New York ISO
Independent System Operator

# 2021-2040 System & Resource Outlook (The Outlook)

**A Report from the New York Independent System Operator**

September 22, 2022

# Table of Contents

**APPENDICES**

## Executive Summary

Driven by New York State's Climate Leadership and Community Protection Act (CLCPA), Accelerated Renewable Energy Growth and Community Benefit Act, and other state clean energy policies, New York's electricity generation, transmission and demand landscape is rapidly changing. This shift leads to re-thinking how and where electric supply and storage resources evolve, and how to efficiently enable their adoption to achieve energy policy targets.

This *2021 – 2040 System & Resource Outlook* (the Outlook), conducted by the New York Independent System Operator (NYISO) in collaboration with stakeholders and state agencies, provides a comprehensive overview of potential resource development over the next 20 years in New York and highlights opportunities for transmission investment driven by economics and public policy in New York State. The Outlook together with the NYISO's *2021-2030 Comprehensive Reliability Plan* (CRP) represent the marquee planning reports that provide a full New York power system outlook to stakeholders, developers, and policymakers.

The Outlook examines a wide range of potential future system conditions and enables comparisons between possible pathways to an increasingly greener resource mix. By simulating several different possible future system configurations and forecasting the transmission constraints for each, the NYISO:

- Projected possible resource mixes that achieve New York's public policy goals while maintaining grid reliability;
- Identified regions of New York where renewable or other resources may be unable to generate at their full capability due to transmission constraints;
- Quantified the extent to which these transmission constraints limit delivery of renewable energy to consumers, and;
- Identified potential opportunities for transmission investment that may provide economic, policy, and/or operational benefits.

There are many potential paths and combinations of resource and transmission builds to achieving New York's climate change requirements. As the current power system continues to evolve, evaluating a variety of expansion scenarios will facilitate identification of common and unique challenges to achieving the electric system mandates New York State has set for 2030 and 2040. A thorough understanding of these challenges will help build a path for stakeholders and policymakers to achieve a greener and reliable future grid efficiently and cost effectively. Through this Outlook several key findings were brought to light:

# 2021 – 2040 System & Resource Outlook

## Key Findings

**Critical Factors for New York's CLCPA Success**

**Add New Resources**
To meet policy objectives and society-wide electrification, over 95 GW of new zero-emission resources will be required by 2040, of which at least 20 GW needs to be added in the next 7 years

**Expand Transmission**
The current New York transmission system, at both local and bulk levels, is inadequate to achieve currently required policy objectives

**Maintain Reliability**
Dispatchable emission-free resources must be developed and deployed throughout New York

**The NYISO's Next Steps**

**Identify Needs & Opportunities**
Continue to assess the evolving system and identify the challenges and opportunities associated with achieving state policies in an economic and reliable manner

**Review Its Wholesale and Reliability Rules**
to facilitate the orderly transition of replacement resources

**Solicit Stakeholder Feedback**
on Public Policy Transmission Needs

Four potential futures are evaluated to best understand the challenges ahead. A Baseline Case evaluates a future with little change from today. A Contract Case includes approximately 9,500 MW of renewable capacity procured by the state and evaluates the impact of those projects. Finally, a Policy Case postulates and examines two separate future scenarios that meet New York policy mandates.

### Grid in Transition: Implementation of Contracted Renewables

Through an annual request for proposals, NYSERDA solicits bids from eligible new large-scale renewable resources and procures Renewable Energy Certificates (RECs) and Offshore Renewable Energy Certificates (ORECs) from these facilities. This Outlook included approximately 9,500 MW of new contracted renewable resources, including 4,262 MW of solar, 899 MW of land-based wind, and 4,316 MW of offshore wind. The addition of these resources to the existing system representation provides insights regarding their impact on system performance in the future.

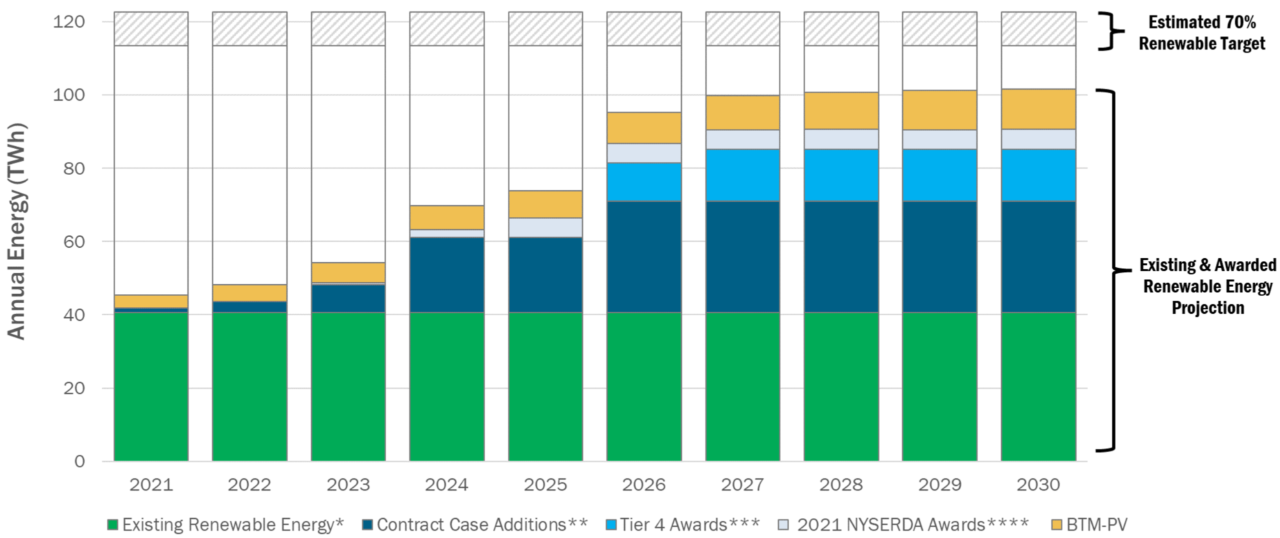
The analysis performed focuses on transmission congestion and how patterns change through time when New York State contracted renewable projects are added to the system. It is important to note that neither case models' generation additions or retirements beyond what was included in the *2021-2030 Comprehensive Reliability Plan* or what has been contracted by the state.

**The contracted renewable project portfolio will exacerbate existing transmission congestion and will encounter new local transmission constraints throughout New York State.** Working from the Baseline Case, the Contract Case was formulated by adding this 9,500 MW (9.5 GW) of future renewable generation projects. Most of the renewable projects are upstate solar or downstate offshore wind projects scheduled for installation prior to 2026.

The additional capacity from the contracted projects represents a nearly five-fold increase in utility scale renewables compared to the system today. Without any major transmission upgrades planned to specifically address this large influx of contracted renewables, transmission congestion increases. When the contracted renewable projects are added, several additional constraints appear, causing a 23% increase in congestion statewide by 2030.

