State of NYISO System & Resource Planning

The System & Resource Outlook ("The Outlook") represents the primary economic planning report and database developed by the NYISO. The Outlook provides a comprehensive overview of the potential system resource development and transmission constraints throughout New York, and highlights opportunities for transmission investment driven by economics and public policy. The Outlook is developed through the Economic Planning Process, which is part of the NYISO's Comprehensive System Planning Process ("CSPP"). Through the CSPP, numerous assessments, evaluations, and plans are developed and relied upon by the NYISO to conduct transmission system planning processes, including the following: demand forecast & analysis, Short-Term Reliability Process, Reliability Planning Process, Public Policy Transmission Planning Process, interregional planning, and Interconnection Studies.

1.1. Demand Forecast & Analysis

The NYISO published the *2022 Load & Capacity Data Report ("Gold Book")*[10] on April 28, 2022. This report presents the NYISO load and capacity data for 2022 and future years, including historic and future energy and peak forecasts through 2052, existing and proposed generating capacity projected through 2032, and existing and proposed transmission facilities. Three load forecasts are produced, specifically the baseline forecast, the high load scenario, and the low load scenario. The two scenarios differ from the baseline forecast in assumptions on adoption of electric vehicles, building electrification, behind-the-meter solar (BTM-PV), and energy efficiency programs. Over a 30-year horizon, the NYCA baseline energy and summer peak demand forecast growth rates both increased compared to 2021, as shown in the following table:

Figure 10: Gold Book Average Annual NYCA Baseline Energy and Summer Peak Demand Growth Rates

	Average Annual Growth Rates							
	Baseline Energy Usage				Baseline Summer Peak Demand			
	Years 1-30	Years 1-10	Years 11-20	Years 21-30	Years 1-30	Years 1-10	Years 11-20	Years 21-30
2021 Gold Book (2021-51)	0.96%	-0.28%	1.15%	1.88%	0.20%	-0.24%	0.44%	0.39%
2022 Gold Book (2022-52)	1.04%	0.22%	2.25%	0.49%	0.39%	0.14%	0.68%	0.32%

Peak load and energy demand remains stable over the first decade of the forecast, as energy efficiency

[10] https://www.nyiso.com/documents/20142/2226333/2022-Gold-Book-Final-Public.pdf/

and BTM-PV installations offset expected econometric load growth. Demand increases in the latter decades as increased adoption of electrification end uses in the building and transportation sector more than offset continued load reductions from energy efficiency and BTM-PV. Due to these forecasted changes, the NYCA system is expected to transition from a summer to a winter peaking system, driven principally by electrification of space heating, in the mid-2030s. The actual loads experienced by the electric system will depend on assumptions related to load flexibility and adoption rates of electrification across scenarios.

Total Resource Capability in NYCA for the summer of 2022 is projected to be 41,060 MW, which is a decrease of 11 MW compared to the information provided for summer 2021 in the 2021 *Gold Book*. This total includes 37,431 MW of NYCA generating capability, 1,164 MW of Special Case Resource ("SCR"), and 2,465 MW of net long-term purchases and sales with neighboring control areas. The NYCA generating capability includes 6,470 MW of renewable resources, including 4,274 MW of hydro, 1,818 MW of wind, 52 MW of large-scale solar PV, and 326 MW of other renewable resources. Since the publication of the 2021 *Gold Book* in April 2021, there has been a reduction of 1,091 megawatts (MW) of summer capability that has been deactivated. Over the same period, there has been an increase of 33 MW in summer capability due to new additions and uprates, and a decrease of 92 MW of summer capability due to ratings changes. As a result, net summer capability as of March 15, 2022 is 37,520 MW, a decrease of 1,150 MW. The NYCA generating capability for summer 2022 is projected to be 359 MW lower than the capability reported for summer 2021 in the 2021 *Gold Book*. Additionally, the *Gold Book* reports on proposed generation, which includes 10,158 MW of wind, 7,109 MW of grid-connected solar, 4,302 MW of energy storage, and 3,262 MW of natural gas or dual-fuel projects.

1.2. Transmission Additions.

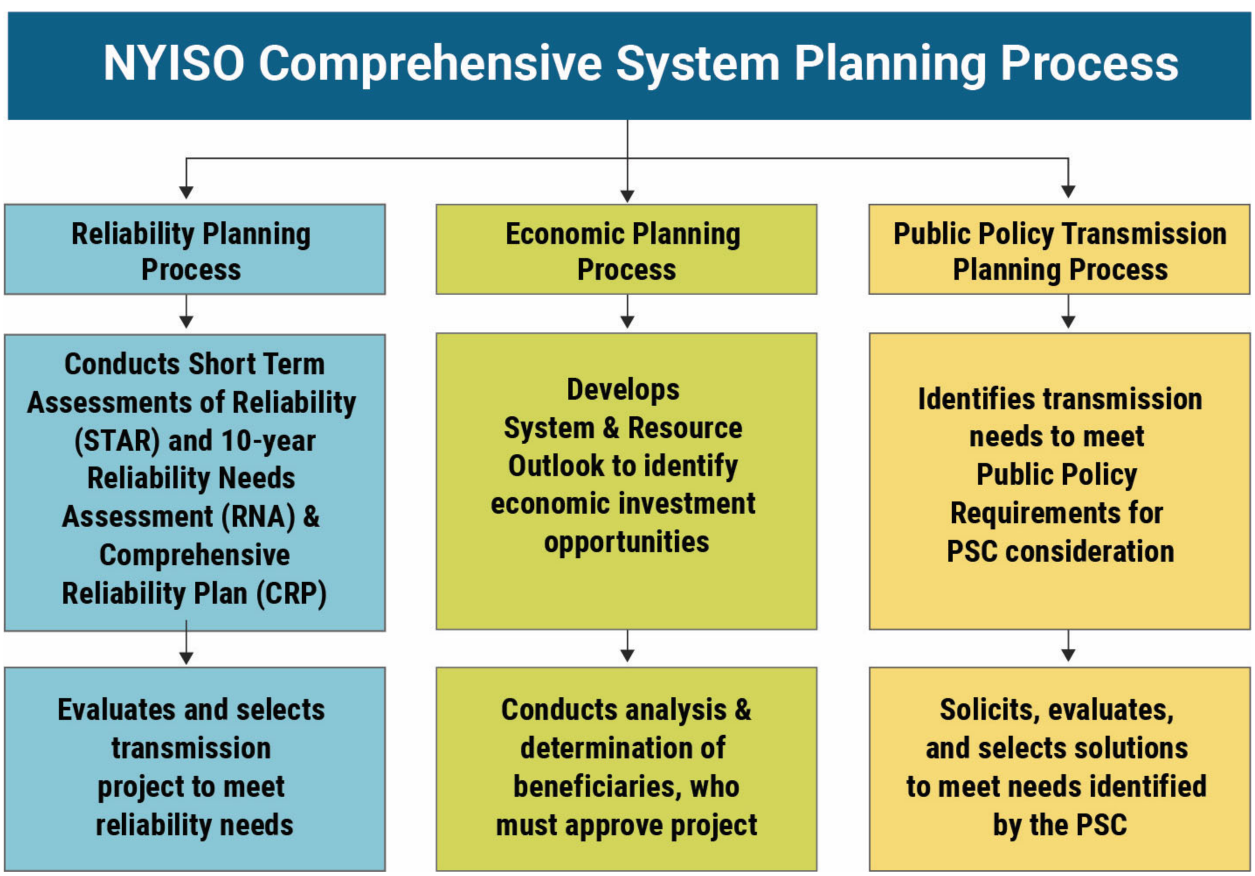
The 2022 *Gold Book* also reports on proposed transmission facilities. Transmission additions include the Smart Path Connect Project, a priority transmission project approved by the New York Public Service Commission ("NYPSC") under New York's Accelerated Renewable Energy Growth and Community Benefit Act. Three public policy transmission projects have been added, as selected by the NYISO Board of Directors: Western New York (Empire State Line by NextEra Energy Transmission New York, Inc.), AC Transmission Segment A (Segment A Double Circuit by LS Power Grid New York, LLC and NYPA), and AC Transmission Segment B (Segment B Knickerbocker-PV by National Grid and New York Transco). The selected developers have received siting approval of their transmission facilities from the NYPSC under Article VII of the Public Service Law, and all selected projects have commenced construction.

1.3 Comprehensive System Planning Process

Understanding the impacts to the generation, transmission, and load components of the bulk electric system is critical to understanding the challenges to reliable electric service in the coming years. The NYISO is evolving its CSPP to match the pace of change on the grid while continuing to find needs and opportunities for investment to promote reliable and efficient operations.

The CSPP establishes the rules by which the NYISO solicits, evaluates, and selects the more efficient or cost-effective solutions to address reliability, economic, and public policy-driven transmission needs in New York. The NYISO's CSPP has four components—the Local Transmission Planning Process, the Reliability Planning Process/Short-Term Reliability Process, the Economic Planning Process, and the Public Policy Transmission Planning Process. In concert with these four components, interregional planning is conducted with the NYISO's neighboring control areas in the United States and Canada under the Northeastern ISO/RTO Planning Coordination Protocol.

Figure 11: NYISO Comprehensive System Planning Process



1.3.1 Reliability Planning Process

The Reliability Planning Process is composed of four components:

1. Each transmission owner conducts a public Local Transmission Planning Process for its transmission district that feeds into statewide planning;
2. The quarterly Short-Term Assessments of Reliability (STARs) address near-term needs, with a focus on needs arising in the next three years. The Short-Term Reliability Process includes assessing the potential for reliability needs arising from proposed generator deactivations;
3. The Reliability Needs Assessment (RNA) focuses on longer-term reliability needs for years four through ten of a ten-year, forward looking study period; and
4. The Comprehensive Reliability Plan (CRP) integrates all of the planning studies into a ten-year reliability for New York.

Together, these processes enable the NYISO to nimbly identify reliability needs ranging from localized needs to broader statewide needs arising over the next decade.

The 2021-2030 Comprehensive Reliability Plan (CRP)[11] completed the NYISO's 2020-2021 cycle of the Reliability Planning Process. The 2020 Reliability Needs Assessment (RNA)[12], approved by the NYISO Board of Directors in November 2020, was the first step of the NYISO's 2020-2021 Reliability Planning Process. The CRP followed the 2020 RNA and post-RNA updates and incorporates findings and solutions from the quarterly Short-Term Reliability Process. The study concluded that the New York State Bulk Power Transmission Facilities as planned will meet all currently applicable reliability criteria from 2021 through 2030 for forecasted system demand in normal weather. Some risk factors to system reliability are noted, namely tightening reserve margins due to additional loss of generation, any delays in planned transmission projects, and extreme weather events such as heatwaves or storms.

The CRP also notes that the mandates in New York's Climate Leadership and Community Protection Act ("CLCPA") of 70% of electricity from renewable resources by 2030 and zero-emissions electricity by 2040 marks significant changes to the electric system, and that understanding the impacts of these mandates is critical to understanding the challenges of maintaining system reliability. Transmission will play a key role in moving energy from the renewable resources to the load centers. Several transmission projects have been approved across upstate to accommodate delivery of renewable energy from northern

[11] https://www.nyiso.com/documents/20142/2248481/2021-2030-Comprehensive-Reliability-Plan.pdf/

[12] https://www.nyiso.com/documents/20142/2248793/2020-RNAReport-Nov2020.pdf

New York. The NYISO is currently evaluating transmission solutions to address the NYSPSC-identified need for facilities to deliver power from offshore wind. Even with the potential benefits provided by these bulk system projects, several renewable generation pockets across the state are projected to persist, which could constrain output from renewable resources, including production from offshore wind. As the level of renewable resource generation increases, the grid will need sufficient flexible and dispatchable resources to balance variations in wind and solar output. The integration of batteries will help store energy for later use on the grid, which will aid with the short duration and daily cycles of reduced renewable resource output.

Looking ahead to 2040, the policy for a zero-emissions electric system will also require the development of new technologies to maintain the supply demand balance. Substantial dispatchable emission-free resources (DEFR) will be required to fully replace fossil fuel-fired generation, which currently serves as the primary balancing resource. Long-duration, dispatchable, and emission-free resources will be necessary to maintain reliability and meet the objectives of the CLCPA. Resources with this combination of attributes are not commercially available at this time but will be critical to future grid reliability.

1.3.2 Public Policy Transmission Planning Process

The Public Policy Transmission Planning Process (PPTPP) is a two-year process performed in parallel with the RNA and the CRP. It occurs in two phases: Phase I, Identify Needs and Assess Solutions; and Phase II, Transmission Evaluation and Selection. In Phase I, the NYISO solicits transmission needs driven by Public Policy Requirements, and the NYSPSC identifies transmission needs and defines additional evaluation criteria. The NYISO then holds a Technical Conference and solicits solutions to address the identified needs. Lastly, the NYISO performs the Viability and Sufficiency Assessment (VSA) on those solutions. In Phase II, the NYISO evaluates the viable and sufficient transmission solutions and recommends the more efficient or cost-effective solution. Thereafter, the NYISO Board may select a transmission solution for purposes of cost allocation and recovery under the NYISO Tariff.

