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Independent System Operator

2023-2042 System & Resource Outlook Update

Sarah Carkner & Nischal Rajbhandari

Long Term Assessments

Electric System Planning Working Group (ESPWG)

Tuesday, October 24, 2023

Agenda

- Scope & Schedule Review
- Draft Assumptions Matrices
- Reference Case Assumptions Update
- Next Steps
- Questions, Comments, & Feedback
- Outlook Data Catalog
- Appendix

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Scope & Schedule Review

System & Resource Outlook Scope

Model Development

- Benchmark
- Assumptions
- Reference Cases
- Sensitivities

Congestion Assessment

- Historic & Future Transmission Congestion
- Congestion Relief Analysis

Analyses

- Resources to Meet Policy Objectives
- Renewable Pockets & Energy Deliverability
- Renewable Generation Profiles
- Future Resource Attributes

Report, Appendix, Data Catalog, & Fact Sheet

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Preliminary Targeted Study Schedule

2023 Q3	Month	July					August				September			
	Week	1	2	3	4	5	1	2	3	4	1	2	3	4
	Benchmarking	X	X	X										
	Assumptions Development	X	X	X	X	X	X	X	X	X	X	X	X	X
	CapEx Model Development	X	X	X	X	X	X	X	X	X	X	X	X	X
	Production Cost Model Development	X	X	X	X	X	X	X	X	X	X	X	X	X
	CapEx Results													
	Production Cost Results													
	Analyses													
	Report													

2023 Q4	Month	October					November				December			
	Week	1	2	3	4	5	1	2	3	4	1	2	3	4
	Benchmarking													
	Assumptions Development	X	X	X	X	X	X	X	X	X				
	CapEx Model Development	X	X	X	X	X	X	X	X	X				
	Production Cost Model Development	X	X	X	X	X	X	X	X	X	X	X	X	X
	CapEx Results										X	X	X	X
	Production Cost Results													
	Analyses													
	Report													

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Draft Assumptions Matrices

Draft Assumptions Matrices

- Also posted with this ESPWG meeting material are the following documents:
  - Production Cost Assumptions Matrix – Draft (10/24/2023)
  - Capacity Expansion Assumptions Matrix – Draft (10/24/2023)
- Base Case assumptions locked down: 10/15/2023
- Contract & Policy Case assumptions lock down date: 10/30/2023

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Base Case Assumptions Update: Lockdown 10/15/23

Single Weather Year Alignment

- **Driven by an increasing proportion of weather dependent resources, modeling correlated profiles is important to capture relationships between generation and load in future year modeling studies**
- **Prior economic planning studies assumed:**
  - 2002 actual weather year to represent load profiles in all the 4 pools
  - Historical actual production profiles from existing generators or NREL for land based and offshore wind (2009) and utility solar (2006) profiles
- **New to this 2023-2042 Outlook**
  - Load profiles use a 2018 actual weather year to represent hourly loads profiles in all the 4 pools
  - DNV database contains 20+ years of hourly LBW, UPV, and OSW data. Renewable generation shapes are represented by 2018 hourly profiles from these databases.

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Emissions Allowance Price Forecast

- **Forecast values proposed in September have been finalized**
  - September ESPWG presentation (slides 17-19): Link
- **Emissions allowance price forecasts from 2021-2040 Outlook**
  - Methodology (slides 19-22): Link
  - Final Forecast Values: Link

	2023-2042 System and Resource Outlook Emission Allowance Price Forecast ($Nominal/ton)						
	SO_2	Annual NO_X	Ozone Season NO_X Group 2	Ozone Season NO_X Group 3	Ontario CO_2	RGGI CO_2	Mass CO_2
2023	$ 2	$ 3	$ 900	$ 3,600	$ 47	$ 14	$ 8
2024	$ 2	$ 3	$ 925	$ 3,600	$ 58	$ 14	$ 8
2025	$ 2	$ 3	$ 950	$ 3,600	$ 69	$ 15	$ 9
2026	$ 2	$ 3	$ 975	$ 3,600	$ 80	$ 15	$ 9
2027	$ 2	$ 3	$ 1,000	$ 3,600	$ 91	$ 16	$ 9
2028	$ 2	$ 3	$ 1,025	$ 3,600	$ 102	$ 17	$ 10
2029	$ 2	$ 3	$ 1,050	$ 3,600	$ 112	$ 18	$ 10
2030	$ 2	$ 3	$ 1,075	$ 3,500	$ 123	$ 19	$ 10
2031	$ 2	$ 3	$ 1,100	$ 3,500	$ 123	$ 20	$ 11
2032	$ 2	$ 3	$ 1,125	$ 3,500	$ 123	$ 22	$ 11
2033	$ 2	$ 3	$ 1,150	$ 3,500	$ 123	$ 23	$ 11
2034	$ 2	$ 3	$ 1,175	$ 3,400	$ 123	$ 25	$ 12
2035	$ 2	$ 3	$ 1,200	$ 3,400	$ 123	$ 27	$ 12
2036	$ 2	$ 3	$ 1,225	$ 3,300	$ 123	$ 29	$ 12
2037	$ 2	$ 3	$ 1,250	$ 3,300	$ 123	$ 31	$ 12
2038	$ 2	$ 3	$ 1,275	$ 3,200	$ 123	$ 33	$ 13
2039	$ 2	$ 3	$ 1,300	$ 3,100	$ 123	$ 36	$ 13
2040	$ 2	$ 3	$ 1,325	$ 3,000	$ 123	$ 39	$ 13
2041	$ 2	$ 3	$ 1,350	$ 3,000	$ 123	$ 42	$ 13
2042	$ 2	$ 3	$ 1,375	$ 2,900	$ 123	$ 45	$ 14