A major impact of the transmission constraints is that larger amounts of renewable generation experience curtailment. Other generation that provides dispatchability to system operators is curtailed as well. Specific to the renewable fleet, renewable generators average approximately five GWh of annual curtailment in the Baseline Case, whereas curtailments increase to an annual average of 163 GWh in the Contract Case. Most of the curtailments are experienced by offshore wind projects connected to Long Island due to inadequate transmission capacity.

**Progress Towards "70 x 30" Mandate[1]**




The contracted renewable additions that were modeled as part of this study as well as NYSERDA's 2021 Tier 1 solicitation project awards show that much progress is being made towards achieving the 2030 mandate of 70% renewable energy. Based on forecasted energy demand, additional renewable projects will be required between now and 2030 to meet the mandate.

By 2030, roughly seven years from the publication of this report, an estimated 20 GW of additional renewable generation must be in-service to support the energy policy target of 70% renewable generation by 2030. For reference, 12.9 GW of new generation has been developed since wholesale electricity markets began more than 20-years ago in 1999. Over the past five years, 2.6 GW of renewable and fossil-fueled generators came on-line while 4.8 GW of generation deactivated. This Outlook demonstrates the need for an unprecedented pace of project deployment that will require significant labor and materials available for New York over a long period of time.

The large amount of renewable energy additions required to achieve the CLCPA mandates will impact the nature of the operations of the existing fossil fuel fleet in the remaining 18-year transition to an emission-free grid. The operational needs of dispatchable generation on the system, such as existing fossil generators, will become more demanding as the state progresses towards policy goals. The number of

[1] *Estimated 2021 renewable energy per NYSERDA CES Compliance Report
**Additional renewable energy modeled from projects included in the Outlook Contract Case
***Tier 4 awards exclude associated renewable projects with existing Tier 1 awards
****Max annual contract quantity of renewable energy from projects awarded in the 2021 NYSERDA Tier 1 solicitation

dispatchable generator starts/stops, daily ramping, operational range, and other flexibility attributes will increase to meet a more dynamic net-load. There will be a greater need for resources that can operate more flexibly to meet the increased variability associated with wind and solar generation. This Outlook demonstrates that the flexible units will be dispatched more frequently but will operate for less hours within the year as the transition unfolds. Until new technologies emerge, continued operation of fossil will be required in some manner during the grid transition.

**AC Transmission Public Policy projects and Ontario nuclear retirements greatly reduce current Central East interface congestion.** With the planned completion of the NYISO AC Transmission Public Policy Projects in 2024, which represent substantial upgrades to the electric grid in the Mohawk and Hudson Valleys, transmission congestion on the Central East/Total East interface is nearly eliminated in the Baseline Case. However, the potential addition of more renewable generation upstream of the Central East interface may result in greater future congestion, as demonstrated in the Contract and Policy Cases.

A secondary contributing factor to reducing Central East congestion is the nuclear retirements and refurbishments planned by the Ontario Independent Electric System Operator (IESO). Between 2021 and 2025 over 10,000 MW of nuclear plant capacity is planned for either retirement or long-term refurbishment. This represents over 25% of the generation capacity in Ontario, which typically accommodates for economic energy exports to the NYISO, nearly all of which traverses the Central East interface. Without inexpensive excess capacity in Ontario for export, the NYISO experiences reductions in Ontario imports and a decrease in congestion on the Central East interface.

### Implementation of Contracted Renewables: Key Takeaways

✓ **The pace of renewable project development is unprecedented and requires an increase in the pace of transmission development.** Every incremental advancement towards policy achievement matters on the path to a greener and reliable grid in the future, not just at the critical deadline years such as 2030 and 2040. In general, resource and transmission expansion take many years from development to deployment.

✓ **Coordination of project additions and retirements is essential to maintaining reliability and achieving policy.** Coordination of renewable energy additions, commercialization, and development of dispatchable technologies, fossil fuel plant operation, and staged fossil fuel plant deactivations over the next 18 years will be essential to facilitate an orderly transition of the grid.

### Road to 2040: Resources to Achieve Policy Targets

Building upon the known contracted resources, the NYISO developed postulated scenarios that reflect full achievement of the CLCPA targets. The scenarios are collectively referred to as the "Policy Case." Examples of policies modeled in this case include the 70% renewable energy by 2030 (70 x 30) renewable mandate and the 100% zero-emissions by 2040 directive (100 x 40). These system representations involve many assumptions and unknowns but provide an informed view of the future to enable sound decision-making by policymakers and stakeholders[2]. The Policy Case will also be utilized as part of the NYISO Public Policy Process, including evaluation of the Long Island Offshore Wind Export Public Policy Transmission Need. Finally, the 2022 Reliability Needs Assessment (RNA) will include a scenario that builds upon the findings from the Outlook Policy Case to provide further insight into system reliability impacts of the potential build out, such as effects on resource adequacy.

Dozens of preliminary scenarios were evaluated. Key factors such as capital cost and demand forecasts were adjusted to investigate the key drivers for resource additions and possible pathways to policy achievement. Among all factors tested, the demand forecast demonstrated the largest impact on the resulting capacity expansion.

After discussions with stakeholders, including state agencies, two distinct scenarios were selected for evaluation as the Policy Cases for this report:

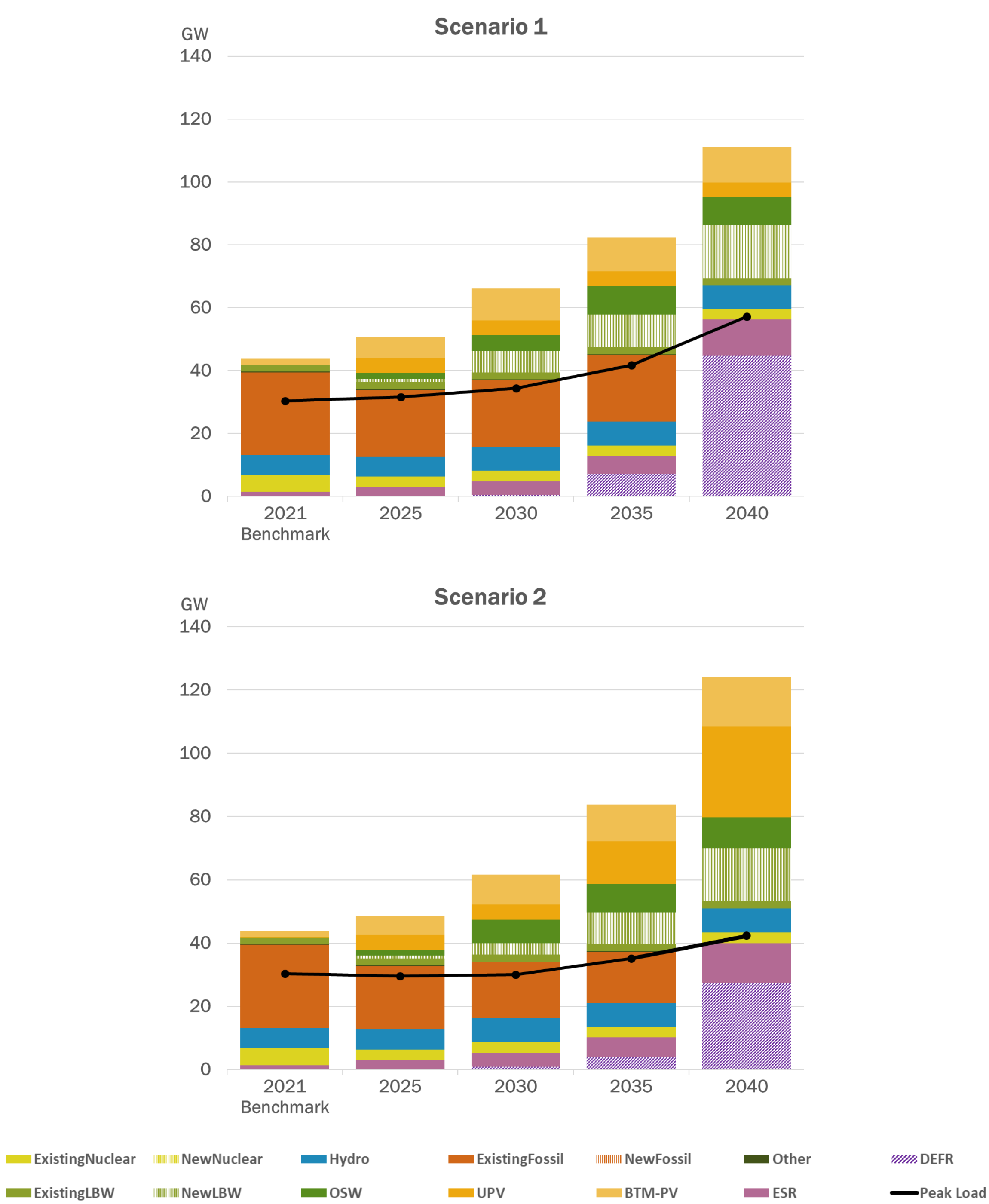
- **Scenario 1 (S1)** - Utilizes industry data and NYISO load forecasts, representing a future with high demand (57,144 MW winter peak and 208,679 GWh energy demand in 2040) and assumes less restrictions in renewable generation buildout options.
- **Scenario 2 (S2)** - Utilizes various assumptions consistent with the Climate Action Council Integration Analysis and represents a future with a moderate peak but a higher overall energy demand (42,301 MW winter peak and 235,731 GWh energy demand in 2040).

The load and capacity forecast for the two scenarios are shown in the following charts. Both scenarios produce a blend of Land-Based Wind (LBW), Offshore Wind (OSW), Utility-Scale Solar (UPV), Behind-the-Meter solar (BTM-PV) and Energy Storage (ESR) to meet the CLCPA policy mandates through 2035. By 2040, all existing fossil generators are assumed to be retired to achieve the CLCPA target for a zero-emission grid and are replaced by Dispatchable Emission-Free Resources (DEFRs). These resources represent a proxy technology that will meet the flexibility and emissions-free energy needs of the future system but are not yet mature technologies that are commercially available (some examples include hydrogen, renewable natural gas, and small modular nuclear reactors).

[2] The complexity of conducting a detailed quantitative assessment specific to year 2040 is beyond the limitation of the commercial software utilized in this study. Certain details, such as local constraints, were removed from the model.

**As more wind, solar, and storage plants are added to the grid, dispatchable emission-free resources must be added to the system (or fossil generation retained) to meet the minimum statewide and locational resource requirements for serving system demand when intermittent generation is unavailable.**

**New York Installed Capacity Generation Resource Mix Scenarios**



Scenario 1 favors land-based wind technologies to meet emission-free targets while Scenario 2 favors a blend of land-based wind and solar. By 2040, Scenario 1 builds approximately 45 GW of DEFR generation capacity while Scenario 2 builds 27 GW. For reference, today's New York fossil fleet totals approximately 26 GW. The large amount of DEFR capacity in Scenario 1 is driven by a 35% higher peak load forecast than Scenario 2 despite having a 13% lower annual energy demand in 2040. **Both scenarios include significant DEFR capacity by 2035, but it is important to note that the lead time necessary for commercialization, development, permitting, and construction of DEFR power plants will require action much sooner if this timeline is to be achieved.**

In another scenario, the NYISO analyzed the impact to the resource mix if investments are not made in research, development, and commercialization of dispatchable emission-free resources. The exclusion of DEFRs as a new technology option, while enforcing the retirement of fossil generators via the zero-emission by 2040 policy, exhausts the amount of land-based wind built and results in the replacement of 45 GW of DEFR capacity in Scenario 1 with 30 GW of offshore wind and 40 GW of energy storage. Note that this capacity replacement estimate is intended to be a directional proxy and would not fully substitute for the attributes provided by either today's fossil fueled fleet or by future DEFRs. Further reliability concerns, such as voltage support and dynamic stability, may require other system reinforcements to maintain reliability in the future grid.

The load and energy forecasts in the Policy Cases include the impact of electrification from other sectors, such as building and transportation, into the power sector. **Electrification is one of the largest factors driving rapid increases in peak and annual energy demand, which lead to the need for new generation resources to meet renewable energy and reliability needs.** While other sectors, such as transportation, currently account for a larger share of greenhouse gas emissions, unmanaged electrification of the sector could lead to higher power sector emissions, wholesale electricity system costs, and reduced system reliability. The impacts of electrification on the power system should be monitored and managed closely.

New York is interconnected to neighboring regions through the high-voltage transmission network. Energy is transmitted in interstate commerce along the interstate grid based on bids and offers across regional lines as provided by federal market rules approved by the Federal Energy Regulatory Commission (FERC) under the Federal Power Act. The economic and operational impact from neighboring electric systems will continue to evolve as the neighboring states also strive to achieve their respective energy policy targets. While the interconnection with external areas is substantial and provides many economic and reliability benefits, it also makes the New York grid susceptible to changes outside of the region. **Grid conditions outside of New York, such as nuclear refurbishments and retirements in Ontario and surplus generation elsewhere, may lead to imports from external $CO_2$-producing fossil generation, which impacts the zero-emission policy attainment in 2040.** The interregional impacts of state-specific policies are dynamic, and the rapid changes will require continuous monitoring and assessment. The Northeastern ISO/RTO Planning Coordination Protocol provides a mechanism by which studies of these impacts can be performed. Potential interregional transmission solutions can be identified to further energy deliverability among regions. The extent to which regions outside New York adopt clean energy goals of their own will determine the mix of renewable and non-renewable resources that are available to serve New York.