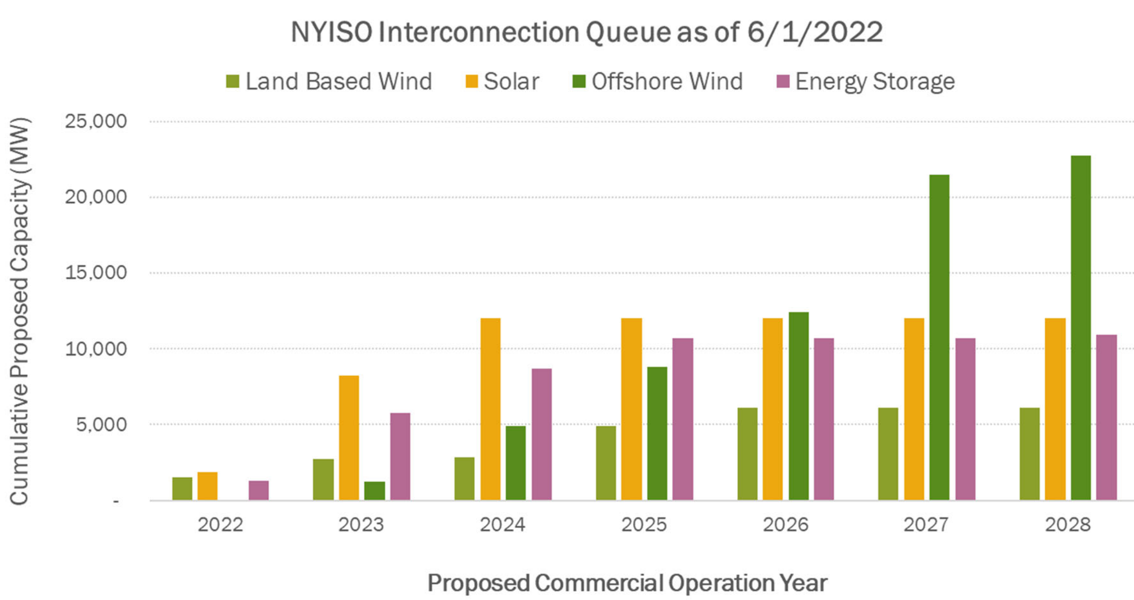
In August 2020, the NYISO solicited transmission needs and received 15 proposals for transmission needs driven by Public Policy Requirements, including the CLCPA and the Accelerated Renewable Growth and Community Benefit Act, and submitted those proposals to the NYSPSC. Eleven of those proposals, associated with the development of transmission in support of offshore wind generation, were also submitted to the Long Island Power Authority for consideration. In its comments to the NYSPSC, the NYISO expressed its support for declaration of Public Policy Transmission Needs to deliver renewable energy to consumers from upstate generation pockets, offshore wind facilities connected to Long Island, and offshore wind facilities connected to New York City.

In March 2021, the NYSPSC issued an order declaring that offshore wind goals are driving the need for additional transmission facilities to deliver that renewable power from Long Island to the rest of New York State. The NYSPSC referred the identified need to the NYISO to solicit potential solutions. Nineteen projects were proposed by four developers, sixteen of which were found to be Viable and Sufficient. The Evaluation and Selection phase for these projects is ongoing.

1.4 Interconnection Studies

The NYISO's Interconnection processes[13] are crucial to facilitating the development and interconnection of proposed generation, transmission, and load facilities to the NYCA system. The interconnection planning process supports grid reliability in that it identifies potential adverse impacts due to proposed interconnection projects, and requires coordination between the NYISO, developers, and associated transmission owners throughout the process. These ongoing processes are necessary to accommodate the significant portfolio of new projects that developers are proposing to interconnect to the grid in response to state policies. Of note, a significant portion of the new projects are renewable energy and energy storage resources, as shown below in Figure 12 to help address these policies.

Figure 12: Proposed Renewable Energy Capacity in the NYISO Interconnection Queue



[13] https://www.nyiso.com/interconnections

Similar to other NYISO Planning Studies, the NYISO's Interconnection planning process is key to the generation and load assumptions in the 2021-2040 System and Resource Outlook study. As it pertains to the Outlook study, the NYISO's Interconnection Queue was used as a reference in each of the three cases, Base, Contract, and Policy Cases, for purposes of generation placement in the NYCA. The Base and Contract Cases include proposed generation and load projects based on the NYISO's Interconnection Queue, as determined using inclusion rules for each case. Specific to the Policy Case, projects proposed in the Interconnection Queue were informative in guiding the process of translating the generation expansion results from the capacity expansion model at a zonal level into discrete generators at the nodal level in production cost modeling. Additional information on the generator placement process for the Policy Case is included in [section placeholder].

1. System & Resource Outlook Overview

In 2020, the NYISO undertook a comprehensive review of its Economic Planning Process to determine how the studies, tools, and metrics in that process could be enhanced. The impetus for the review arose, in part, from the rapidly shifting resource landscape toward renewable resources driven by the CLCPA and other state clean energy policies. This changing landscape led the NYISO to engage stakeholders to examine how the NYISO's Economic Planning studies could be enhanced to identify the most economic and efficient locations for the construction of renewable resources, the transmission needed to deliver energy to consumers from onshore and offshore renewable resources, and the impact of the renewable resources on the transmission system. The enhancements developed extend the study outlook to 20 years and broaden the benefits considered in evaluating potential projects to address congestion, such as the deliverability of energy output from new renewable resources and capacity cost savings associated with transmission expansion. These enhancements were approved by stakeholders and were accepted by FERC in April 2021.

For the first time, the NYISO has compiled this 20-year System & Resource Outlook. The Outlook provides a comprehensive overview of system resources and transmission constraints throughout New York, highlighting opportunities for transmission investment driven by economics and public policy. Together, the Comprehensive Reliability Plan and the System & Resource Outlook provide a full power system outlook to stakeholders, developers, and policymakers.

The Outlook provides a wide range of potential future system conditions and enables comparisons between possible pathways to an increasingly lower emissions resource mix. By forecasting transmission congestion, the NYISO will:

- Identify regions of New York where renewable generation may be heavily curtailed due to transmission constraints;
- Quantify the extent to which these constraints limit delivery of renewable energy to consumers; and identify potential transmission opportunities that may provide economic and/or operational benefits.

This new Outlook process provides transmission developers and resources the ability to request their own studies using the NYISO tools to identify the most economic opportunities for investment. Moreover, if a developer proposes a regulated transmission project to address constraints identified in the Economic Planning Process, the NYISO will perform an evaluation of the proposed project. Load serving entities ("LSEs") identified by the NYISO as the project beneficiaries must approve the selection of a proposed regulated transmission project by a super-majority vote. If a project is approved, it is eligible for cost allocation and recovery through the NYISO tariffs.

In the Outlook, the system is evaluated under various future system conditions and resource buildouts to provide multiple potential future outcomes for analysis. Unlike previous Economic Planning studies, which only evaluated a single base case, the Outlook evaluates three reference cases. The development of each of the reference cases leverages NYISO's expertise in power system data and modeling as well as consistent and meaningful engagement with stakeholders.

The three reference cases are:

Base Case - The Base Case is a "business-as-usual" type scenario that aligns with the Reliability Planning Process to define the demand, generation, and transmission assumptions. Strict inclusion rules limit the amount of new projects that are assumed in this case and generic future generation is added to meet reliability requirements through 2030, if needed. The Baseline utilizes the demand and energy forecasts from the 2021 NYISO Load & Capacity Data Report ("Gold Book").

Contract Case - This case builds upon the Base Case by adding incremental renewable generation projects that have obtained financial contracts with the state (e.g., NYSERDA Renewable Energy Credit ("REC") contracts) and thus have a higher likelihood of completion, even though they do not yet meet Base Case inclusion rules. Incremental projects may include both those within New York and within the neighboring regions.

Policy Case - Assumptions in the Policy case reflect the federal, state, and local policies that impact the New York power system. Examples of policies modeled in this case include the "70 by 30" renewable mandate and the 2040 zero-emissions directive. This system representation will also be utilized as part of the Public Policy Process, including evaluation of the Long Island offshore wind export Public Policy Transmission Need.

The suite of analyses in the Outlook provides a wide range of potential future system conditions and afford the ability to compare possible pathways to the future resource mix. Through the projection of future transmission congestion utilizing complex hourly production cost simulations, the NYISO will: (1) identify regions of New York where renewable generation "pockets" are expected to form, (2) quantify the extent to which those pockets limit delivery of renewable energy to consumers, and (3) present information for stakeholders to identify potential transmission opportunities that may provide economic and operational benefits. In addition, the NYISO will utilize the simulations to investigate and assess future system performance including ramping, reserves, and cycling of conventional thermal generators. This will in turn inform reliability studies, including the 2022 Reliability Needs Assessment.

Base Case Findings

3.1. Key Assumptions Review

The implementation of the Economic Planning Process requires the gathering, assembling, and coordination of a significant amount of data, in addition to that already developed for the Reliability Planning Processes. The 2021 Outlook Study Period aligns with the ten-year planning horizon for the 2021-2030 Comprehensive Reliability Plan with an additional ten years to 2040, and study assumptions are based on any updates that met the NYISO's inclusion rules as of the lock-down date for data inputs into the Outlook. The NYISO chose the August 1, 2021 lock-down date because it aligns with the most recent reliability case lockdown date for the 2021 Comprehensive Reliability Plan.

The Outlook Base Case can be viewed as a "Business as Usual" case starting with the most recent Reliability Planning Process Base Case and incorporating incremental resource changes based on the NYISO's Reliability Planning Process study inclusion rules.[14] Appendix placeholder includes a detailed description of the assumptions utilized in the Outlook analysis.

The key assumptions for the Base Case are:

- The load and capacity forecasts are updated using the 2021 Load and Capacity Data Report ("Gold Book") Baseline forecast for energy and peak demand by Zone for the 20-year Study Period. New resources and changes in resource capacity ratings were incorporated based on the Reliability Needs Assessment inclusion rules.
- The power flow case uses the 2021 Reliability Planning Process (RPP) case as the starting point and is updated with the latest information from the 2021 Gold Book.
- The transmission and constraint model utilizes a bulk power system representation for most of the Eastern Interconnection, as described below. The model uses transfer limits and actual operating limits from the 2021 RPP case.
- The production cost model performs a security constrained economic dispatch of generation resources to serve the load. The production cost curves, unit heat rates, fuel forecasts, and emission allowance price forecasts were developed by the NYISO from multiple data sets, including public domain information, proprietary forecasts, and confidential market information. The model includes scheduled generation maintenance periods based on a

[14] See Reliability Planning Process Manual, Manual No. 36, § 3.2.

combination of each unit's planned and forced outage rates.

Figure 13: Major Model Inputs and Changes

Major Modeling Inputs	
Input Parameter	**Change from 2019 CARIS 1**
Load Forecast	comparable
	Modeled Large Loads from the 2021 Load and Capacity Data Report
Natural Gas Price Forecast	higher
CO_2 Price Forecast	higher
NO_x Price Forecast	Annual NO_X lower, Ozone NO_X high in earlier years and lower in later years
SO_2 Price Forecast	same
Hurdle Rates	PJM lower, MISO higher
Modeling Changes	
MAPS Software Upgrades	GE MAPS Version 14.400.1404 was used for production cost simulation
PJM/NYISO JOA	same
NY Transmission Upgrades	LTP Updates on Con Edison 345/138 kV PAR controlled feeder lines in NY city.
	STRP solution for addressing 2023 short-term need
	SR in-service on following 345 kV cables: 71, 72, M51, M52
	Bypassing the SR on the following 345 kV cables: 41, 42, Y49

Figure 14: Timeline of Major NYCA Modeling Changes

Year	Year-to-year Modeling Changes
2021	Janis Solar, 20 MW, in service 7/1/2021
	Cassadaga Wind, 126.5 MW, in service: 7/6/2021
	Puckett Solar, 20 MW, in service 8/1/2021
	Tayandenega Solar, 20 MW, in service: 9/1/2021
	Albany County 1 Solar, 20 MW, in service: 11/1/2021
	Albany County 2 Solar, 20 MW, in service: 11/1/2021
	Greene County 1 Solar, 20 MW, in service: 11/1/2021
	Greene County 2 Solar, 10 MW, in service: 11/1/2021
	North Country Solar, 15 MW, in service: 11/1/2021
	Pattersonville Solar, 20 MW, in service: 11/1/2021
	Grissom Solar, 20 MW, in service: 12/1/2021
	Darby Solar, 20 MW, in service: 11/1/2021
	Branscomb Solar, 20 MW, in service: 11/1/2021
	ELP Stillwater Solar, 20 MW, in service: 11/1/2021
	Regan Solar, 20 MW, in service: 12/1/2021
	Rock District Solar, 20 MW, in service: 12/1/2021
	Roaring Brook Wind, 79.7 MW, in service: 12/1/2021
2022	WNY Stamp Load, in service 1/1/2022
	Greenidge Load, in service 1/1/2022
	Somerset Load, in service 1/1/2022
	Cayuga Load, in service 1/1/2022
	NCDC Load, in service 1/1/2022
	Skyline Solar, 20 MW, in service 3/1/2022
	Dog Corners Solar, 20 MW, in service 5/1/2022
	Sky High Solar, 20 MW, in service 8/1/2022
	Eight Point Wind Energy, 101.8 MW, in service 9/1/2022
	Number 3 Wind Energy, 103.9 MW, in service 9/1/2022
	Martin Solar, 20 MW, in service 10/1/2022
	Bakerstrand Solar, 20 MW, in service 10/1/2022
	Scipio Solar, 18 MW, in service 12/1/2022
	Niagara Solar, 20 MW, in service 12/1/2022
	Ball Hill Wind, 100 MW, in service 12/1/2022
2023	Watkins Road Solar, 20 MW, in service 6/1/2023
	Baron Winds, 238.4 MW, in service 7/1/2023
2024	Athens SPS retired on 1/2024

3.2. Simulation Results

This section presents summary level results for the Outlook Base Case. Study results are described in more detail in Appendix placeholder.