Hydro Resources Modeling

- All NYCA hydro resources, except Niagara, in the production cost model switched to hourly modifiers utilizing 2018 historical year for hourly shapes
- Hourly modifiers have fixed dispatch schedule to mimic minimal to no pondage capability for hydro resources in NY
- Hydro generation targets are based on 15-year historic averages of annual generation as reported in EIA 923
- Hydro resource modeling assumptions will carry forward to the Contract and Policy Cases (including capacity expansion model)

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Interface Limits

- Leverage 2020 ATR as primary source for interface limit definitions for internal New York interfaces
- Changes to interface limits due to specific transmission projects captured as incremental changes to ATR limits

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Contract Case Assumptions Update: Lockdown 10/30/23

Contract Case Assumptions

- Load, fuel price, and emission allowance price assumptions will be the same as the Base Case forecasts
- Renewable generation resource additions will be based on the current NYSERDA Renewable Energy Certificate (REC) contracts database as of the lockdown date. Incremental additions will consider resources already included in the Base Case due to the inclusion rules
- Inclusion of approved Phase 1 and 2 transmission projects approved in February 2023 PSC Order including the Brooklyn Clean Energy Hub

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Contract Case Additional Generation

- Referenced NYSERDA LSR Database
- Renewable generators filtered from the complete NYSERDA LSR database to represent all awarded resources with “operational” and “under development” status, some of which are included in the base case
  - Include generators that meet the blue filter criteria

Filter Criteria

Step 1	Step 2	Step 3	Step 4
Project Status	Eligibility	Renewable Technology	New Renewable Capacity (MW)
Operational	Tier 1	Offshore Wind	>= 10
Under Development	Non-Tier 1	Hydroelectric	< 10
Cancelled	OREC	Land Based Wind	
Completed	Tier 2	Solar	
	Maintenance	Biogas - ADG	
	Tier 4	Biogas - LFG	
		Biomass	
		Maintenance Biomass	
		Fuel Cell	
		Maintenance Hydroelectric	

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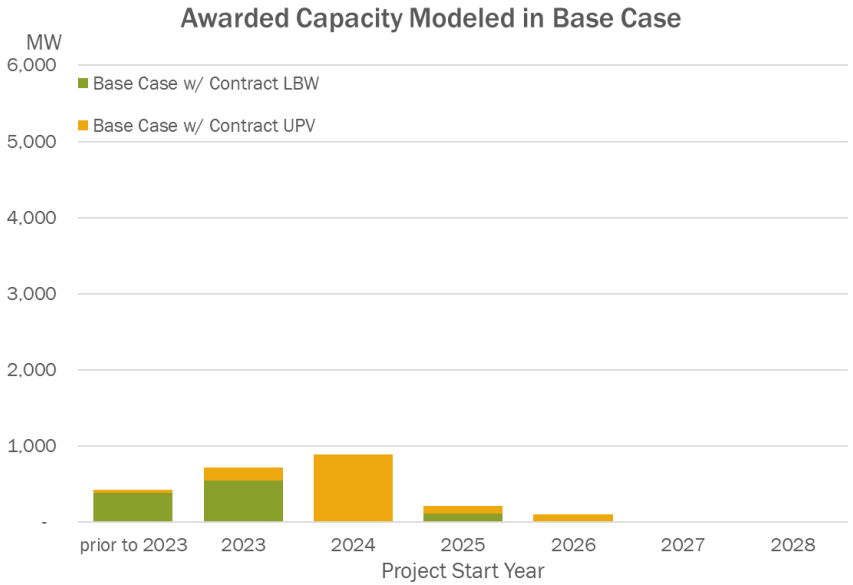
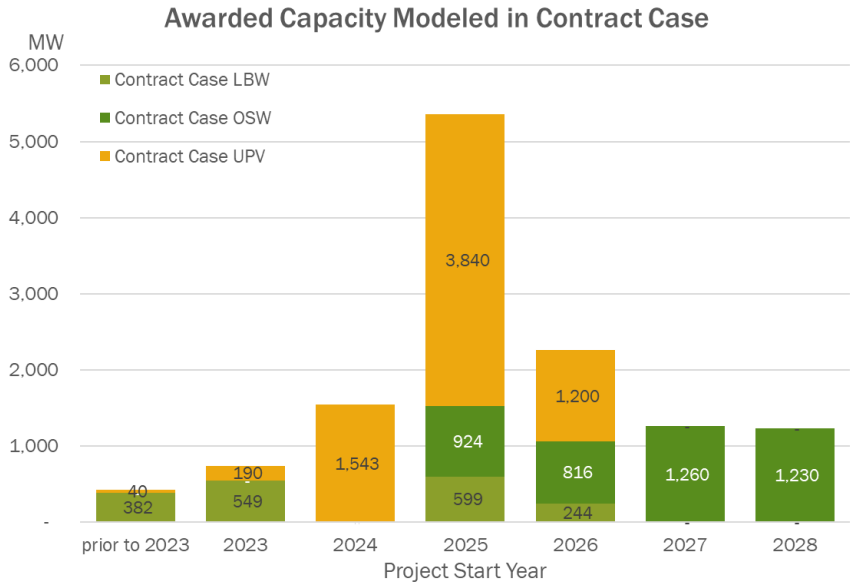
Summary of Contract Case Capacity Additions