### Road to 2040: Key Takeaways

✓ **Significant new resource development will be required to achieve CLCPA energy targets.** The total installed generation capacity to meet policy objectives within New York is projected to range between 111 GW and 124 GW by 2040. At least 95 GW of this capacity will consist of new generation projects and/or modifications to existing plants[3]. Even with these additions, New York still may not be sufficient to fully meet CLCPA compliance criteria[4] and maintain the reliable electricity supply on which New York consumers rely[5]. The sheer scale of resources needed to satisfy system reliability and policy requirements within the next 20-years is unprecedented.

✓ **To achieve an emission-free grid, dispatchable emission-free resources (DEFRs) must be developed and deployed throughout New York.** DEFRs that provide sustained on-demand power and system stability will be essential to meeting policy objectives while maintaining a reliable electric grid. While essential to the grid of the future, such DEFR technologies are not commercially viable today. DEFRs will require committed public and private investment in research and development efforts to identify the most efficient and cost-effective technologies with a view towards the development and eventual adoption of commercially viable resources. The development and construction lead times necessary for these technologies may extend beyond policy target dates.

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[3] As compared to the 2021 baseline, including the in-front-of the meter and behind-the-meter renewable generation addition by 2040, assuming deactivation of the existing fossil-fired generation.

[4] This report does not attempt to identify the resources needed to achieve full policy attainment such as reducing 85% GHG by 2050

[5] Reliability will be evaluated in the NYISO Reliability Planning Process through the Comprehensive Reliability Process and Reliability Needs Assessment.

✓ **As the energy policies in neighboring regions evolve, New York's imports and exports of energy could vary significantly due to the resulting changes in neighboring grids.** New York is fortunate to have strong interconnections with neighboring regions and has enjoyed reliability and economic benefits from such connections. The availability of energy for interchange is predicted to shift fundamentally as policy achievement progresses. Balancing the need to serve demand reliably while achieving New York's emission-free target will require continuous monitoring and collaboration with our neighboring states.

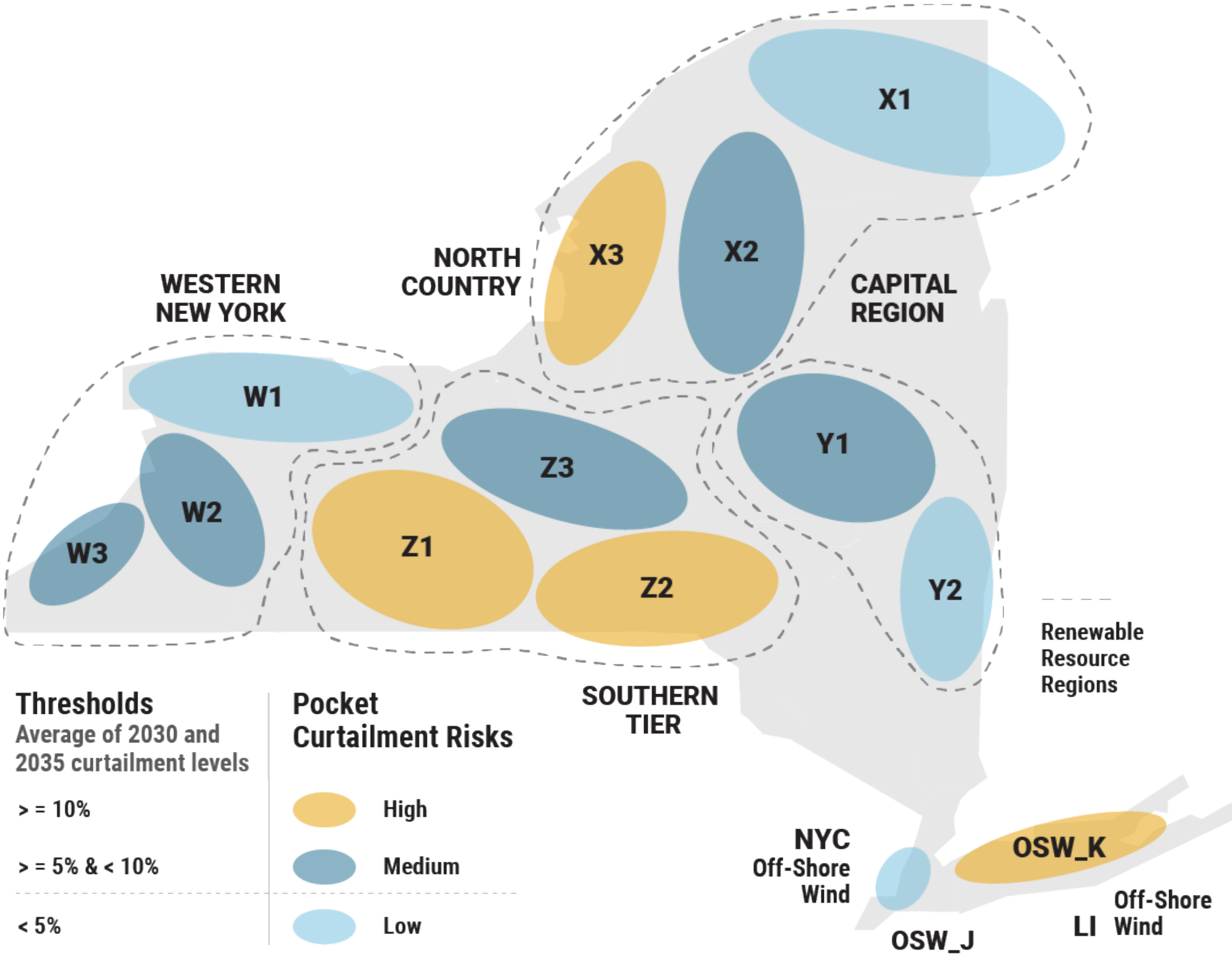
### Renewable Generation Pockets: Transmission Challenges and Opportunities

Due to the significant resource additions, new transmission constraints appear across the system as CLCPA achievement approaches in 2040. To better understand the impacts from these new constraints, generation pockets are identified based on their geographical locations, as shown on the following map. Each pocket depicts a geographic grouping of renewable generators, and transmission constraints in a local area and are further highlighted in sub-pockets. The renewable generation pocket concept originated with the "70 x 30" scenario in the 2019 economic planning study, and a similar framework was used for this Outlook with the addition of the new energy deliverability metric.

Energy deliverability represents the ability of renewable generation (wind, solar, and hydro) to inject energy into the grid to serve end-use consumers without curtailment. Generally, energy deliverability is reduced as more renewable capacity is added to the system, driven by transmission constraints across the system. The greater the renewable generation curtailment in a given pocket, the greater the opportunity for transmission investment. High curtailment pockets represent transmission needs that must be addressed in order to achieve the public policy targets of the CLCPA.

Curtailment of renewable generation occurs when a transmission line would otherwise be overloaded if that renewable generation were not reduced to a lower output level. The curtailment of a specific renewable generator is dependent upon both electrical location and energy market bids. A second form of renewable generation reduction, termed "spillage," can also occur. Spillage of renewable energy can occur when all relevant dispatchable resources have been set to minimum levels and energy export limits have been reached, which would necessitate a reduction in renewable generation output to balance the system. Spillage conditions are projected to occur as early as 2030 and would be most prevalent during the spring season when electricity demand is low and renewable generator production is high.