3.2.1. Generation

Figure 15: Projected NYCA Generation by Zone

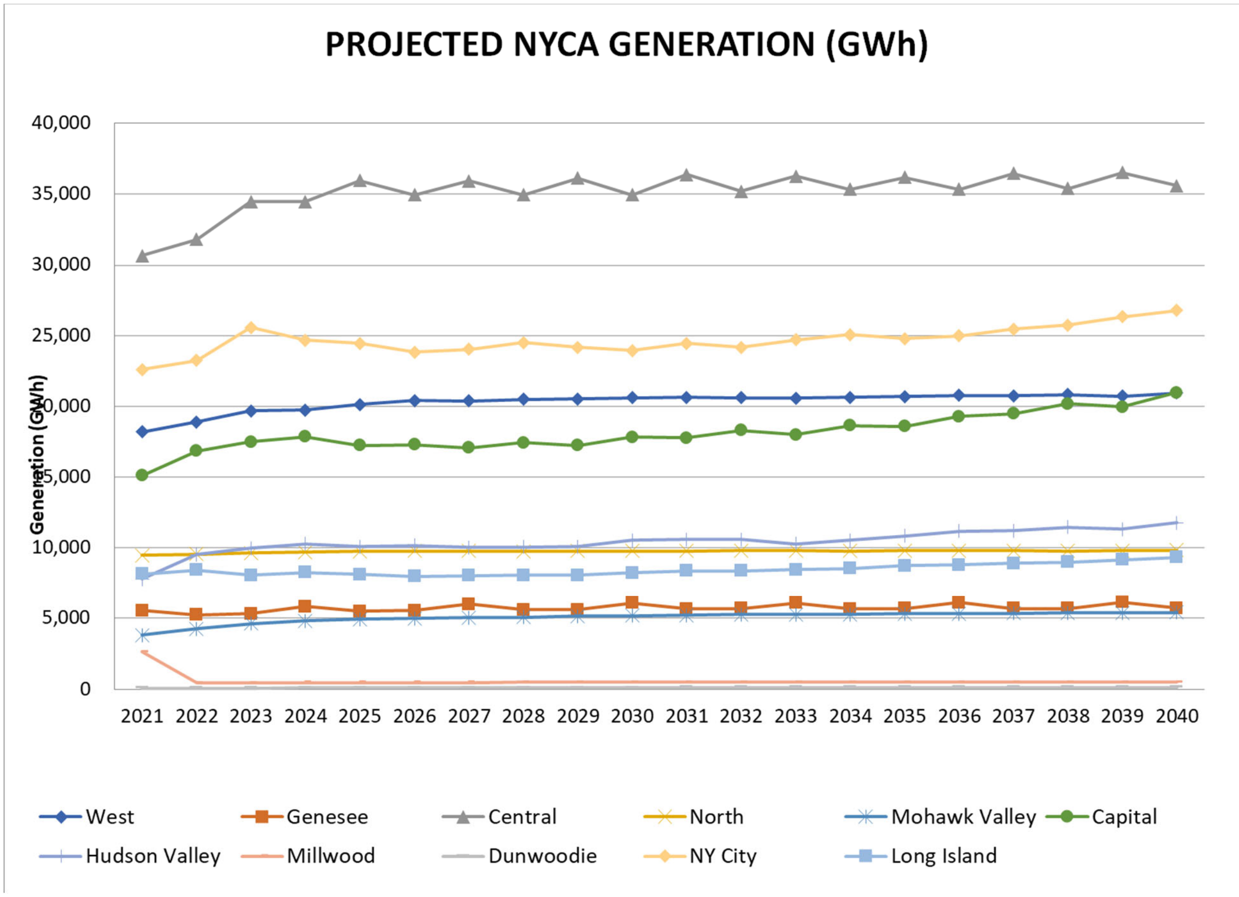


Figure 15 shows the projection of annual generation by NYCA zone over the study period. Generation is largely flat in the Base Case, with Millwood(Zone H) generation sharply decreasing after the retirement of Indian Point and Zone C and Zone F generation subsequently increasing. Intra year variations in Central (Zone C) generation can be explained by nuclear unit maintenance scheduled in the MAPS database. New York City (Zone J) generation also declines after 2023 with the addition of AC Transmission.

3.2.2. Net Imports

Figure 16: Projected Net Imports by Interface

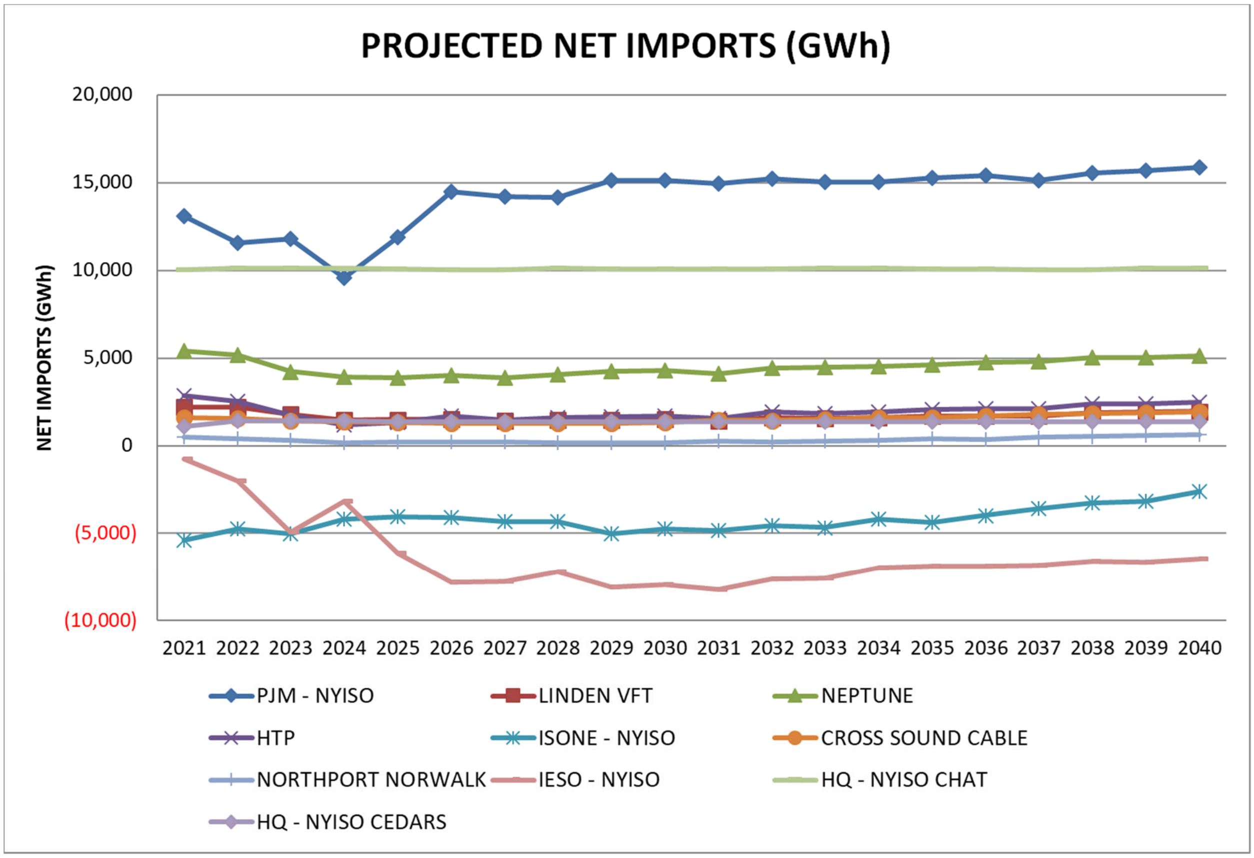
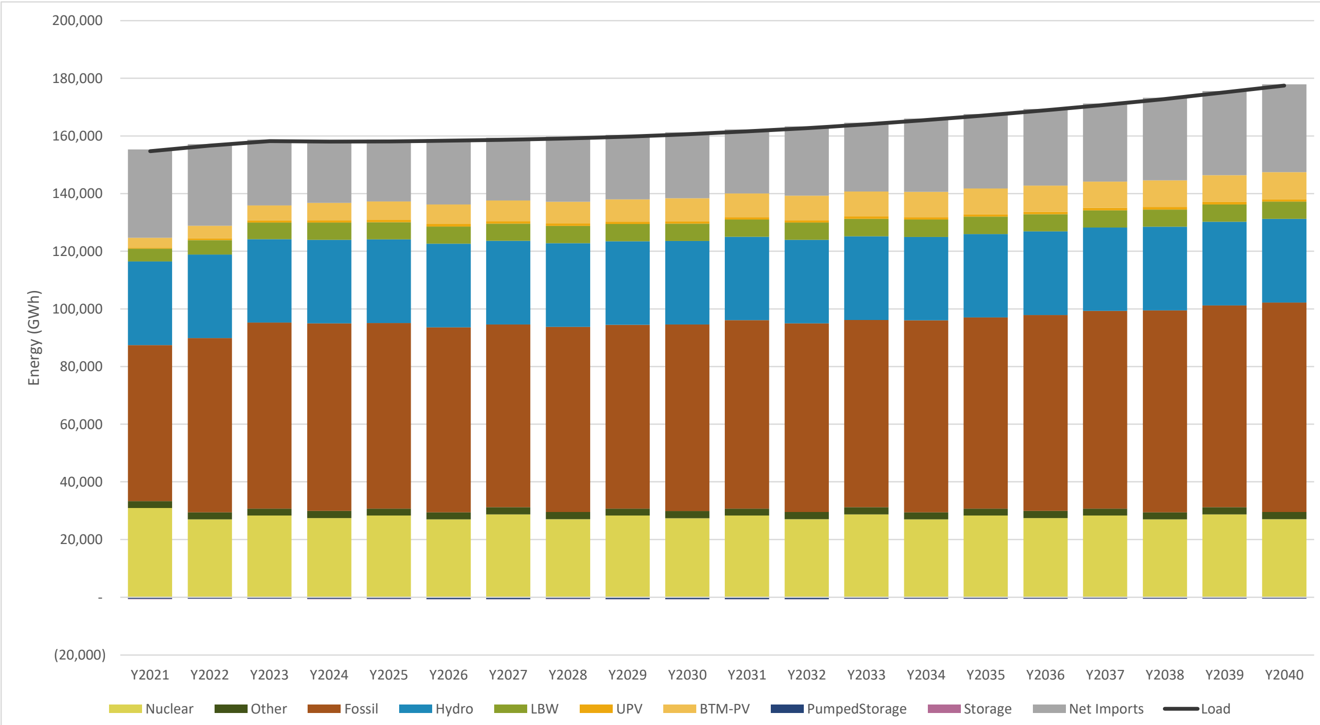


Figure 16 shows the projection of net imports on each interface for the Base Case. Net imports from Ontario decline with the retirement of the Pickering nuclear power plant in 2024 and 2025 and the refurbishment of the Darlington and Bruce nuclear power plants throughout the study period. Net imports from PJM increase in response to this refurbishment schedule. Across the other interfaces, net imports are largely flat through the study period.

Figure 17 shows the annual projection of generation by unit type, along with the forecast of net imports and load.

Figure 17: Base Case NYCA Generation and Net Imports (GWh)



3.2.3. Congestion Assessment

The Outlook includes the development of a twenty-year projection of future Demand$ Congestion costs. This projection is combined with the past five years of historic congestion to identify significant and recurring congestion. The results of the historical and future perspective are presented in the following two sections.

In order to assess and identify the most congested elements, both positive and negative congestion on constrained elements are taken into consideration. Whether congestion is positive or negative depends on the choice of the reference point. All metrics are referenced to the Marcy 345 kV bus near Utica, New York. In the absence of losses, any location with LBMP greater than the Marcy LBMP has positive congestion, and any location with LBMP lower than the Marcy LBMP has negative congestion. The negative congestion typically happens due to transmission constraints that prevent lower cost resources from being delivered towards the Marcy bus.

Historic Congestion

Historic congestion assessments are based on actual market operation and have been conducted at the NYISO since 2005 with metrics and procedures developed in consultation with stakeholders. Four congestion metrics were developed to assess historic congestion: Bid-Production Cost as the primary metric, Load Payments metric, Generator Payments metric, and Congestion Payment metric. Starting in 2018, followed by Tariff changes in Appendix A of Attachment Y to the OATT, only the following historic Day-Ahead Market congestion-related data were reported: (i) LBMP load costs (energy, congestion and losses) by Load Zone; (ii) LBMP payments to generators (energy, congestion and losses) by Load Zone; (iii) congestion cost by constraint; and (iv) congestion cost of each constraint to load (commonly referred to in the Outlook as "demand$ congestion" by constraint). The results of the historic congestion analyses are posted on the NYISO website.[15]

Historic congestion costs by Zone, expressed as Demand$ Congestion, are presented in Figure 18, indicating that the highest congestion occurred in New York City and Long Island.