- Figures show capacity added to the Base Case generation resources, which also have existing NYSERDA awards and meet filter criteria





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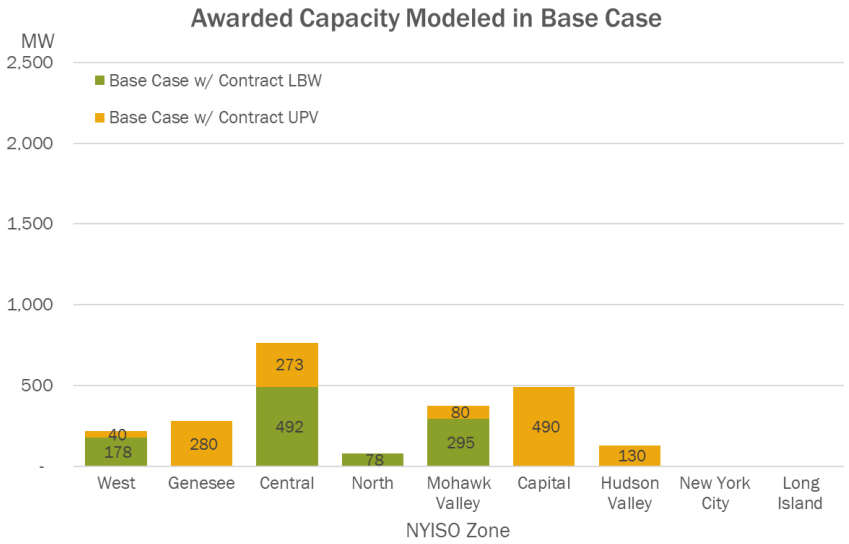

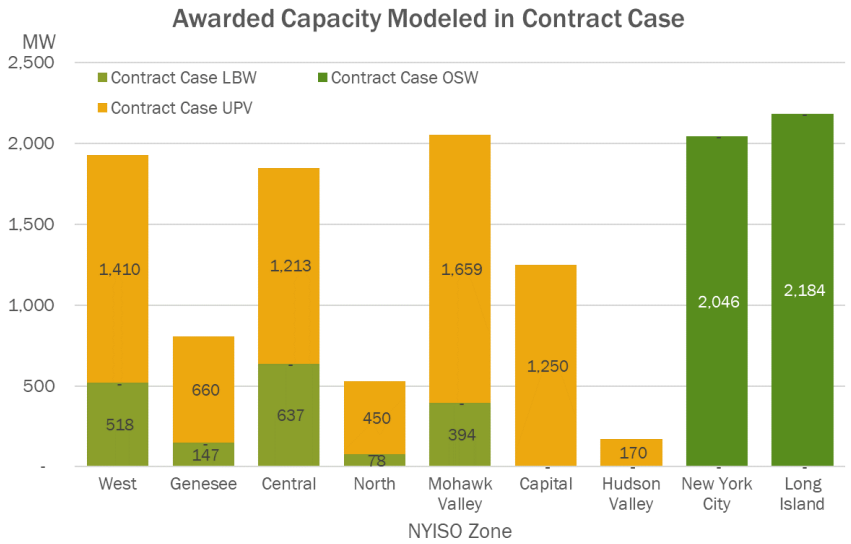

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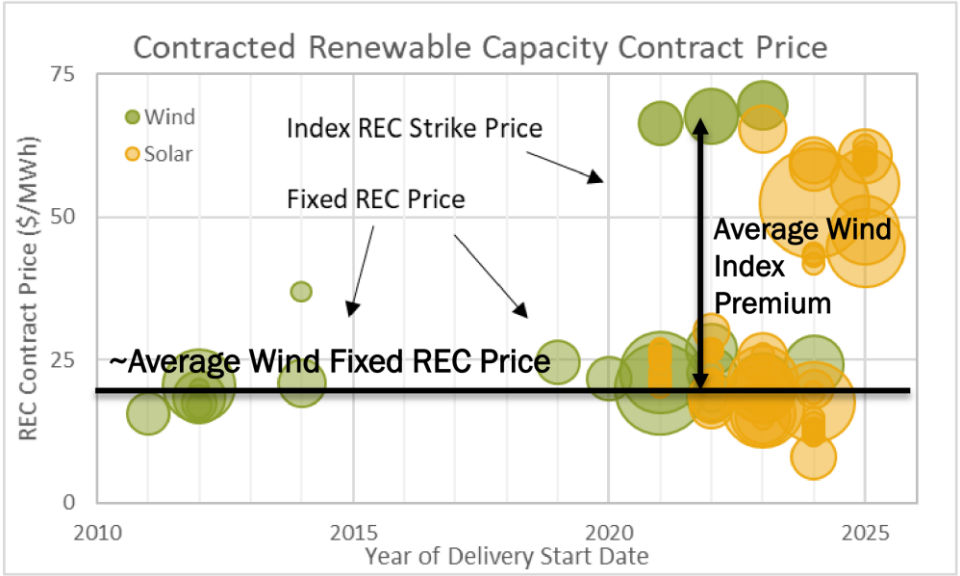
REC Contract Prices and Modeling Framework