**New York Renewable Generation Pocket Map**




Four pockets will particularly benefit from transmission expansion in the near-term: Finger Lakes (Z1), Southern Tier (Z2), Watertown (X3), and Long Island. Without investment in transmission, these areas of the New York grid will experience persistent and significant limitations to deliver the renewable power from these pockets to consumers in the upcoming years.

### Renewable Generation Pockets: Key Takeaways

✓ **Transmission limitations prevent full delivery of renewable energy.** A minimum of 5 TWh of renewable energy in 2030 and 10 TWh in 2035 is projected to be curtailed due to transmission limitations in renewable pockets. This equates to roughly 5% less renewable energy that can be produced, and thus may not be counted toward the CLCPA targets.

✓ **Transmission expansion is critical to facilitating efficient CLCPA energy target achievement**. The current New York transmission system, at both local and bulk levels, is inadequate to achieve currently required policy objectives. Some renewable generation pockets throughout the State already face curtailments, more curtailments will be experienced in the future and will become more constrained as an increasing number of intermittent generation resources interconnect.

✓ **Four pockets will particularly benefit from transmission expansion**. The Finger Lakes (Z1), Southern Tier (Z2), Watertown (X3), and Long Island. Without investment in transmission, these areas of the New York grid will experience persistent and significant limitations to deliver the renewable power from these pockets to consumers in the upcoming years.

### Next Steps

The Outlook has, for the first time, built upon the data, modelling, and studies developed within the NYISO's System & Resource Planning Department and will serve as another building block for continued analyses and study work both within and outside of the NYISO. The data and findings provided by the Outlook are designed and intended to be used by policymakers, investors, and other stakeholders to identify the challenges and opportunities associated with achieving state policies in an economic and reliable manner.

The *2022 Reliability Needs Assessment (RNA)* will leverage data from the Outlook to identify commitment and dispatch trends and related bulk power system reliability impacts as policy goals are approached. The *2022 Grid in Transition study* that the NYISO is also performing will leverage data from the Outlook to continue analysis surrounding potential grid needs and inform market designs for the future grid.

The 2022-2023 Public Policy Transmission Planning cycle kicks off in August, at which time the NYISO will provide an opportunity for any stakeholders or interested parties to submit comments regarding proposed transmission needs that may be driven by public policy requirements, such as the transmission opportunities identified in this Outlook, and for which transmission solutions should be requested and evaluated. Stakeholders and interested parties should consider the findings and recommendations of the Outlook in formulating their proposed Public Policy Transmission Needs.

### Recommendations and Observations

The important findings identified in the 2021-2040 System & Resource Outlook are the basis for several recommendations to address the challenges revealed by the study:

- Many transmission needs will arise over the next 20 years driven by public policy requirements, most notable the New York State climate mandates enacted in 2019 and 2020. The most significant and urgent transmission needs include:

- **Long Island offshore wind export** - The NYISO is currently evaluating the viable and sufficient project proposals to the Long Island Offshore Wind Export Public Policy Transmission Need (Long Island PPTN), based on the Order issued by the New York State Public Service Commission on March 19, 2021. If a more efficient or cost-effective solution is selected to meet the Long Island PPTN, the congestion in Long Island is expected to be reduced significantly. However, offshore wind resource additions of up to 20 GW that are under discussion[6] may necessitate additional transmission to deliver offshore wind energy to New Yorkers.
- **The Watertown/Tug Hill Plateau renewable generation pocket (X3)** - The 115 kV network is expected to limit the availability of the already-contracted wind and solar generation in this area, and the limitation will become more severe when more renewable resources are interconnected. Additional transmission is necessary to provide the resources access to the bulk grid.
- **Southern Tier renewable generation pocket (Z1, Z2)** - The land and natural resource availability in this region (wind and solar) attract renewable generation buildout in this area. Transmission expansion from this pocket to the bulk grid would benefit New York consumers statewide.

- Future uncertainty is the only thing certain about the electric power industry. From policy advancements to new dispatchable emissions-free resource technology innovation and ultimate development, the system is set to change at a rapid pace. Situational awareness of system changes and continuous assessment are critical to ensure a reliable and lower-emissions grid for New York. The Economic Planning databases and models will be continually updated with new information and the Outlook study will be improved and performed on a biennial basis.
- To meet the minimum capacity requirement in 2040, at least 95 GW of new emission-free resources, including approximately 9.5 GW of new contracted renewable resources, will be required to come on-line. Furthermore, to fully achieve the emission-free grid target by 2040, even more resources will likely be needed along with transmission to deliver the clean power to consumers. The scope of the additional renewable resource need is both substantial and unprecedented. Compared to the 2.6 GW capacity entering service in the past five years while New York experienced a net loss of approximately 2.2 GW, the installation rate in the next 20 years must increase significantly to achieve state law climate change requirements. State agencies should consider releasing a more detailed procurement schedule for renewable resources to guide the long-term system planning and provide clarity to the market.
- The challenges identified in the Outlook cannot be solved by any single entity. New York's Climate Action Council (CAC) has released a draft scoping plan to reduce New York State's

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[6] New York State Climate Action Council Draft Scoping Plan, December 30, 2021, available at, https://climate.ny.gov/Our-Climate-Act/Draft-Scoping-Plan.

carbon footprint across all sectors, make our communities more resilient, and adapt to a changing climate. This plan further supports the state's mission by quantifying the evolving challenges in the electricity sector resulting from widespread beneficial electrification and making recommendations to address those challenges. In addition to much more renewable resources, this plan identifies other key factors for success, such as significant transmission expansion, and efficient peak load management. The full set of comprehensive electric system requirements will need participation among policymakers, generator owners, transmission owners, and consumers. Communication and collaboration between stakeholders is essential to making progress toward achieving policy objectives while maintaining an efficient power market and reliable power grid.

# 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 from the rapidly shifting resource landscape toward renewable resources driven by the state's enactment of the CLCPA and the Accelerated Renewables Act in two successive years and by its 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 horizon to 20-years and broaden the metrics considered in evaluating the system, such as the deliverability of energy output from new renewable resources and generation capacity expansion model metrics. 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). 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* (CRP) and the System & Resource Outlook provide a full reliability and economic power system outlook to stakeholders, developers, and policymakers.

The 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 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 reference case leverages NYISO's expertise in power system data and modeling as well as ongoing meaningful engagement with stakeholders.

The three reference cases are:

**Baseline Case** – The Baseline 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 number of new projects that are assumed to be completed in this case for consideration, 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 Baseline Case by adding incremental renewable generation projects that have been the announced recipients of project awards and financial contracts with the state (e.g., NYSERDA Renewable Energy Certificates (REC) contracts) and thus have a higher likelihood of completion, even though they do not yet meet Baseline Case inclusion rules.