Figure 18: Historic Demand$ Congestion by Zone 2016-2020 (nominal $M)[16]

Zone	2016	2017	2018	2019	2020
West	$116	$63	$65	$88	$49
Genesee	$7	$12	$10	$2	$5
Central	$29	$40	$37	$24	$17
North	$7	$6	$15	$6	$10
Mohawk Valley	$7	$10	$7	$5	$3
Capital	$95	$90	$80	$70	$55
Hudson Valley	$64	$66	$50	$44	$33
Millwood	$19	$21	$16	$13	$11
Dunwoodie	$41	$44	$34	$30	$21
New York City	$378	$443	$405	$320	$200
Long Island	$339	$287	$303	$220	$242
NYCA Total	**$1,102**	**$1,082**	**$1,024**	**$823**	**$644**

Figure 19 below ranks historic congestion costs, expressed as Demand$ Congestion, for the top NYCA constraints from 2016 to 2020. The top congested paths are shown below.

15 For more information on the historical results below see: https://www.nyiso.com/ny-power-system-information-outlook

16 Reported values do not deduct TCCs. NYCA totals represent the sum of absolute values. DAM data include Virtual Bidding and Planned Transmission Outages.

Figure 19: Historic Demand$ Congestion by Constrained Paths 2016-2020 (nominal $M)

Demand Congestion (Nominal $M)	Historic					Total
	2016	2017	2018	2019	2020	
CENTRAL EAST	641	598	540	516	402	2,696
DUNWOODIE TO LONG ISLAND	164	88	133	82	98	565
EDIC MARCY	32	125	107	4	2	270
LEEDS PLEASANT VALLEY	63	101	9	20	1	195
GREENWOOD	31	18	62	25	22	159
PACKARD HUNTLEY	54	30	41	9	3	136
DUNWOODIE MOTTHAVEN	2	30	65	28	4	129
CHESTR-SHOEMAKR_138	-	-	-	19	10	30
UPNY-ConEd	-	4	-	0	3	8
VOLNEY SCRIBA	0	1	1	3	1	6

Projected Future Congestion

Future congestion for the Base Case study period was determined from a MAPS software simulation. As reported in the "Historic Congestion" section above, congestion is reported as Demand$ Congestion. MAPS software simulations are highly dependent upon many long-term assumptions, each of which affects the study results. The MAPS software utilizes the input assumptions listed in Appendix placeholder.

When comparing historic congestion costs to projected congestion costs, it is important to note that there are significant assumptions not included in projected congestion costs using MAPS software including: (a) virtual bidding; (b) transmission outages; (c) price-capped load; (d) generation and demand bid price; (e) Bid Production Cost Guarantee payments; (f) co-optimization with ancillary services, and (g) real-time events and forecast uncertainty. As in prior Economic Planning Process cycles, the projected congestion is less severe than historic levels due to the factors cited.

Figure 20 presents the projected congestion from 2021 through 2040 by load zone. Year-to-year changes in congestion reflect changes in the model, which are discussed in the "Baseline System Assumptions" section above.

Figure 20: Projection of Future Demand$ Congestion 2021-2040 by Zone for Base Case (nominal $M)

Demand Congestion ($M)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
West	$33	$14	$6	$3	$3	$6	$6	$10	$13	$15
Genesee	$16	$8	$3	$2	$2	$3	$3	$5	$6	$6
Central	$51	$42	$26	$25	$32	$42	$40	$45	$48	$47
North	$3	$2	$0	$0	$1	$0	$1	$1	$1	$1
Mohawk Valley	$12	$6	$2	$0	$1	$1	$1	$1	$1	$0
Capital	$96	$45	$19	$13	$4	$2	$2	$3	$1	$1
Hudson Valley	$51	$22	$11	$0	$4	$7	$6	$7	$8	$9
Millwood	$16	$7	$3	$1	$1	$2	$2	$2	$2	$2
Dunwoodie	$30	$14	$7	$2	$2	$3	$3	$3	$4	$4
NY City	$266	$129	$66	$21	$9	$20	$19	$20	$25	$26
Long Island	$246	$153	$94	$58	$44	$37	$36	$34	$39	$45
NYCA Total	**$819**	**$442**	**$238**	**$125**	**$103**	**$122**	**$119**	**$130**	**$148**	**$157**

Demand Congestion ($M)	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
West	$17	$20	$21	$21	$24	$32	$32	$39	$39	$42
Genesee	$7	$8	$9	$9	$10	$13	$14	$16	$17	$19
Central	$49	$48	$51	$49	$51	$55	$62	$63	$69	$74
North	$0	$2	$2	$2	$2	$2	$2	$2	$2	$3
Mohawk Valley	$2	$3	$1	$1	$1	$2	$3	$3	$3	$3
Capital	$1	$0	$3	$6	$2	$1	$4	$2	$2	$1
Hudson Valley	$8	$10	$10	$9	$10	$13	$14	$15	$16	$19
Millwood	$2	$3	$3	$2	$2	$3	$3	$3	$3	$3
Dunwoodie	$4	$5	$5	$4	$5	$7	$5	$6	$7	$7
NY City	$22	$30	$32	$25	$26	$40	$24	$39	$42	$24
Long Island	$58	$58	$71	$82	$100	$89	$109	$119	$141	$150
NYCA Total	**$172**	**$188**	**$209**	**$209**	**$234**	**$256**	**$270**	**$308**	**$341**	**$345**

Note: Reported costs have not been reduced to reflect TCC hedges and represent absolute values.

Based on the positive Demand$ Congestion costs, the future top congested paths are shown in Figure 21.

Figure 21: Projection of Future Demand$ Congestion 2021-2040 by Constrained Path for Base Case (nominal $M)

Demand Congestion ($M)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
CENTRAL EAST	$609	$286	$122	$25	$4	$1	$1	$4	$1	$2
DUNWOODIE TO LONG ISLAND	$56	$40	$29	$26	$27	$27	$29	$27	$30	$32
N.WAV-E.SAYR_115	$25	$29	$18	$12	$15	$17	$18	$18	$20	$20
ELWOOD-PULASKI_69	$24	$24	$14	$8	$5	$4	$1	$1	$6	$8
VOLNEY SCRIBA	$6	$6	$7	$6	$7	$8	$6	$8	$9	$9
UPNY-ConEd	$0	$0	$0	$2	$2	$2	$1	$3	$6	$5
CHESTR-SHOEMAKR_138	$31	$27	$26	$2	$1	$1	$1	$2	$3	$2
NEW SCOTLAND KNCKRBOC	$0	$0	$0	$20	$8	$3	$5	$13	$7	$8
SGRLF-RAMAPO_138	$0	$0	$0	$8	$5	$4	$5	$5	$5	$4
NORTHPORT PILGRIM	$7	$8	$5	$4	$2	$2	$1	$1	$3	$4
GREENBSH-STEPHTWN_115	$0	$0	$0	$5	$5	$5	$4	$5	$5	$5
INGHAMS CD-INGHAMS E_115	$0	$0	$0	$11	$2	$2	$2	$4	$2	$1
ALCOA-NM - ALCOA N_115	$0	$1	$1	$2	$2	$3	$3	$4	$4	$4
DUNWOODIE MOTTHAVEN	$3	$3	$0	$1	$1	$3	$3	$1	$2	$2
OWENSCRN-SABICO_115	$0	$0	$0	$3	$3	$3	$3	$2	$3	$3
FERND-W.WDB_115	$13	$6	$8	$2	$2	$1	$0	$0	$2	$1

Demand Congestion ($M)	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
CENTRAL EAST	$1	$1	$2	$6	$3	$5	$6	$7	$2	$1
DUNWOODIE TO LONG ISLAND	$38	$39	$47	$46	$58	$53	$57	$62	$72	$75
N.WAV-E.SAYR_115	$21	$21	$23	$21	$23	$26	$29	$30	$34	$36
ELWOOD-PULASKI_69	$9	$12	$13	$15	$18	$21	$26	$27	$31	$37
VOLNEY SCRIBA	$10	$10	$12	$11	$15	$12	$15	$15	$17	$18
UPNY-ConEd	$5	$4	$4	$5	$4	$6	$19	$19	$27	$42
CHESTR-SHOEMAKR_138	$1	$1	$4	$2	$5	$4	$3	$4	$4	$6
NEW SCOTLAND KNCKRBOC	$9	$8	$7	$12	$11	$4	$4	$3	$3	$1
SGRLF-RAMAPO_138	$6	$7	$6	$7	$10	$7	$16	$14	$9	$7
NORTHPORT PILGRIM	$4	$4	$4	$4	$6	$7	$7	$8	$9	$11
GREENBSH-STEPHTWN_115	$5	$5	$6	$6	$7	$7	$8	$8	$9	$9
INGHAMS CD-INGHAMS E_115	$2	$3	$5	$10	$4	$7	$11	$9	$11	$10
ALCOA-NM - ALCOA N_115	$4	$5	$5	$5	$5	$6	$5	$6	$6	$7
DUNWOODIE MOTTHAVEN	$3	$5	$4	$2	$3	$5	$6	$5	$3	$19
OWENSCRN-SABICO_115	$3	$4	$4	$5	$5	$5	$5	$7	$7	$8
FERND-W.WDB_115	$2	$2	$2	$3	$1	$3	$4	$4	$3	$1

Ranking of Congested Elements

The identified congested elements from the twenty-year projected congestion are appended to the past five years of identified historic congested elements to develop twenty-five years of Demand$ Congestion statistics for each initially identified top constraint. The twenty-five years of statistics are analyzed to identify recurring congestion. Ranking the identified constraints is initially based on the highest present value of congestion over the twenty-five year period with five years of historic and twenty years of projected congestion.

Figure 22 lists the ranked elements based on the highest present value of congestion over the twenty-five years of the study, including both positive and negative congestion.

Figure 2: Ranked Elements Based on the Highest Present Value of Demand$ Congestion over the 25 Yr Aggregate (Base Case)

Demand Congestion (2021 $M)	Hist. Total	Proj. Total	25Y Total
CENTRAL EAST	3,487	1,061	4,548
DUNWOODIE TO LONG ISLAND	733	467	1,200
EDIC MARCY	359	0	359
LEEDS PLEASANT VALLEY	266	5	271
N.WAV-E.SAYR_115	-	251	251
GREENWOOD	203	22	225
DUNWOODIE MOTTHAVEN	164	35	199
PACKARD HUNTLEY	184	-	184
ELWOOD-PULASKI_69	-	161	161
CHESTR-SHOEMAKR_138	34	101	135
VOLNEY SCRIBA	7	107	114
NEW SCOTLAND KNCKRBOC	-	73	73
UPNY-ConEd	10	58	67
SGRLF-RAMAPO_138	-	59	59
NORTHPORT PILGRIM	-	55	55
GREENBSH-STEPHTWN_115	-	49	49

The frequency of historic and projected congestion is shown in Figures 23 and 24. The figures present the historic number of congested hours by constraint, from 2016 through 2020, and projected hours of congestion, from 2021 through 2040. Historic congested elements which are not congested, or congestion is limited to few hours in the projected years are replaced with new constraints in Figure 24 which are congested for greater number of hours.

Figure 23: Historical Number of Congested Hours by Constraint (Base Case)

Congested Hours	Historic				
	2016	2017	2018	2019	2020
CENTRAL EAST	4,636	5,062	4,031	5,308	4,482
DUNWOODIE TO LONG ISLAND	6,085	8,212	8,624	6,645	6,902
EDIC MARCY	164	307	312	17	26
LEEDS PLEASANT VALLEY	623	982	83	159	51
GREENWOOD	7,347	7,573	7,310	3,996	3,120
DUNWOODIE MOTTHAVEN	134	1,281	2,743	1,317	674
PACKARD HUNTLEY	1,425	821	818	355	29
CHESTR-SHOEMAKR_138	-	-	-	228	234
VOLNEY SCRIBA	46	324	254	1,093	112
UPNY-ConEd	-	22	-	9	59

Figure 24: Projected Number of Congested Hours by Constraint (Base Case)

Congested Hours	Projected 2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
ALCOA-NM - ALCOA N_115	207	315	577	656	818	985	988	957	999	995
CENTRAL EAST	3649	2548	1582	448	97	22	25	67	14	35
CHESTR-SHOEMAKR_138	276	341	295	20	11	8	7	17	20	20
DUNWOODIE MOTTHAVEN	1199	1081	348	509	476	498	545	520	527	514
DUNWOODIE TO LONG ISLAND	7253	7172	7520	7894	7693	7297	7450	7507	7416	7588
ELWOOD-PULASKI_69	318	302	243	240	208	161	142	159	183	214
GREENBSH-STEPHTWN_115	2	1	1	93	88	82	78	78	78	81
INGHAMS CD-INGHAMS E_115	0	0	0	291	82	52	44	97	37	36
N.WAV-E.SAYR_115	5586	7678	5924	5533	6302	6444	6120	5914	5961	5413
NEW SCOTLAND KNCKRBOC	0	0	0	215	93	43	74	103	76	68
NORTHPORT PILGRIM	0	0	5600	4708	5989	7437	7561	6945	7739	7576
North Tie: OH-NY	316	375	314	334	283	234	206	187	156	214
OWENSCRN-SABICO_115	3	96	64	1740	1372	1364	1166	1035	1167	1212
SGRLF-RAMAPO_138	0	0	0	214	149	91	115	83	79	96
UPNY-ConEd	0	0	19	12	19	17	11	17	45	37
VOLNEY SCRIBA	1845	1982	2348	2156	2636	2594	2362	2293	2634	2407