- REC contract prices to be included as negative bid adder in the Contract and Policy Cases to represent impact of out of market payments
- Aggregate premium of Index REC Strike price to Fixed RECs would be used to adjust negative bid adder for Index RECs
  - Link to methodology (Slides 15-16)
  - Premiums by technology type calculated in 2021-2040 Outlook will be used in this Outlook

Chart from 2021-2040 Outlook



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Policy Case Assumptions Update: Lockdown 10/30/23

Policy Case

- **Policy Case will include incremental changes to the Contract Case, including additional assumptions specific to achievement of policy objectives**
  - More detailed information on these assumptions is included in the assumption matrix posted with today's meeting materials
- **Model development for capacity expansion and production cost models in the Policy Case is ongoing**
  - Detail on the capacity expansion model is included in today's meeting materials
  - Additional detail on the production cost model for the Policy Case will be provided at future ESPWG meetings
- **Three scenarios will be modeled in the Policy Case for the 2023-2042 Outlook**
  - Lower Demand Policy Scenario
  - Higher Demand Policy Scenario
  - State Scenario

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Policy Case: Load Forecast Summary

Lower Demand

Year	NYCA Annual Energy (GWh)	NYCA Summer Peak (MW)	NYCA Winter Peak (MW)
2025	151,339	32,279	24,651
2030	153,043	30,490	29,624
2035	172,946	31,557	38,297
2040	199,498	32,918	47,493
2042	207,998	33,601	49,967

Higher Demand

Year	NYCA Annual Energy (GWh)	NYCA Summer Peak (MW)	NYCA Winter Peak (MW)
2025	152,792	33,100	24,943
2030	159,820	33,495	31,467
2035	189,794	36,589	43,338
2040	228,579	40,939	57,015
2042	242,112	42,621	61,346

State Scenario

Year	NYCA Annual Energy (GWh)	NYCA Summer Peak (MW)	NYCA Winter Peak (MW)
2025	150,133	29,568	21,833
2030	161,858	29,861	26,999
2035	198,833	34,033	37,047
2040	228,107	37,915	45,062
2042	236,937	39,167	47,046

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Policy Targets Assumed

Policy Target	Lower Demand Policy Scenario	Higher Demand Policy Scenario	State Scenario
BTM-PV capacity	6 GW by 2025 10 GW by 2030		
Energy storage capacity	1.5 GW by 2025		
	3 GW by 2030		6 GW by 2030
"70x30"	70% renewable energy by 2030		70% renewable energy by 2030; consistent with Integration Analysis, CHPE is incremental to 70x30 while generation associated with CPNY count towards 70x30
Offshore wind capacity	9 GW by 2035		
"100x40"	Zero carbon electricity by 2040		Zero carbon electricity by 2040; net zero imports overall from IESO, PJM, and ISO-NE

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Capacity Expansion Enhancements

- Based on “lessons learned” discussions with stakeholders and the MMU review of the 2021-2040 Outlook, recommended enhancements to the capacity expansion model are undergoing review, testing, and evaluation
- Ongoing assessment of proposed enhancements to the capacity expansion model for use in the Policy Case, include:
  - Updated marginal ELCC curves
  - Time representation methodology
  - Addition of external pools
  - Addition of generation supply curves for renewable technologies

**Topics in blue will be discussed in further detail on the following slides*

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Capacity Expansion Enhancements: Marginal ELCC Curves

- Marginal ELCC curves - evaluation of declining capacity value curves
- Details on the methodologies used in the prior study are included in section E.3.1 of 2021-2040 Outlook Appendix E
- For the 2023-2042 Outlook, recommend:
  - Calculating marginal ELCC curves for resource types based on updated information in the 2023-2042 Outlook database consistent with the methodology used in the Grid In Evolution Study for "Lower Demand" and "Higher Demand" Policy Scenarios, and
  - Implementing marginal ELCC curves calculated in the Integration Analysis for resource types in the "State Scenario"

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Capacity Expansion Enhancements: Marginal ELCC Curves Proposal

- **For all Policy Case scenarios, marginal ELCC curves will be assumed for LBW, OSW, UPV, and ESR resources**
  - Updated regional ELCC curves for LBW, OSW, UPV, and storage would be based on factors such as hourly input load forecast and resource contribution (by technology type) to quantify the capacity value for that resource type at varying levels of installed capacity
  - This method will base the marginal ELCC values on the load levels and capacity mix specific to each scenario for 2030 model year
- **Marginal ELCC curves will be applied on a NYCA wide and Locality specific basis, as applicable to the resource**
  - "Lower Demand Policy" and "Higher Demand Policy" Scenarios will assume unique curves for summer/winter seasons
  - "State Scenario" will assume annual curves, consistent with the Integration Analysis

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Capacity Expansion Enhancements: Time Representation

- Time representation methodology - framework for the time representation in the capacity expansion model
- Details on the methodologies used in the prior study are included in section E.3.1 of 2021-2040 Outlook Appendix E
- For the 2023-2042 Outlook, recommend a framework with representative days for each year and preserves chronology within each representative day
  - Representative days will be applied and weighted across each model year to most accurately match the input generation and peak totals for that year
  - Representative days will be solved individually and chronologically over all the model years
  - This method preserves the chronology, including the state-of-charge (SoC) of energy storage resources, within each day

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Time Representation Research and Development