**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 x 30 renewable mandate and the 2040 zero-emissions directive. To align policy-based review, 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 affords 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 continue or form anew, (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. These analyses will, in turn, inform reliability studies, including the 2022 Reliability Needs Assessment (RNA), which will include a scenario based upon the Outlook Policy Case.

## State of System & Resource Planning

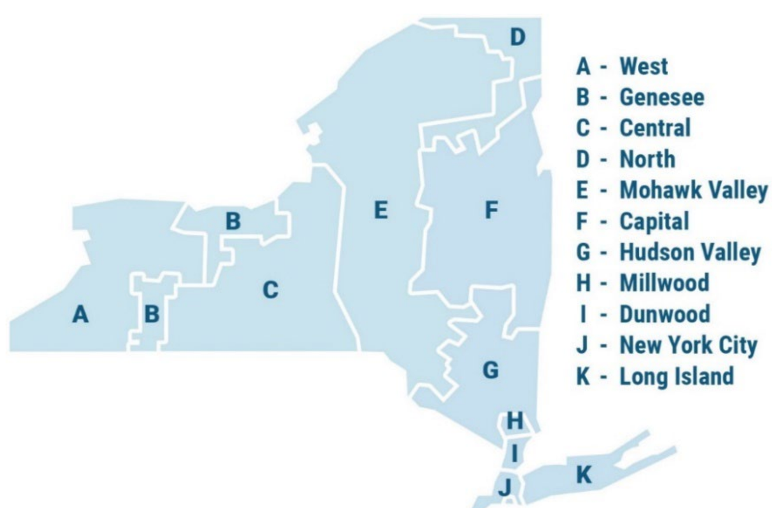
The Outlook is developed through the Economic Planning Process, which is part of the NYISO's Comprehensive System Planning Process (CSPP). The Outlook provides a comprehensive overview of the potential system resource development and transmission constraints throughout New York, and highlights opportunities for transmission investment driven by economics and public policy. Through the CSPP, numerous assessments, evaluations, and plans are developed and relied upon by the NYISO to conduct system planning, including demand forecast & analysis, reliability planning, economic planning, public policy planning, interregional planning, and interconnection studies.

### State of the Grid

How New York's power grid serves consumers is changing dramatically, and the bulk power system is evolving to meet the state's clean energy objectives. The NYISO offers two annual publications: the Load & Capacity Data Report[7] (Gold Book) and Power Trends[8], that provide independent sources of information and analysis on New York's complex electric system.

The New York Control Area (NYCA) is comprised of 11 geographical zones from western New York (Zone A) through Long Island (Zone K). These zones are referred to throughout this report to provide locational details regarding system demand, projected resource mixes, and anticipated transmission constraints. A map of the NYISO zones is shown in Figure 1.

**Figure 1: NYISO Load Zone Map**




[7] 2022 Load & Capacity Data Report

[8] 2022 Power Trends

The detailed data and analysis of the generation in New York can be found in Power Trends. A summary of the current system resources is provided below to facilitate understanding of the findings in this report. Figure 2 depicts the projected mix of resource capacity expected to be available for the 2022 summer capability period. Figure 3 provides the energy production by fuel sources in 2021. In 2021, zero-emission resources made up 91% of upstate production, while fossil units downstate made up 89% of the production from that region.