Congested Hours	Projected 2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
ALCOA-NM - ALCOA N_115	986	1052	974	958	973	1120	1003	1021	964	1009
CENTRAL EAST	16	31	26	82	38	76	66	69	42	27
CHESTR-SHOEMAKR_138	13	11	22	16	23	19	17	18	17	22
DUNWOODIE MOTTHAVEN	672	726	657	691	809	771	817	860	879	1043
DUNWOODIE TO LONG ISLAND	7721	7731	7865	7904	7944	7941	7930	7972	8041	8087
ELWOOD-PULASKI_69	222	254	266	243	273	302	327	306	323	400
GREENBSH-STEPHTWN_115	85	92	97	107	115	120	128	136	144	148
INGHAMS CD-INGHAMS E_115	31	55	79	145	49	110	131	104	107	84
N.WAV-E.SAYR_115	5794	5322	5159	5266	5440	5407	5517	5454	5554	5961
NEW SCOTLAND KNCKRBOC	76	66	74	84	110	53	50	42	50	21
NORTHPORT PILGRIM	7906	7325	7252	7027	7061	7209	7188	7070	7205	7205
North Tie: OH-NY	231	223	230	227	245	275	260	272	286	319
OWENSCRN-SABICO_115	1204	1381	1419	1491	1489	1648	1466	1837	1691	2169
SGRLF-RAMAPO_138	127	136	129	162	157	131	220	181	114	91
UPNY-ConEd	43	36	31	31	29	31	69	53	67	93
VOLNEY SCRIBA	2655	2347	2963	2442	3154	2411	2951	2489	2884	2867

3.2.4. Unserved Energy

In the production cost model, unserved energy occurs when the model lacks sufficient resources to serve load in a given hour. Any unserved energy in a load zone is met by a zonal 'dummy' generator in the MAPS program. In the Base Case, four hours in Zone J in 2040 experience unserved load, which results in 409 MWh of operation from the dummy generator in Zone J. It is important to note that while the study period of the Base Case ends in 2040, no new generation is added to the case past 2023 based on the inclusion rules. A lack of new resources over a period of almost 20 years is unrealistic, and the presence of unserved load in later years should not be interpreted as projected violation of system reliability.

3.2.5. Key Findings

- Demand congestion declines sharply in the first five years of the study period across the Central East interface. This decline is largely due to the retirement and refurbishment of nuclear generators in Ontario. The model forecasts NYCA becoming a significant exporter to IESO over the course of the study period. The decline in Central East congestion may also be attributed to the AC Transmission project coming into service as well as the introduction of the large loads located upstream of the interface.
- The large loads located in zones A, C, and D are served primarily by increased output from fossil fuel-fired generation located upstate. As a result, upstate zonal CO_2 emissions as well as zonal demand congestion increase through the study period.
- The large non-conforming loads, which do not follow conventional diurnal patterns as conventional loads and mostly have a flat profile, comprise of approximately 20% of Zone A, 6% of Zone C and 23% of Zone D total energy requirement by 2027 when all loads are at their maximum capacities. This increase in upstate load is primarily served by existing upstate fossil fuel-fired resources. This causes congestion on major bulk transmission lines such as Central East to decrease as a result of less power flowing through the interface to serve downstate loads.
- As expected, the CLCPA target of 70 by 30 is not achieved in the Base Case. This case uses the most conservative input assumptions of the three Outlook cases and is meant to serve as a reference case for the Contract and Policy cases.

Contract Case Findings

4.1. Key Assumptions Review

Through an annual request for proposals, NYSERDA solicits bids from eligible new large-scale renewable resources and procures Renewable Energy Credits ("RECs") from these facilities.[17] The Contract Case of the 2021 Outlook builds off the Base Case and additionally models the awarded units through NYSERDA's 2020 Solicitation that have not yet met the inclusion rules of the Outlook Base Case. Approximately 9,500 MW of new renewable units are added in this case, including 4,262 MW of solar, 899 MW of land-based wind, and 4,316 MW of offshore wind. The zonal breakdown of these additions is shown below. [18]

Figure 25: Zonal Renewable Generation Additions in the Contract Case (MW)

Zone		Solar	Land Based Wind	Offshore Wind	Total
A	West	290	339		629
B	Genesee	1,330	200		1,530
C	Central	852	147		999
D	North	180			180
E	Mohawk Valley	739	213		952
F	Capital	730			730
G	Hudson Valley	140			140
J	New York City			2,046	2,046
K	Long Island			2,270	2,270
	Total	4,262	899	4,316	9,476

4.2. Simulation Results

This section summarizes study results for the Outlook Contract Case. Detailed results are described in more detail in Appendix placeholder.

4.2.1. Annual Generation

[17] https://data.ny.gov/Energy-Environment/Large-scale-Renewable-Projects-Reported-by-NYSERDA/dprp-55ye

[18] A more detailed list of units added to the Contract Case can be found at https://www.nyiso.com/documents/20142/26278859/System_Resource_Outlook-Contract_Case_Renewables.xlsx/

Figure 26: Projected NYCA Generation by Zone, Delta from Base Case

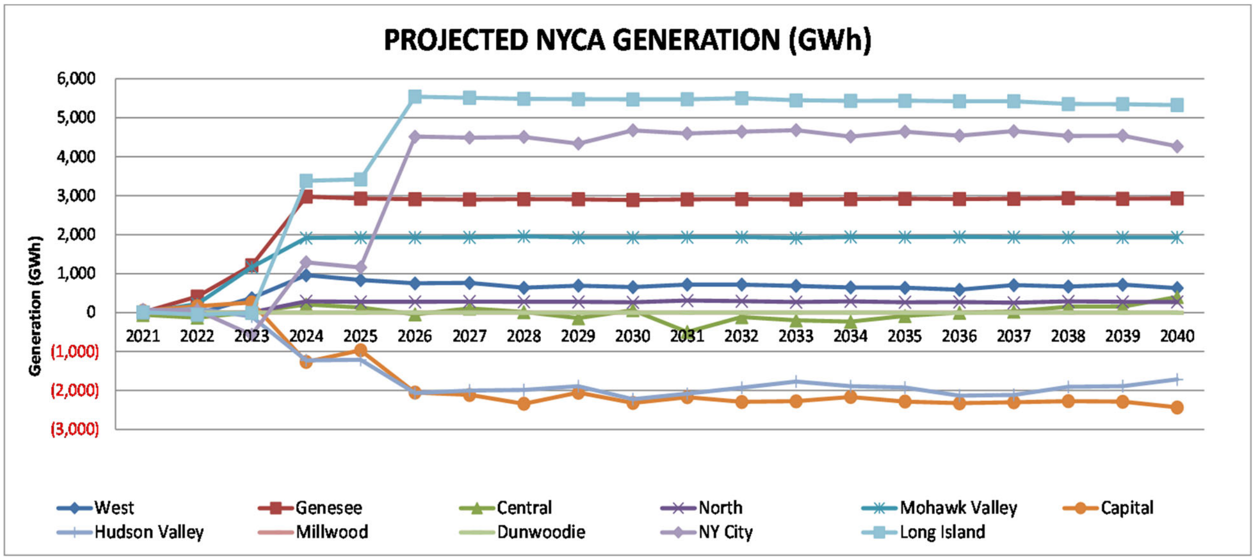
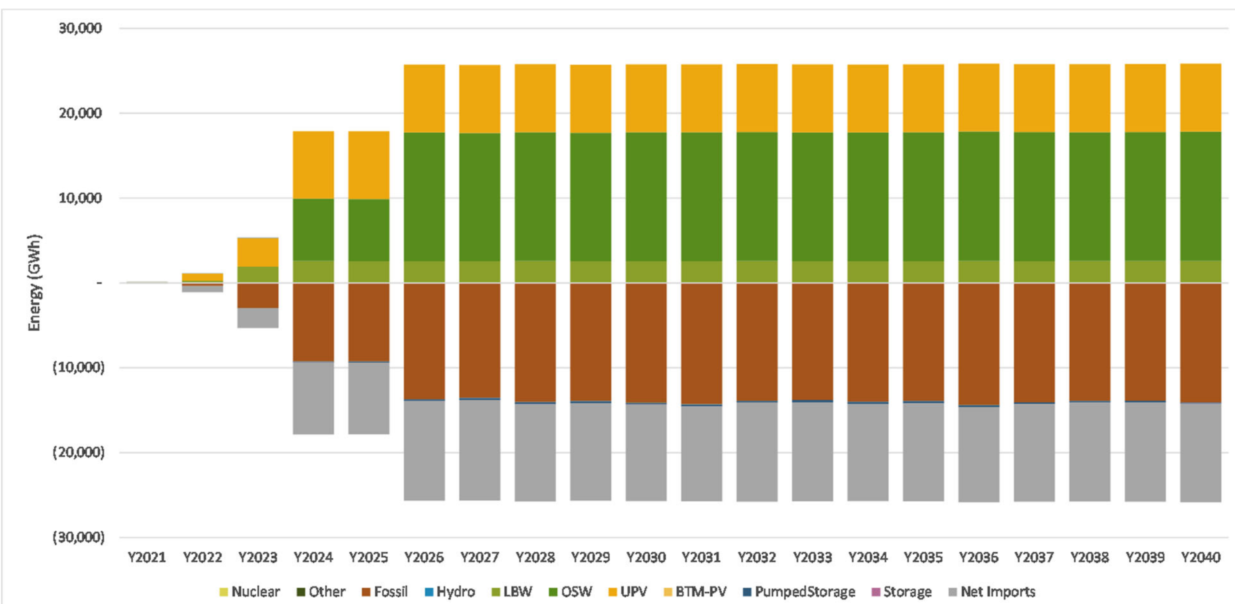
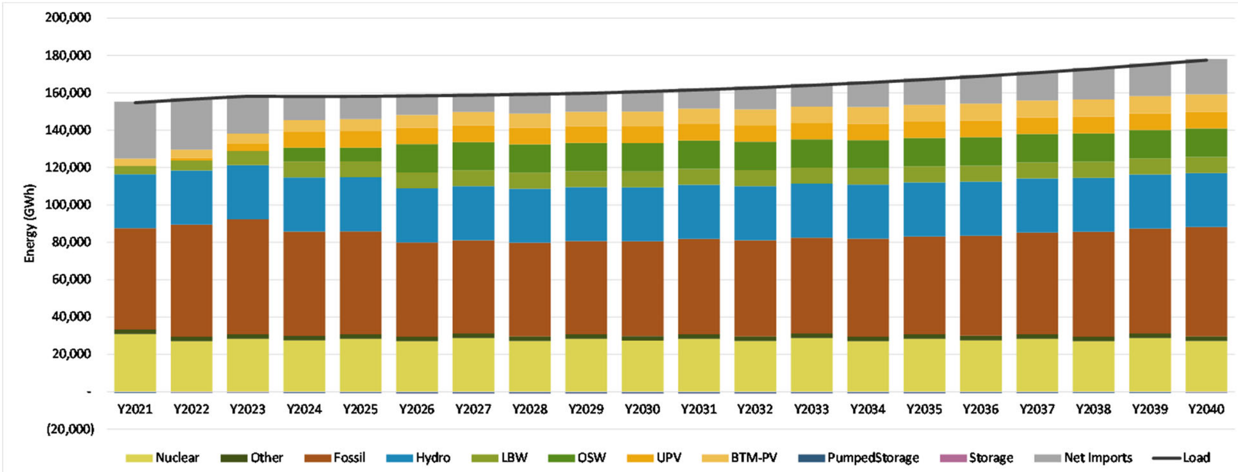


Figure 27: Projected NYCA Generation by Fuel Type, Delta from Base Case



Figures 26 and 27 show the changes in projected NYCA generation from the Base Case, both zonally and by fuel type. Generation increases across the upstate zones and in Zones J and K with the increases in available renewable energy. These increases displace primarily fossil fuel-fired energy in the Capital and in the Hudson Valley regions. Figure 27 also shows that the additions of renewable energy displaces net imports through the study period. Figure 28 shows the resulting fuel mix for the Contract Case.