- In the "Grid in Transition" study conducted for the NYISO, the Brattle group also used representative days and weighted them over each year
  - Selected peak and near peak of each season, and filled remaining days with the best fit of other selected "general" days
- EPRI's US-REGEN model uses groupings on a plot of energy, wind capacity factor, and solar capacity factor to select representative hours for each region
  - Priority given to representing "extreme" hours, e.g., highest load & lowest wind and solar
- There are several accepted methods to create groups for representative days:
  - Above/Below a statistic, such as the mean or median
  - K-means/K-medioids Clustering
  - Spectral Clustering
  - Hierarchical Clustering

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Capacity Expansion Enhancements: Time Representation Proposal

- For the 2023-2042 Outlook, propose to model each year with 13 representative days to represent a year's variety of conditions
- For each model year, base representative days on load, wind (OSW and LBW), and solar values
- Seek to preserve annual energy total, seasonal peaks, and variable performance of renewable resources
- Each year will include the following representative days (totaling 13 per year):
  - Peak summer day (weighted 1x)
  - Peak winter day (weighted 1x)
  - Near peak summer day (weighted 5x)
  - Near peak winter day (weighted 5x)
  - Moderate day (weighted based on clustering)
  - 8 groups to represent each combination of high/low energy, wind, and solar

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DEFR Overview

- The selection of specific DEFRs is a key assumption driving the resulting system cost and operation
- The “Lower Demand Policy” and “Higher Demand Policy” Scenarios will assume multiple DEFR options as candidates for generation expansion to represent proxy generators
- The “State Scenario” will assume retrofit (new and existing units) hydrogen combustion turbine technology to fit the need of dispatchable emission-free resource

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Sample DEFR Technology Attributes

		2023 NYCA Summer Capacity (MW)	Energy Attributes						Other Reliability Attributes			
			Carbon Free[47]	Dependable Fuel Source	Energy Limited	Dispatchable	Quick start	Flexible	Multi start	Inertial Response	Dynamic Reactive control	High Short Circuit current
Sample Technology	Fossil	25,667	No	Yes[48]	No	Yes	Yes[49]	Yes	Yes	Yes	Yes	Yes
	Hydro	4,265	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Pumped Hydro	1,407	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Hydrogen Fuel Cell	0	Yes	Yes[50]	No	Yes	Yes	Yes	Yes	No	Yes	No
	Hydrogen Combustion	0	Yes	Yes[60]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Nuclear	3,305	Yes	Yes	No	No	No	No	No	Yes	Yes	Yes
	Modular Nuclear	0	Yes	Yes	No	No	No	Yes	No	Yes	Yes	Yes
	Battery	0	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No
	Solar	154	Yes	No	Yes	No[51]	Yes	Yes	Yes	No	Yes	No
	Wind	2,051	Yes	No	Yes	No[50]	Yes	Yes	Yes	No	Yes	No
	Demand Response[52]	1,234	Yes[53]	Yes	Yes	No	No	Yes	No	No	No	No
	Synchronous Condenser[54]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Yes	Yes	Yes	Yes

From draft 2023-2032 Comprehensive Reliability Plan

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DEFR Proposal

- Cost data from other studies is limited, assumption based, highly uncertain, and difficult to compare across studies
- The following slides include information on generator capital, variable O&M, and fixed O&M costs for a variety of generators from various sources for reference
  - Additional detail on the generator types and sources are outlined on the following slides
- The capacity expansion model will select among the proxy generators based on optimal cost and performance. This will inform relative value of energy and capacity in future systems

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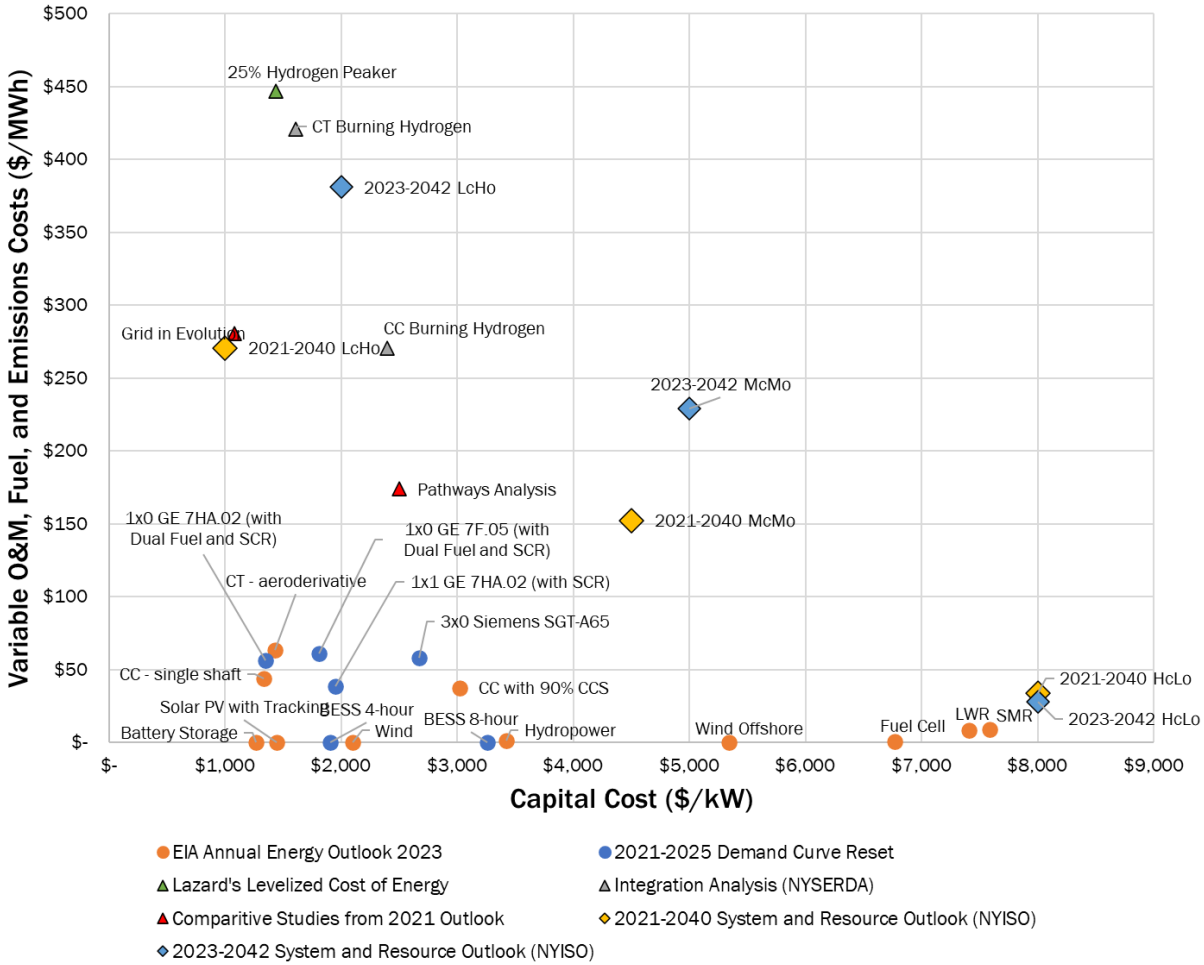
Generator Capital Cost vs. Variable O&M, Fuel, and Emissions Costs