**Figure 2: Summer Installed Capacity (MW) by Fuel Source – Statewide, Upstate, & Downstate New York: 2022**

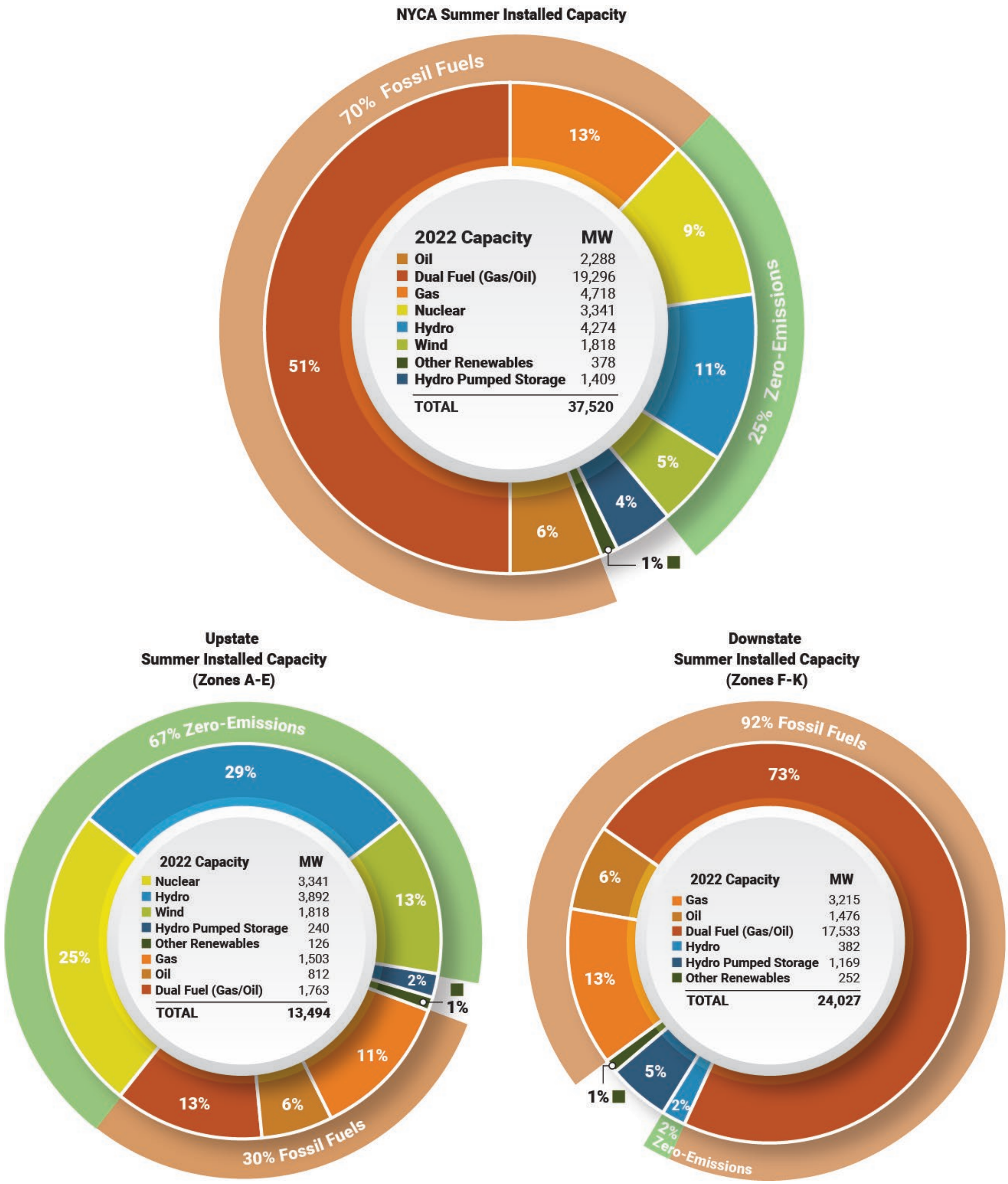
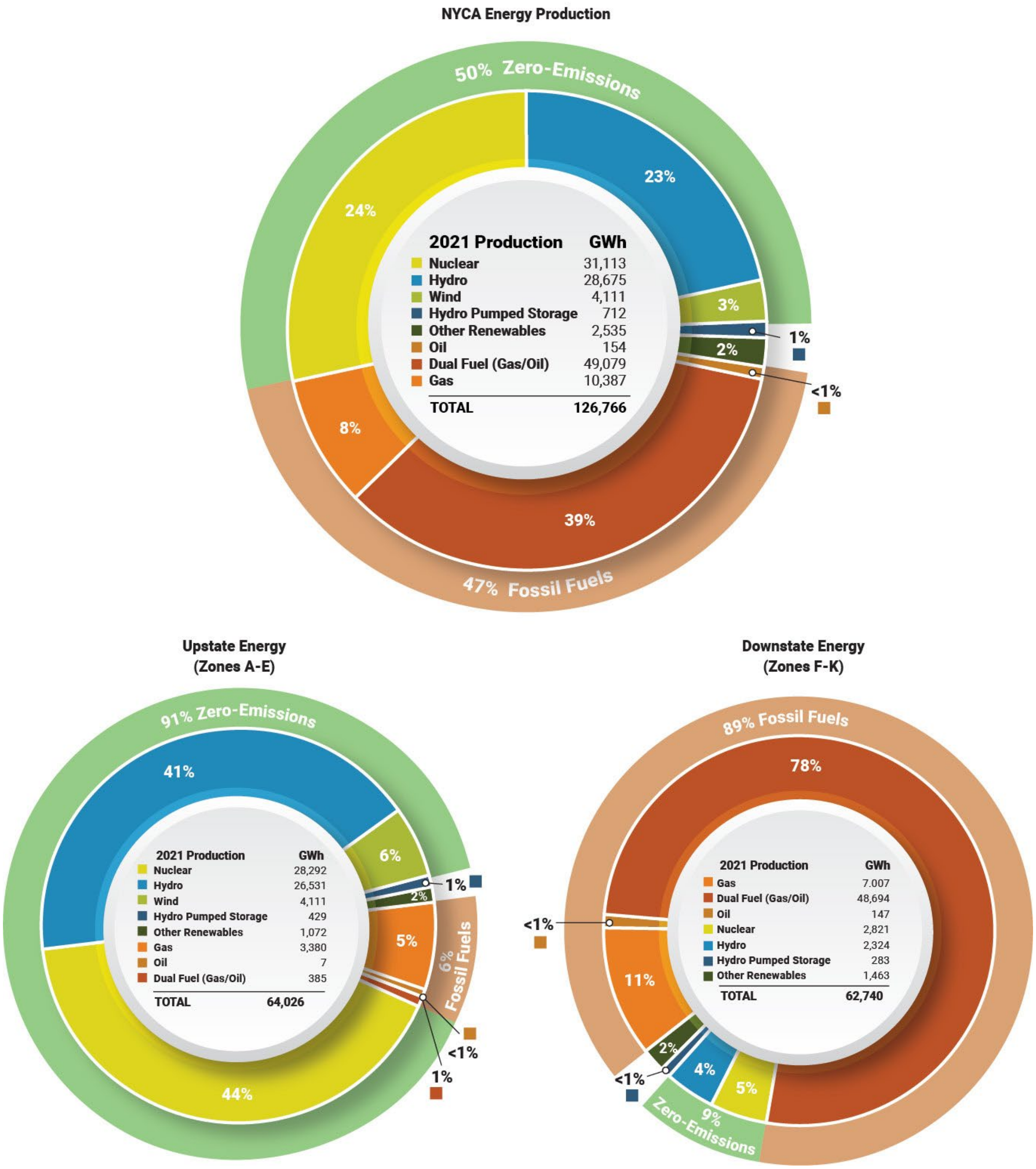


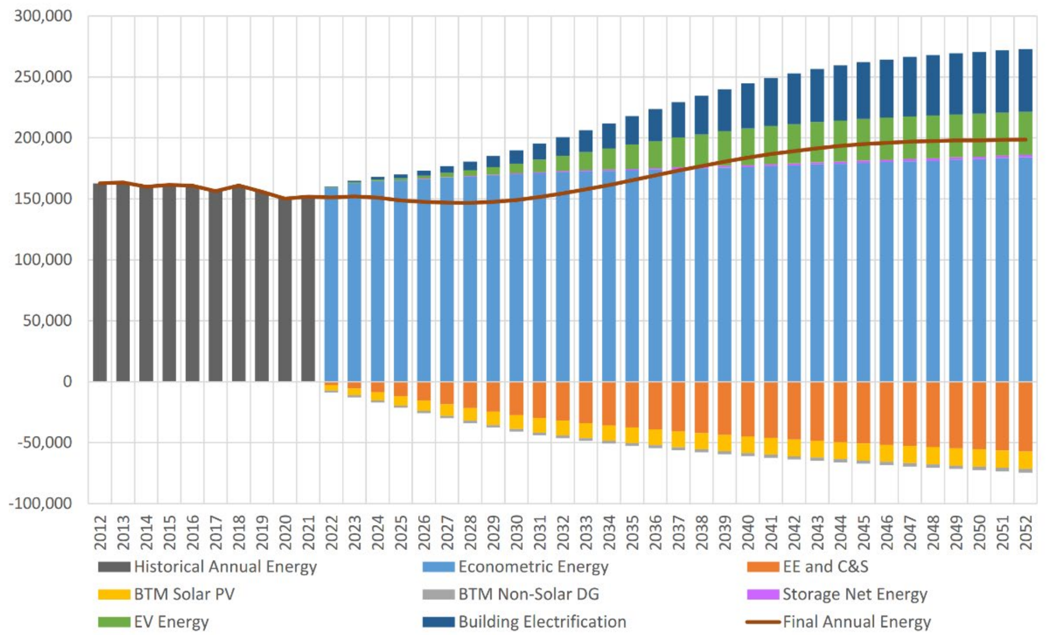
**Figure 3: Energy Production by Fuel Source (GWh) – Statewide, Upstate, & Downstate New York: 2021**



