15	14
Dunwoodie	0	0
New York City	1,153	909
Long Island	477	392
NYCA	4,740	4,062

Figure A-5: Zonal Demand Congestion Summary (nominal $M)

2024 Zonal Demand Congestion	SCUC	Benchmark
West	3	1
Genesee	2	2
Central	7	28
North	4	0
Mohawk Valley	4	6
Capital	39	28
Hudson Valley	19	11
Millwood	9	4
Dunwoodie	15	8
New York City	164	128
Long Island	180	108
NYCA	446	324

Figure A-6: Top Transmission Constraint Congestion Summary (nominal $M)

2024 Top 10 Demand Congestion Constraints	SCUC	Benchmark
CENTRAL EAST	228	141
DUNWOODIE TO LONG ISLAND	63	29
DUNWOODIE MOTTHAVEN	30	3
ELWOOD PULASKI 69kV	25	23
GORDON RD ROTTERDAM 230kV	24	27
GREENWOOD 138kV	16	16
PILGRIM 138kV	12	29
E179THST HELLGT ASTORIA 138kV	9	0
SHOEMAKER RAMAPO 138kV	8	13
CARLPLCE EGRDNCITY 138kV	8	7

Figure A-7: Zonal LBMP Summary ($/MWh)

2024 Zonal Average LBMP	Actual	Benchmark
West	31.67	29.10
Genesee	32.31	30.05
Central	33.63	32.04
North	32.64	29.73
Mohawk Valley	34.85	31.52
Capital	36.74	33.63
Hudson Valley	36.39	32.78
Millwood	37.57	33.08
Dunwoodie	37.52	32.58
New York City	39.44	32.82
Long Island	42.16	40.74

Figure A-8: Zonal Generation Summary (GWh)

2024 Zonal Generation	Actual	Benchmark
West	16,962	17,565
Genesee	4,874	5,278
Central	31,226	33,571
North	9,039	9,937
Mohawk Valley	3,747	3,984
Capital	14,480	14,664
Hudson Valley	10,895	10,032
Millwood	398	458
Dunwoodie	0	0
New York City	27,437	27,061
Long Island	10,181	9,882
NYCA	129,238	132,431

Figure A-9: Zonal Load Summary (GWh)

2024 Zonal Load	Actual	Benchmark
West	15,417	15,479
Genesee	9,350	9,368
Central	14,643	14,711
North	5,659	5,696
Mohawk Valley	7,194	7,212
Capital	11,402	11,494
Hudson Valley	9,286	9,321
Millwood	2,764	2,772
Dunwoodie	5,723	5,739
New York City	49,703	49,838
Long Island	19,801	19,872
NYCA	150,942	151,500

Figure A-10: Import Summary (GWh)

2024 Import Energy	Actual	Benchmark
PJM-NYISO	8,794	8,470
LINDEN VFT	2,521	2,663
NEPTUNE	5,412	5,544
HTP	3,376	3,509
ISONE-NYISO	602	934
CROSS SOUND CABLE	1,554	1,644
NORTHPORT NORWALKCABLE	339	178
IMO-NYISO	6,351	4,698
HQ-NYISO CHAT	1,407	1,407
HQ-NYISO CEDARS	225	225
TOTAL IMPORT	30,581	29,273

Figure A-11: Export Summary (GWh)

2024 Export Energy	Actual	Benchmark
PJM-NYISO	52	55
LINDEN VFT	0	14
NEPTUNE	0	0
HTP	0	0
ISONE-NYISO	6,467	6,410
CROSS SOUND CABLE	0	0
NORTHPORT NORWALKCABLE	262	125
IMO-NYISO	84	211
HQ-NYISO CHAT	2,955	2,955
HQ-NYISO CEDARS	45	45
TOTAL EXPORT	9,866	9,815

Figure A-12: Net Import Summary (GWh)

2024 Net Import Energy	Actual	Benchmark
PJM-NYISO	8,636	8,416
LINDEN VFT	2,521	2,648
NEPTUNE	5,412	5,544
HTP	3,376	3,509
ISONE-NYISO	-5,865	-5,476
CROSS SOUND CABLE	1,554	1,644
NORTHPORT NORWALKCABLE	77	53
IMO-NYISO	6,267	4,487
HQ-NYISO CHAT	-1,549	-1,549
HQ-NYISO CEDARS	179	179
TOTAL NET IMPORT	20,609	19,457

The benchmark results highlight a reasonable representation of zonal load and generation, imports, and exports. The modeled zonal LBMPs, load payments, and generator payments were slightly lower than historical values. There are several factors that contribute to the lower than historical values. For instance, not all transmission outages, generator outages, and generator derates from 2024 can be included in the model due to modeling complexity and software limitations. This leads to the optimization committing and dispatching the cheapest generators; however, in real-time operations, those generators and/or transmission lines may not have been available.

Additionally, the production cost model attempts to mimic day-ahead commitments and real-time dispatch in the four-pool system, but out-of-market commitments and operator actions in real time are not captured by the model. These differences are a result of utilizing a mathematical model to approximate real system conditions.

Summary

The benchmarking analysis found that the production cost model outputs are close to historical annual outputs for generation, load, LBMPs, generator payments, load payments, zonal demand congestion, and import/export flows. While differences remain in the model outputs compared to actual historical values, the differences can mostly be attributed to modeling limitations and real-time operations of the actual markets.

The NYISO further updated the production cost model from the benchmarking analysis to reflect future system conditions. Such updates incorporate forecasts for, among other things, load,

fuel prices, emission prices, future transmission, and generation buildout to be utilized in the 2025-2044 System and Resource Outlook reference cases.

[Conversion of benchmark assumptions to forecasts and assumptions for forward looking simulations]

[This section will be populated in future versions.]