- Orange dots represent the assumed variable O&M and capital costs of assumed national average generation from EIA Energy Outlook
- Blue dots represent the assumed variable O&M and capital costs from the 2021-2025 Demand Curve Reset study
- Green, red, and grey triangles represent the assumed variable O&M and capital costs from other studies focused on potential emission-free technologies
- Candidate DEFRs shown in blue diamonds represent the proposed range of operating and capital costs

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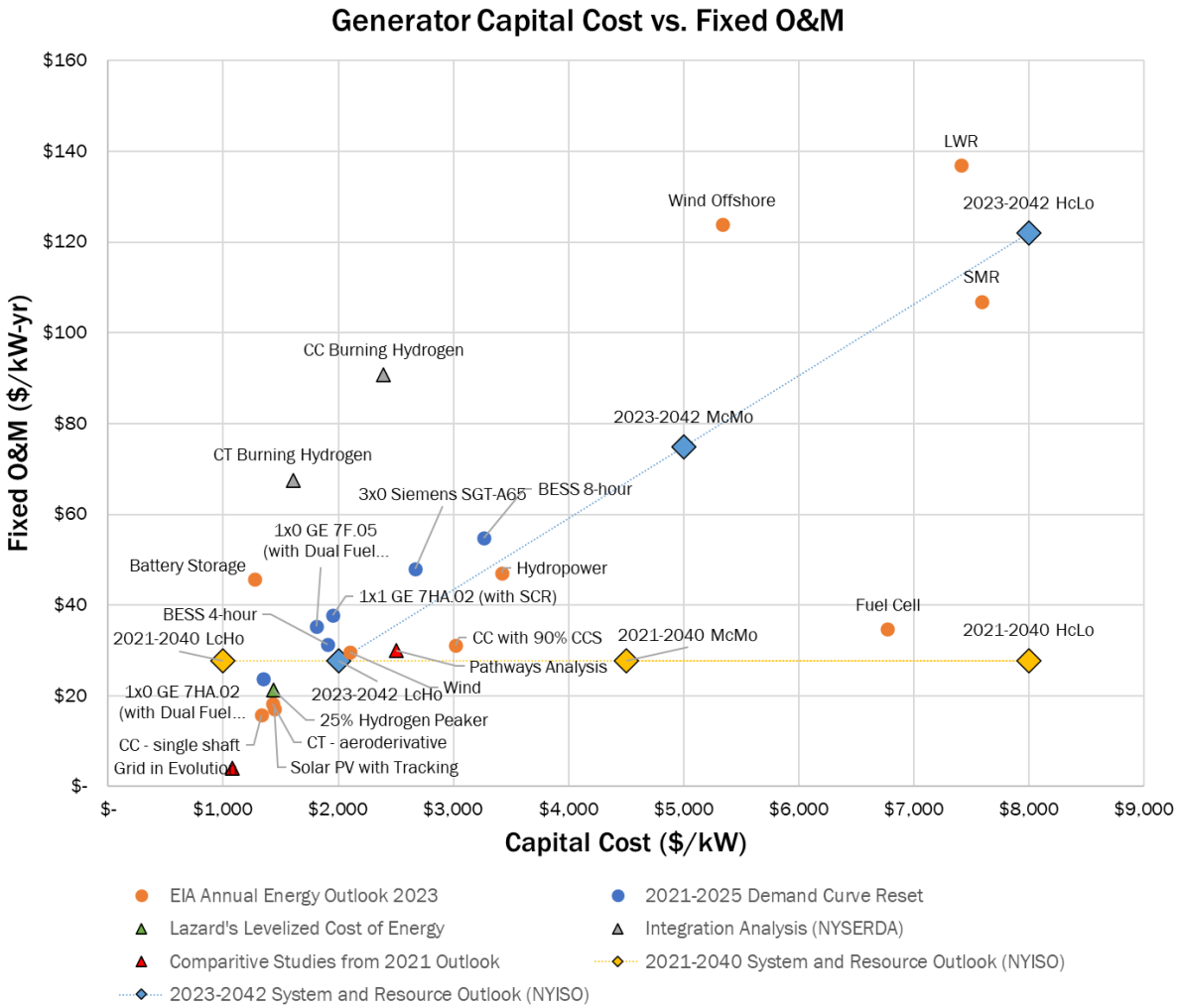