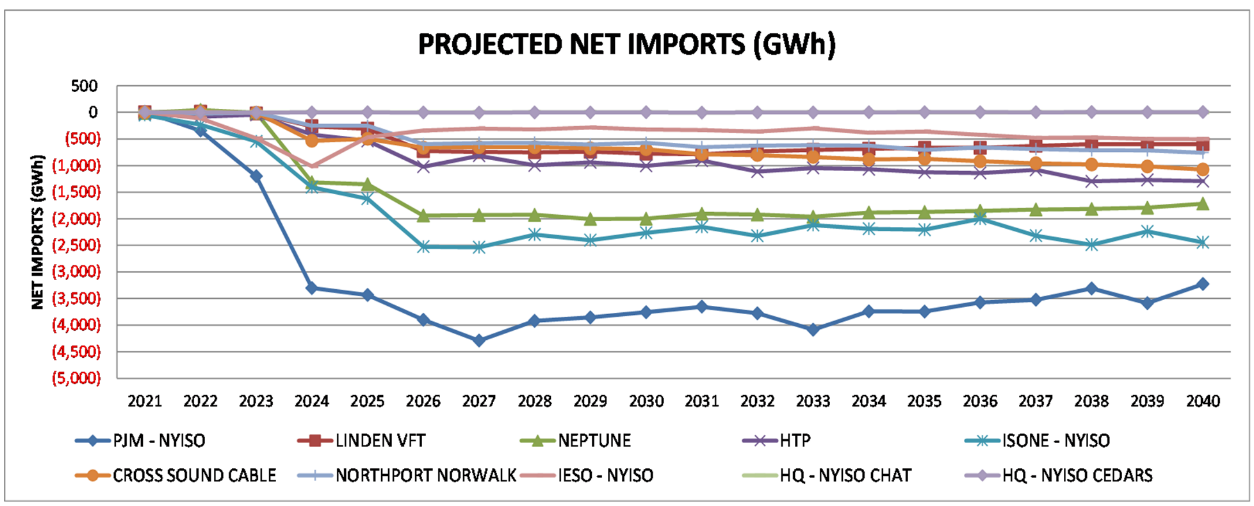
Figure 28: Projected NYCA Generation by Fuel Type



4.2.2. Net Imports

As seen in Figure 27, net imports in the Contract Case are displaced by the added renewable generators in NYCA. Figure 29 shows the change in net imports from the Base Case by interface.

Figure 29: Projected Net Imports by Interface, Delta from Base Case



4.2.3. Emissions

Figure 30: Projected Zonal CO_2 Emissions, Delta from Base Case

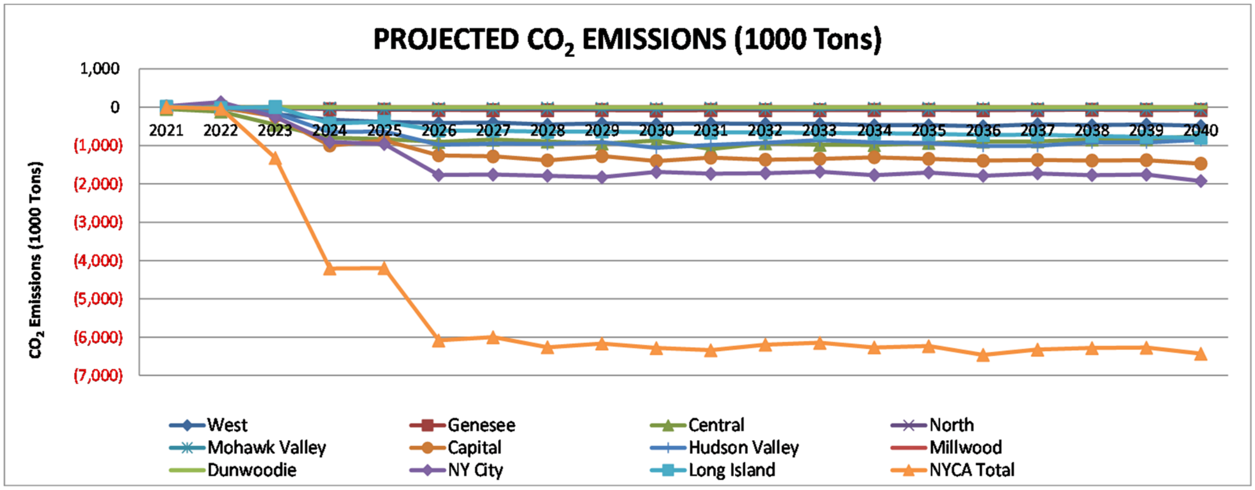


Figure 30 shows the projected change from the Base Case in zonal and NYCA CO_2 emissions. New York City and Capital see the largest reductions, and NYCA sees an annual reduction of approximately 6 million tons over most of the study period.

4.2.4. Congestion

Figure 31: Projected Demand Congestion by Zone, Delta from Base Case

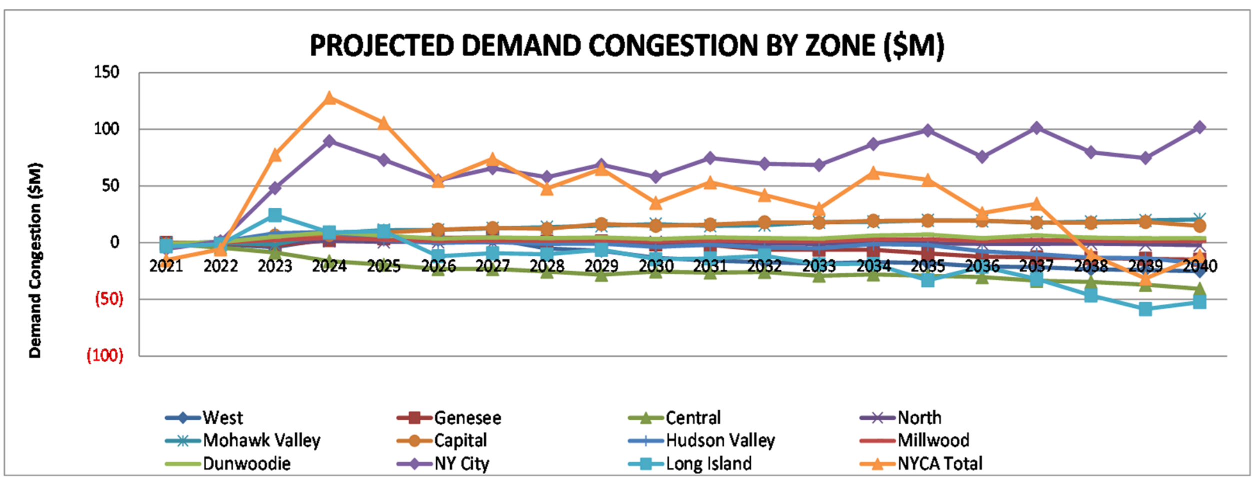
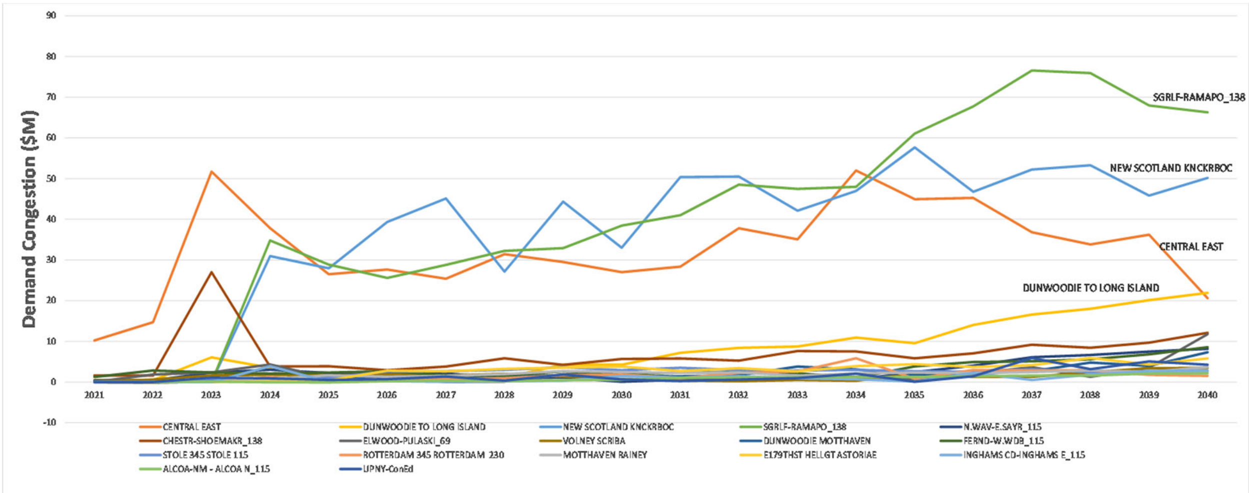


Figure 32: Demand Congestion by Constraint, Delta from Base Case

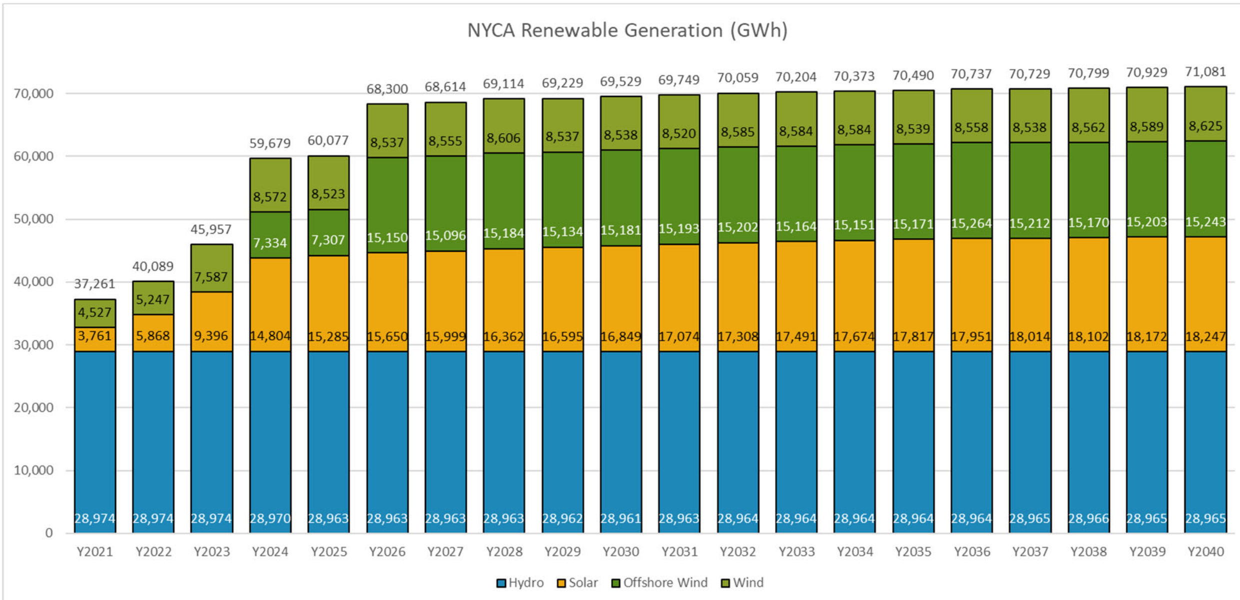


Figures 31 and 32 show the changes from the Base Case in demand congestion both zonally and by constraint. Zone J sees the most significant increase in demand congestion while Central and Long Island see decreases in demand congestion. The constraints with the most prominent increases in demand congestion are Sugarloaf to Ramapo, New Scotland to Knickerbocker, Central East, and Dunwoodie to Long Island.

4.2.5. Renewable generation and curtailment

The Contract Case generator additions include renewable energy projects under contracts with NYSERDA that have procured REC contracts to serve energy in New York. The following chart shows renewable energy generation by type in each zone for the 20 years studied in the Contract Case.

Figure 33: Annual Generation by Unit Type and Zone



REC prices for each project are modeled as a negative bid adder in production cost simulation to represent impact from out of market payments. This price sets the priority order for economic dispatch and curtailment of resources due to transmission congestion.

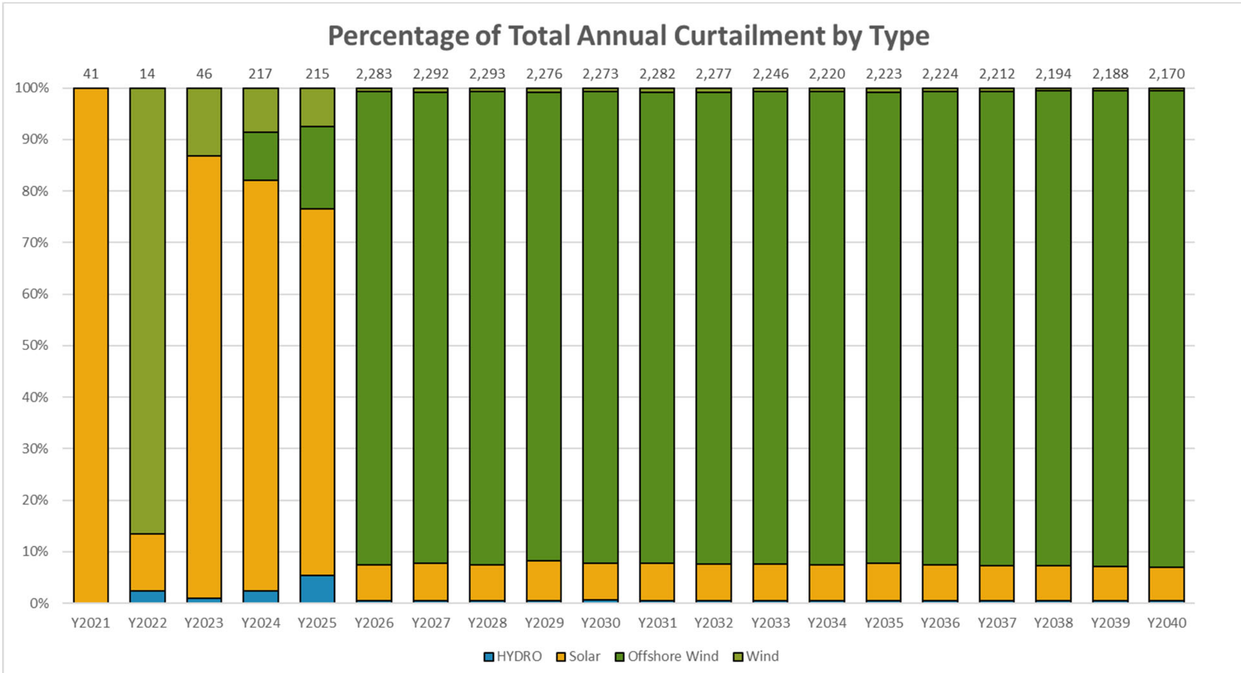
The aggregate premium of Index REC Strike price to Fixed RECs is used as a proxy to represent a negative bid adder for Index RECs. Index RECs are difficult to model in production cost simulations and therefore the following bid values were used for fixed and index REC prices:

Modeled Fixed REC bid = - REC price

Modeled Indexed REC bid = - (Index Strike Price – Average Index Premium)

For each generator with Index RECs, the bids are offset by the average index premium by generator type. For example, if the average wind fixed REC is \$21, the average wind index REC is \$55, and hypothetical Wind Plant X’s index REC is \$60, modeled REC bid = -(\$60-(\$55-\$21)) = -\$26.