- Orange dots represent the assumed fixed O&M and capital costs of assumed national average generation from EIA Energy Outlook
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- Candidate DEFRs shown in blue diamonds represent the proposed range of operating and capital costs

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References

- EIA Annual Energy Outlook 2023
- 2021-2025 Demand Curve Reset study
- Lazard's Levelized Cost of Energy
- Integration Analysis
- Pathways to Deep Decarbonization in New York State (Pathways Analysis)
- New York's Evolution to a Zero Emission Power System (Grid In Evolution)
- 2021-2040 System & Resource Outlook

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Next Steps

Next Steps

- **Continue assumptions development**
  - Contract and Policy Case lockdown date: 10/30/2023
- **Continue model development of production cost and capacity expansion models**
- **Upcoming Stakeholder Presentations**
  - November 2nd, 2023 TPAS/ESPWG
  - November 21st, 2023 ESPWG

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Questions, Comments, & Feedback?

Email additional feedback to:
SCarkner@nyiso.com
one week prior the next ESPWG

2023-2042 System & Resource Outlook Data Catalog

Report

Report Placeholder

Study Summary

Summary Placeholder

Stakeholder Presentations

November 18, 2022
- 2021 Outlook Lessons Learned
- NYSERDA Outlook Suggestions

June 16, 2023
- 2023-2042 Outlook Kickoff

July 17, 2023
- 2023-2042 Outlook Benchmark
- 2023-2042 Outlook Update

August 22, 2023
- 2023-2042 Outlook Preliminary Reference Case Assumptions

September 21, 2023
- 2023-2042 Outlook Reference Case Assumptions Update

Report Appendices

Production Cost Model Benchmark Draft

Data Documents

2021-2040 System & Resource Outlook Data Catalog

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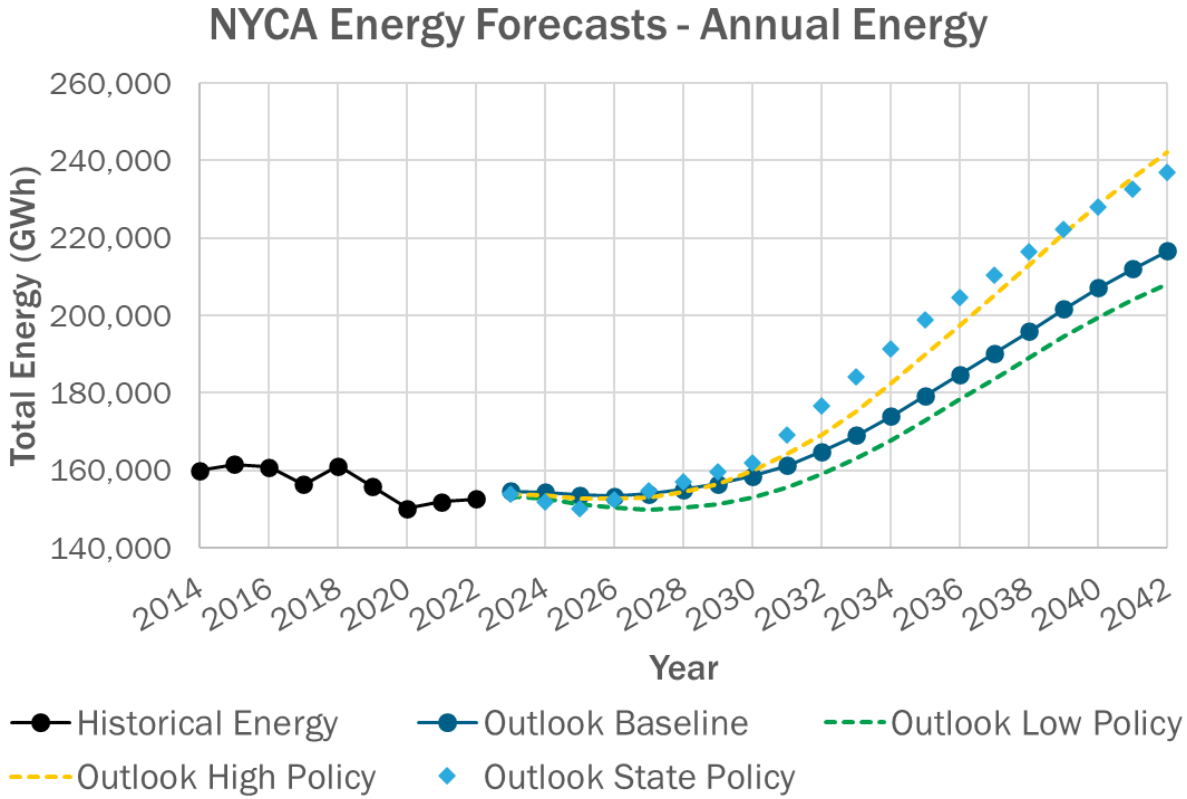
Appendix