Figure 34: Annual Curtailment by Unit Type



As shown in the chart above, curtailment levels are low in the Contract Case in the early years of the study period and can be attributed mostly to solar units in upstate New York. The NYISO also observed an amount of hydro and land-based wind resource curtailment. Starting in 2026, a significant increase in offshore wind curtailment can be observed. The Contract Case includes offshore wind projects which have received ORECs from NYSERDA. The offshore wind curtailment can mostly be attributed to local constraints at the point of interconnection in Zone K. Specific upgrades related to the interconnection of each project were not modeled as part of the production cost modeling.

4.2.6. Unserved energy

Periods of unserved energy in production cost simulations occur when there are not enough dispatchable resources available to serve load in an area. This is typically caused by transmission congestion in a localized zone which does not allow load to be served within that pocket or zone. To ameliorate this condition, the NYISO's production cost database has 'DD' units, which are hypothetical, high operating cost thermal units designed to come online and serve load in situations where capacity is deficient or dispatchable resources in the system are unable to serve load due to congestion. The output from these units is distributed to each load bus in a zone proportional to the load factor of the bus. Activation of any zone's DD unit for any number of hours indicates that there exists a capacity deficiency in that particular hour or there are significant amounts of congestion in and around the load such that energy cannot be delivered. The Contract Case observed three hours in 2040 when DD units operate in New York City.

4.2.7. Renewable generation pockets and map

The 2019 CARIS 1 70x30 scenario ("2019 70x30 Scenario") examined the congestion and constraint results from sensitivity cases to form renewable generation pockets within NYCA. These pockets illustrated transmission constraints that could prevent full utilization of renewable resources within the area. A similar analysis was performed here for the Contract Case for the year 2030 and two Policy Case scenarios for years 2030 and 2035.

The 2019 70x30 Scenario pocket definitions were taken as the starting point to identify constraints and generators within the pockets in the Contract Case as well as the Policy cases. Pocket names and geographic locations of the pockets were kept consistent with the 2019 70x30 scenario. It should be noted that since the assumptions and generation mix in the Contract and Policy cases are different in the Outlook than the 2019 70x30 Scenario, some pockets might not form as a result of constraints that are non-binding within the pocket definition.

The renewable curtailment in the cases studied could result from a combination of drivers, including: (i) resource siting location, (ii) size of renewable buildout, (iii) the congestion pattern of transmission constraints, (iv) existing thermal unit operations, and (v) zonal load level and shape. Renewable generation located upstream of transmission constraints is more likely to be curtailed compared with those located at downstream of the constraints. In general, renewable curtailments due to transmission constraints include constraints inside generation pockets, tie line constraints, and constraints outside of generation pockets.

Bulk level constraints which are historically binding remain among the most congested elements in the Contract Case. Some constraints could be more congested and new constraints might appear due to resource shifts in the system. Generation from fossil fuel-fired plants is replaced with that from land-based wind and solar renewable energy resources additions located upstate and away from load centers in Southeast New York.

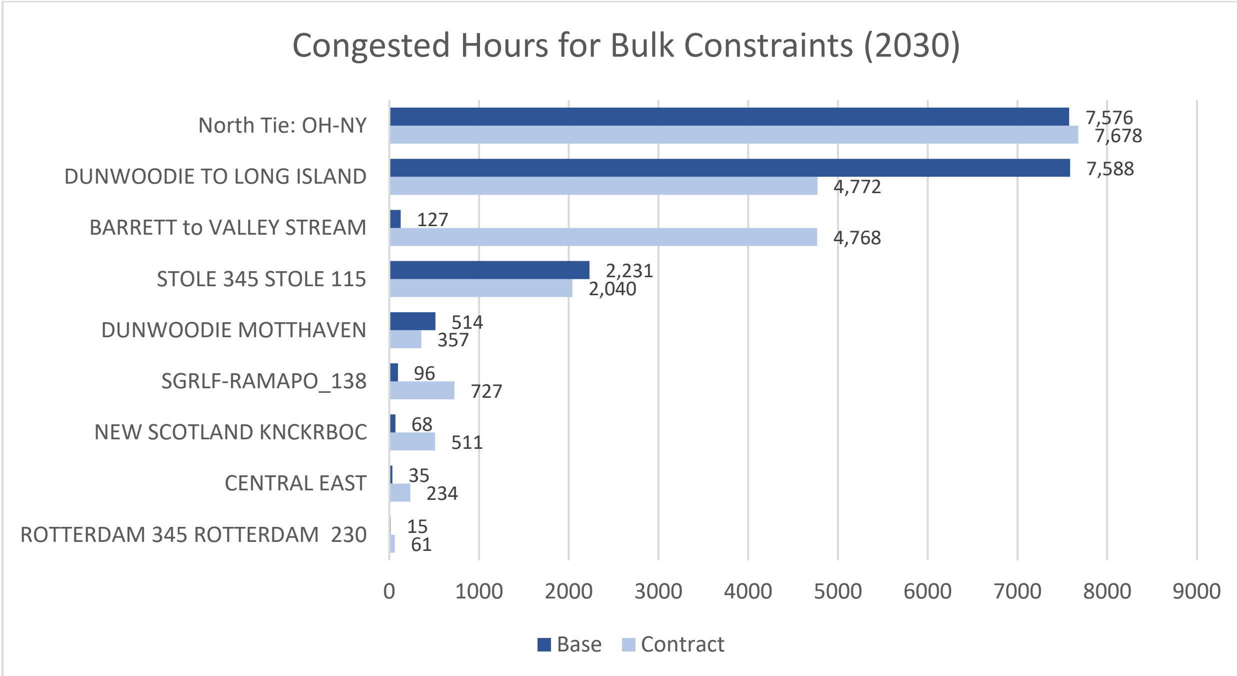
It is important to note that the Contract Case does not have the same amount of renewable capacity buildout as the 2019 70x30 Scenario. A comparison between the capacity builds in the two cases shows that the contract case has less renewable capacity built through 2030 compared to the 70x30 case, which was designed to meet the mandate of 70% renewable generation by 2030.

Figure 35: Comparison of Renewable Capacity from 2019 CARIS 1 70x30 Scenario to Contract Case

Resource Type	2019 CARIS 1 70x30 Scenario Load Case (MW)	2021 System and Resource Outlook Contract Case (MW)
HYDRO	4,467	4,489
UPV	10,831	4,804
OSW	6,098	4,316
LBW	6,476	3,670
Total	**27,872**	**17,279**

The decrease in congestion for land-based wind and solar resources from the 2019 70x30 Scenario to the Contract Case is driven primarily by a decrease in capacity and different load assumptions. Despite decreases in congestion and curtailment in the Contract Case, this study identifies the same pockets as in the 2019 70x30 Scenario. The pocket analysis indicates potential areas of generator curtailment for new renewable resources due to nearby transmission constraints. As such, these pockets identified in the 2019 70x30 Scenario continue to exist in the system modeled in the Contract Case, which contains probable future renewable generation locations for wind and solar and also persistent patterns of congestion that could lead to curtailment of such resources.

Figure 36: Number of Congested Hours by Constraint, Base and Contract Cases

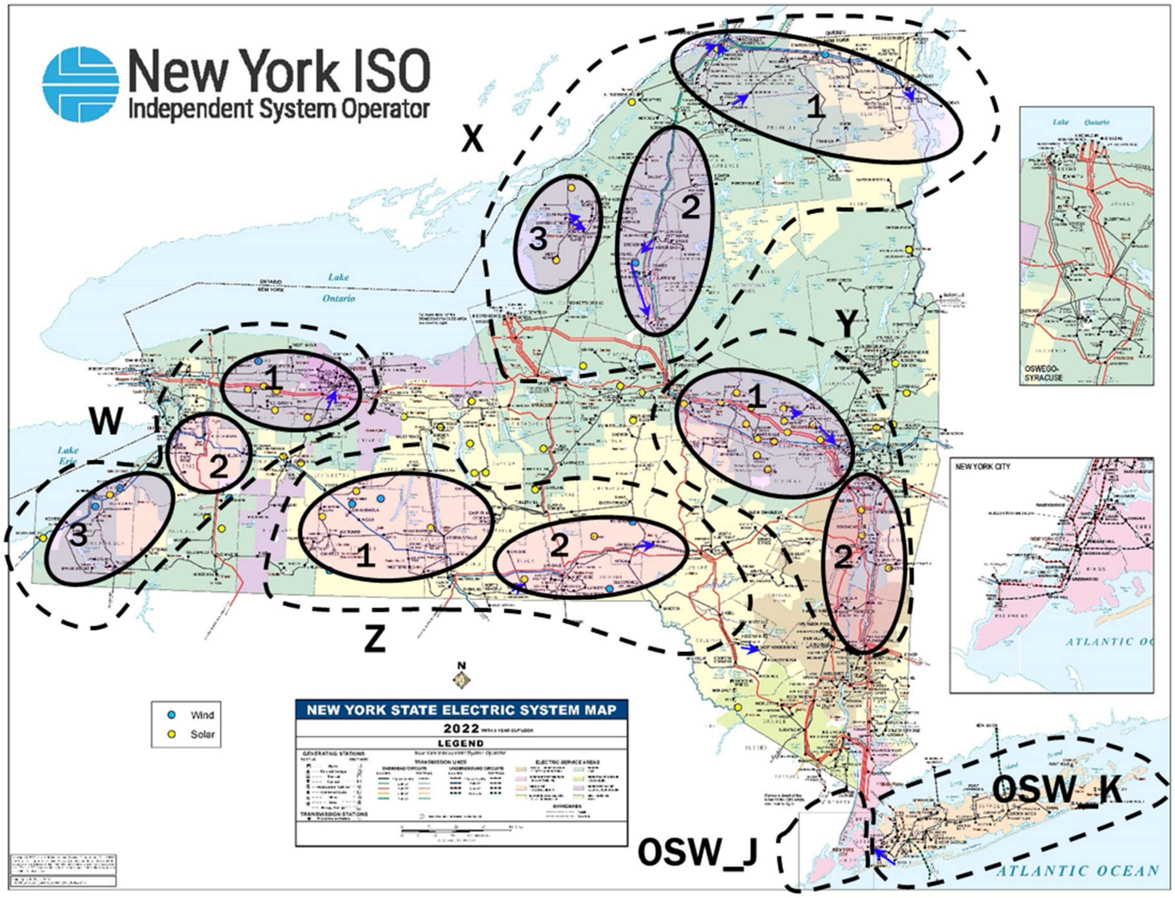


The above figure shows the number of hours bulk level constraints are congested in the year 2030. Since most of the contracted resources are scheduled to be in-service by this time, using 2030 as the reference year for comparison between the Base and Contract cases is particularly meaningful. Congested hours is the primary metric used to identify congested elements in the pocket analysis for the contract and policy cases. It indicates the amount of time the flow on a particular element is at its limit or exceeds its limit in a specific year.

Historically congested paths such as *Central East* show very low numbers of congested hours in the Base Case as well as the Contract Case. This can be attributed to the following major factors: 1) AC transmission projects being in-service, 2) lower imports from IESO due to nuclear refurbishment and retirements, and 3) higher load overall in upstate New York (due to addition of large non-conforming loads) compared to prior study cycles. The *Dunwoodie to Long Island* interface, which is highly congested in the Base Case, is congested for fewer hours in the Contract Case as a result of offshore wind resources in Zone K injecting into Long Island and pushing back some of the flow coming into the island through the Y49 and Y50 lines. The *North Tie: OH-NY interface,* which is comprised of the L33 and L34 PARs on the New York to Ontario border, remains highly congested in both cases.

The two parallel 138 kV lines from Barrett to Valley Stream are one of the most congested elements in the system in the Contract Case. Congestion on these lines results from the injection of offshore wind energy interconnected to the Barrett substation. This study does not model system interconnection upgrades for contracted resources which are yet to be determined in the NYISO Interconnection Process. Therefore, the impact on congestion of any upgrades required for a particular project to interconnect at a substation were not captured as part of this study.