Baseline and Policy Load Forecasts



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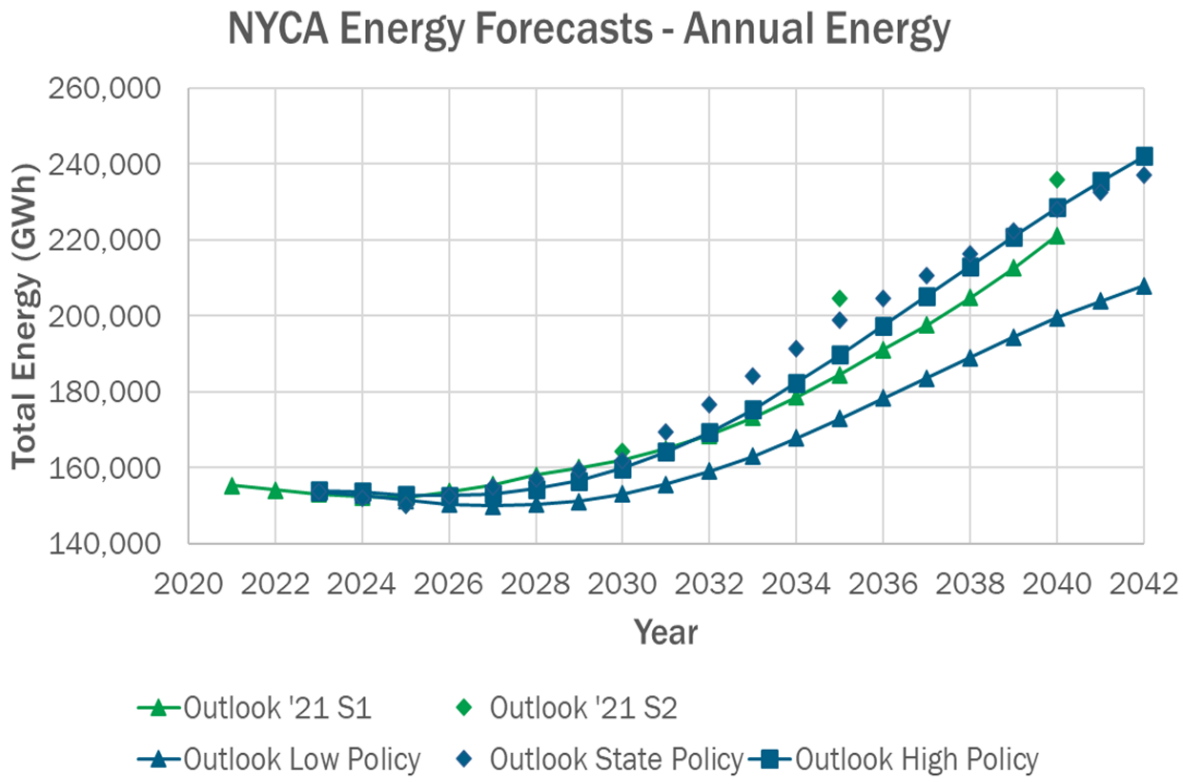
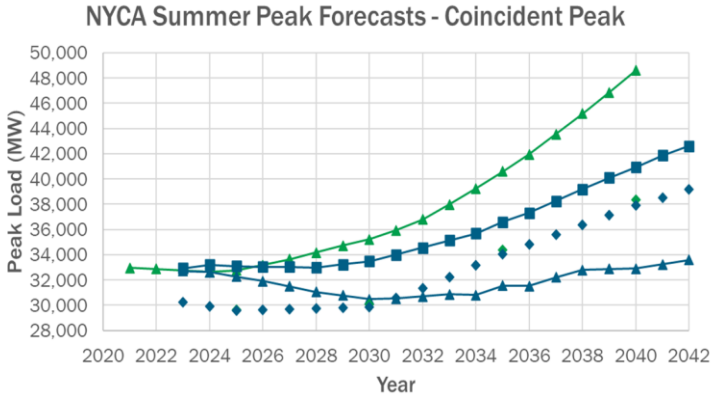
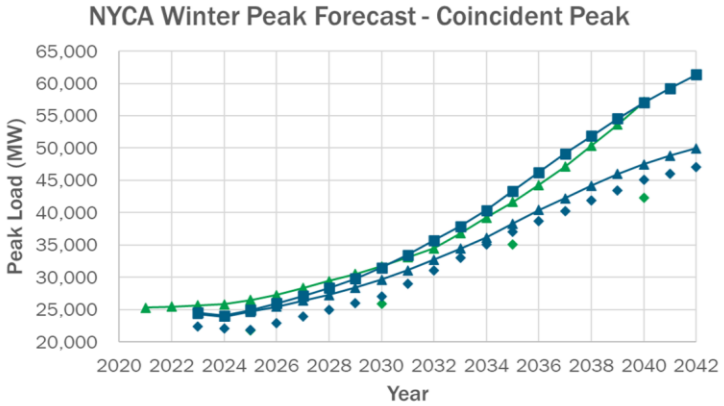
Policy Load Comparison







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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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