Figure 37: 2030 Contract Case Pocket Map



Consistent with the methodology developed in the 2019 70x30 Scenario, the generation pocket assignments are defined by two main considerations: renewable generation buildout location, and the constraint congestion results from the contract case. Each pocket (W, X, Y and Z), along with corresponding sub-pockets (W1, X2, Y1, etc.), depicts a geographic grouping of renewable generation and the transmission constraints in a local area. Blue and yellow colored circles show approximate locations of new contracted renewables (wind and solar generation respectively) that are not included in the Base Case. Blue arrows overlayed on transmission paths indicate the direction of congested elements within a pocket.

These constrained paths, which are generally on the lower kV network, are electrically close to new contracted generators added in the Contract Case. Congestion on lines within the pocket could cause curtailment of generators within the pocket if alternate paths are not available or there are limited opportunities for redispatch in a given hour. There could also be higher kV bulk level constraints which limit the flow of energy from upstate to downstate, but usually lower kV constraints, which have lower line ratings, would become congested first, limiting the amount of energy that can flow out of the generation pocket and onto the bulk system.

It should be noted that not all renewable energy pockets were identified for the Contract Case compared to the 2019 70x30 Scenario as the buildout of renewable resources is different. Therefore, not all areas observe enough congestion or resources added to be studied as a pocket in the Contract Case.

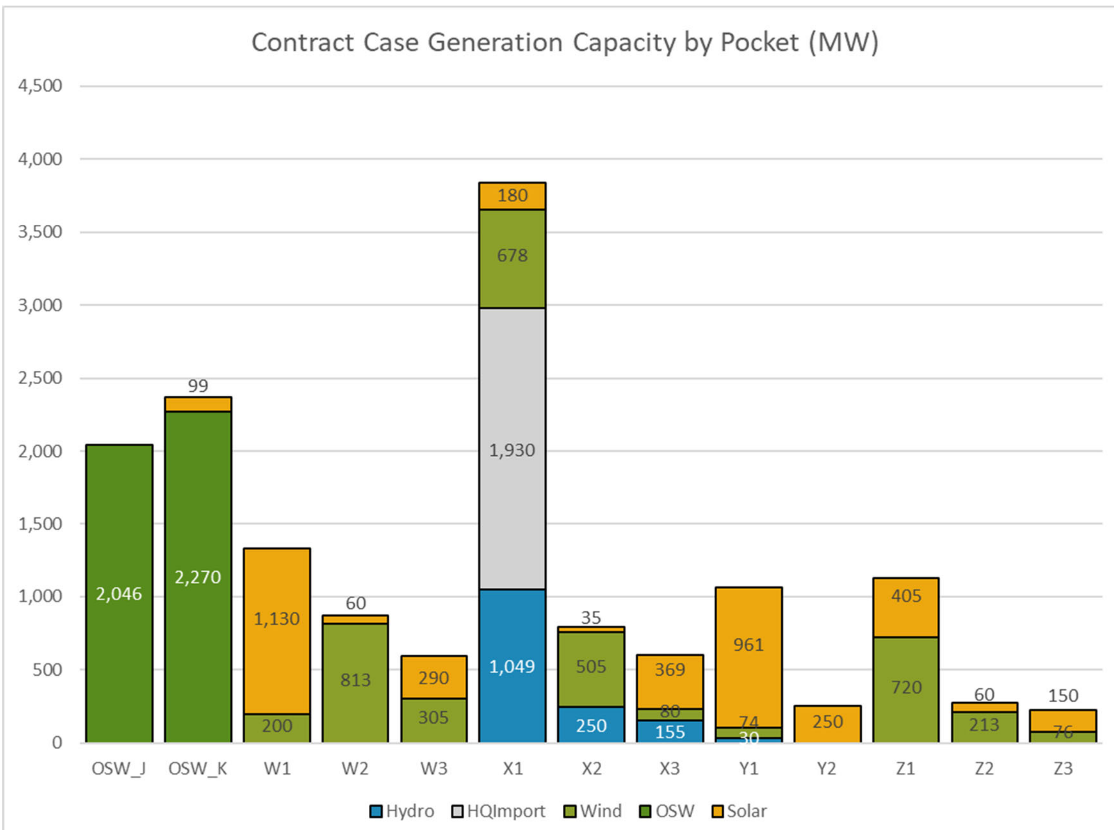
The following pockets are studied in the Contract and Policy Cases:

- **Western NY (Pocket W)**: Western NY constraints, mainly 115 kV in Buffalo and Rochester areas:
  1) **W1**: Orleans-Rochester Wind (115 kV)
  2) **W2**: Buffalo Erie region Wind & Solar (115 kV)
  3) **W3**: Chautauqua Wind & Solar (115kV)
- **North Country (Pocket X)**: Northern NY constraints, including the 230 kV and 115 kV facilities in the North Country:
  1) **X1:** North Area Wind (mainly 230 kV in Clinton County)
  2) **X2**: Mohawk Area Wind & Solar (mainly 115 kV in Lewis County)
  3) **X3**: Mohawk Area Wind & Solar (115 kV in Jefferson & Oswego Counties)
- **Capital Region (Pocket Y)**: Eastern NY constraints, mainly the 115 kV facilities in the Capital Region:
  1) **Y1**: Capital Region Solar Generation (115 kV in Montgomery County)
  2) **Y2**: Hudson Valley Corridor (115 kV)
- **Southern Tier (Pocket Z)**: Southern Tier constraints, mainly the 115 kV constraints in the Finger Lakes area:
  1) **Z1**: Finger Lakes Region Wind & Solar (115 kV)
  2) **Z2**: Southern Tier Transmission Corridor (115kV)
  3) **Z3**: Central and Mohawk Area Wind and Solar (115kV)
- **Offshore Wind:** offshore wind generation connected to New York City (Zone J) and Long

Island (Zone K)

Renewable energy generation capacity by generation pockets is shown below in Figure 38 for the Contract Case. Offshore wind makes up the majority of renewable generation added in Zones J and K. Upstate renewable generation is a mix of utility scale solar and land-based wind resources. The existing HQ imports into Zone D are considered qualifying renewable generation injecting into the X1 pocket.

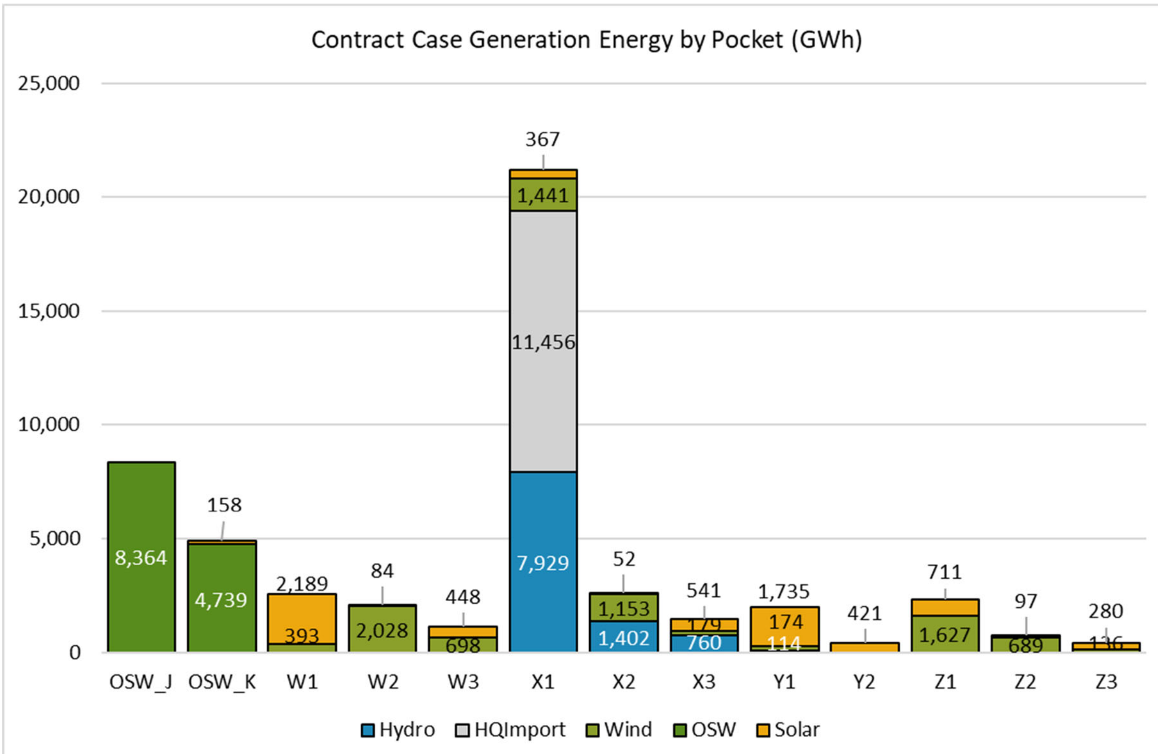
Figure 38: Contract Case Generation Capacity by Pocket (MW)



Each renewable generator is associated with an hourly generation profile for modeling purposes in the production cost simulation program. Owing to load, renewable scheduled generation, local transmission topology, and system conditions, a portion of potential renewable generator output may be curtailed. Curtailment of scheduled generation is usually caused when a generator is located upstream of a transmission bottleneck or in localized pockets with limited export capabilities.

As defined in above section, the pockets identified in this study are based on the combination of renewable generation and transmission system modeling assumptions. The aggregate amount of renewable energy curtailments within the pockets defined in this study accounts for 99% of all NYCA renewable energy curtailments in the Contract Case.

Figure 39: Contract Case Generation Energy by Pocket (GWh)



4.2.8. Energy deliverability calculations

Energy deliverability for a pocket is defined as the total energy utilized to serve load from a group of resources in a pocket. It is calculated by dividing the energy dispatched in a year for each resource type by the total scheduled energy for that resource.

$$Energy\ Deliverability = \frac{Total\ Dispatched\ Energy}{Total\ Scheduled\ Energy}$$

The energy deliverability metric gives an idea about how much of the total energy was utilized and how much was curtailed. The table below shows the Energy Deliverability metric by pocket and resource type.

Figure 40: Contract Case Energy Deliverability by Pocket and Resource Type

Pocket	Type	Capacity (MW)	Scheduled Energy (GWh)	Dispatched Energy (GWh)	Curtailment (GWh)	Energy Deliverability (%)
W1	Wind	200	393	393	0	100.0%
	Solar	1,130	2,214	2,189	25	98.9%
W2	Wind	813	2,029	2,028	2	99.9%
	Solar	60	84	84	0	100.0%
W3	Wind	305	700	698	2	99.6%
	Solar	290	448	448	0	100.0%
X1	Hydro	1,049	7,929	7,929	0	100.0%
	HQImport	1,930	11,498	11,456	41	99.6%
	Wind	678	1,441	1,441	0	100.0%
	Solar	180	367	367	0	100.0%
X2	Hydro	250	1,405	1,402	3	99.8%
	Wind	505	1,154	1,153	0	100.0%
	Solar	35	54	52	2	96.2%
X3	Hydro	155	771	760	11	98.6%
	Wind	80	179	179	0	100.0%
	Solar	369	609	541	69	89.9%
Y1	Hydro	30	114	114	0	99.8%
	Wind	74	179	174	5	97.3%
	Solar	961	1,801	1,735	66	96.5%
Y2	Wind	-	-	-	-	-
	Solar	250	421	421	0	100.0%
Z1	Wind	720	1,628	1,627	0	100.0%
	Solar	405	711	711	0	100.0%
Z2	Wind	213	696	689	7	99.0%
	Solar	60	97	97	0	100.0%
Z3	Wind	76	136	136	0	99.7%
	Solar	150	280	280	0	100.0%
OSW_J	Offshore Wind	2,046	8,366	8,364	2	100.0%
	HQImport	-	-	-	-	-
OSW_K	Offshore Wind	2,270	8,891	6,815	2,076	76.7%
	Solar	99	159	158	1	99.5%

The majority of curtailment is limited to Long Island from offshore wind injection. This results in a low energy deliverability percentage compared to other pockets and resource types. Some solar curtailment is seen in upstate New York in pockets X2, X3, and Y1, which have increasing amounts of solar projects proposed in the Interconnection Queue. These curtailments are generally due to a lack of a strongly interconnected network to deliver power, at both bulk and local system levels.

Detailed analysis of each pocket identified in the Contract and Policy Cases are included in

Appendix XX of this report.

4.2.9. Key Findings

- Resource additions in the Contract Case were not designed to fulfill any policy requirements**.** Renewable capacity is less than what was built for 2019 70x30 Scenario, which results in different congestion patterns and levels of curtailment.
- Local and bulk level constraints in the system (existing or new ones) may lead to renewable resources not being able to deliver all the scheduled energy at a given hour. Curtailment of resources within a localized area is studied by grouping together generators and constraints inside renewable generation pockets.
- Congestion patterns on the constraints inside the pockets show that the elements are more congested as additional resources are added to the area. More pockets may develop in the system where the geographic location might be suitable for renewable energy development, but existing transmission paths may not be adequate to transmit power out of the region.
- Curtailment of resources and congestion patterns are highly dependent on where the resources are located in the system, the transmission system topology, and capability of available transmission lines to deliver power to loads.
- Overall, the majority of the curtailments seen in the contract case can be attributed to offshore wind resources in Zone K. Injecting large amounts of power into a transmission system not designed to handle such levels causes the curtailment.