## Demand Forecasting & Analysis

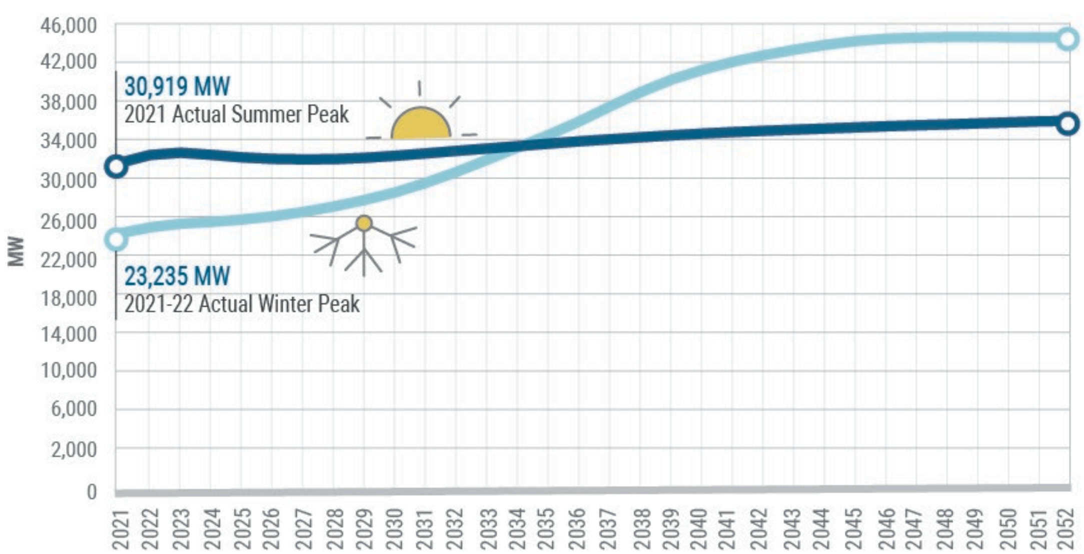
The 2022 Gold Book presents the NYISO load and capacity data for 2022 and future years, including historic and future energy and peak forecasts through 2052, existing and proposed generating capacity projected through 2032, and existing and proposed transmission facilities.

**Figure 4: NYCA Baseline Annual Energy Forecast Components (GWh)**




The Gold Book Baseline forecast estimates a transition from a summer peaking system to a winter peaking system in 2034 primarily driven by electrification.

**Figure 5: Electric Summer and Winter Peak Demand – Actual & Forecast: 2021-2052**



Over a 30-year horizon, the New York Control Area (NYCA) baseline energy and summer peak demand forecast growth rates both increased compared to 2021, as shown in the following table:

**Figure 6: Gold Book Average Annual NYCA Baseline Energy and Summer Peak Demand Growth Rates**

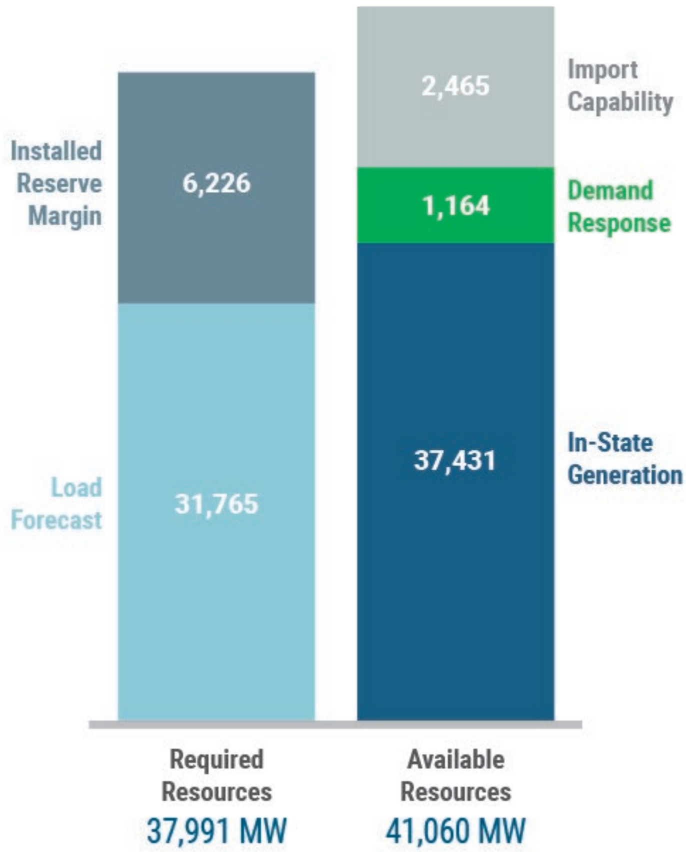
| Publication | Average Annual Growth Rates | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Baseline Energy Usage | | | | Baseline Summer Peak Demand | | | |
| | Years 1-30 | Years 1-10 | Years 11-20 | Years 21-30 | Years 1-30 | Years 1-10 | Years 11-20 | Years 21-30 |
| 2021 Gold Book (2021-2051) | 0.96% | -0.28% | 1.15% | 1.88% | 0.20% | -0.24% | 0.44% | 0.39% |
| 2022 Gold Book (2022-2052) | 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 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 outpace 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 generation resource capability in New York for the summer of 2022 is projected to be 41,060 MW, which includes 37,431 MW of generating capability, 1,164 MW of Special Case Resources (SCR) and/or demand response, and 2,465 MW of net long-term purchases and sales with neighboring control areas. The generation capacity projection beyond 2022 is discussed further in this report.

For the 2022-23 capability year beginning May 1, 2022, the approved Installed Reserve Margin (IRM) is 19.6%. Based on a projected summer 2022 peak demand of 31,765 MW, the total installed capacity requirement for the upcoming summer capability period is 37,991 MW.

**Figure 7: Statewide Resource Availability: Summer 2022**




### Transmission Additions

Three public policy transmission projects have been included in all of the Outlook analyses, 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 Empire State Line is now in-service while Segment A and Segment B are under construction.

Additionally, three proposed transmission additions beyond the Baseline are included in the Road to 2040 Policy Case analysis: the Smart Path Connect Project and two "Tier 4" HVDC projects. Even though these projects are not under construction yet, they have certain approvals by the New York Public Service Commission (NYPSC) to meet CLCPA targets.

New York Power Authority's Smart Path Connect Project[9] is a "priority transmission project"

[9] Smart Path Connect (nypa.gov), approved in October 2020 by NYSPSC under New York's Accelerated Renewable Energy Growth and Community Benefit Act

upgrading the existing 230 kV lines in Northern New York to 345 kV, along with substation construction and upgrades. Two other projects received Tier 4 renewable energy credit (REC) awards and their contracts have been accepted by the Commission to establish transmission corridors to bring renewable energy to New York City:

- Champlain Hudson Power Express project[10] (CHPE), jointly developed by Transmission Developers, Inc., and Hydro-Québec, is a 1,250 MW, 375-mile submarine and underground HVDC transmission project delivering power from Québec, Canada to New York City.
- Clean Path New York project[11] (CPNY), jointly developed by Forward Power (a joint venture of Invenergy and EnergyRe) and the New York Power Authority, is a 1,300 MW, 174 mile underground and submarine HVDC transmission line from Fraser substation in upstate New York to New York City.

### Comprehensive System Planning Process

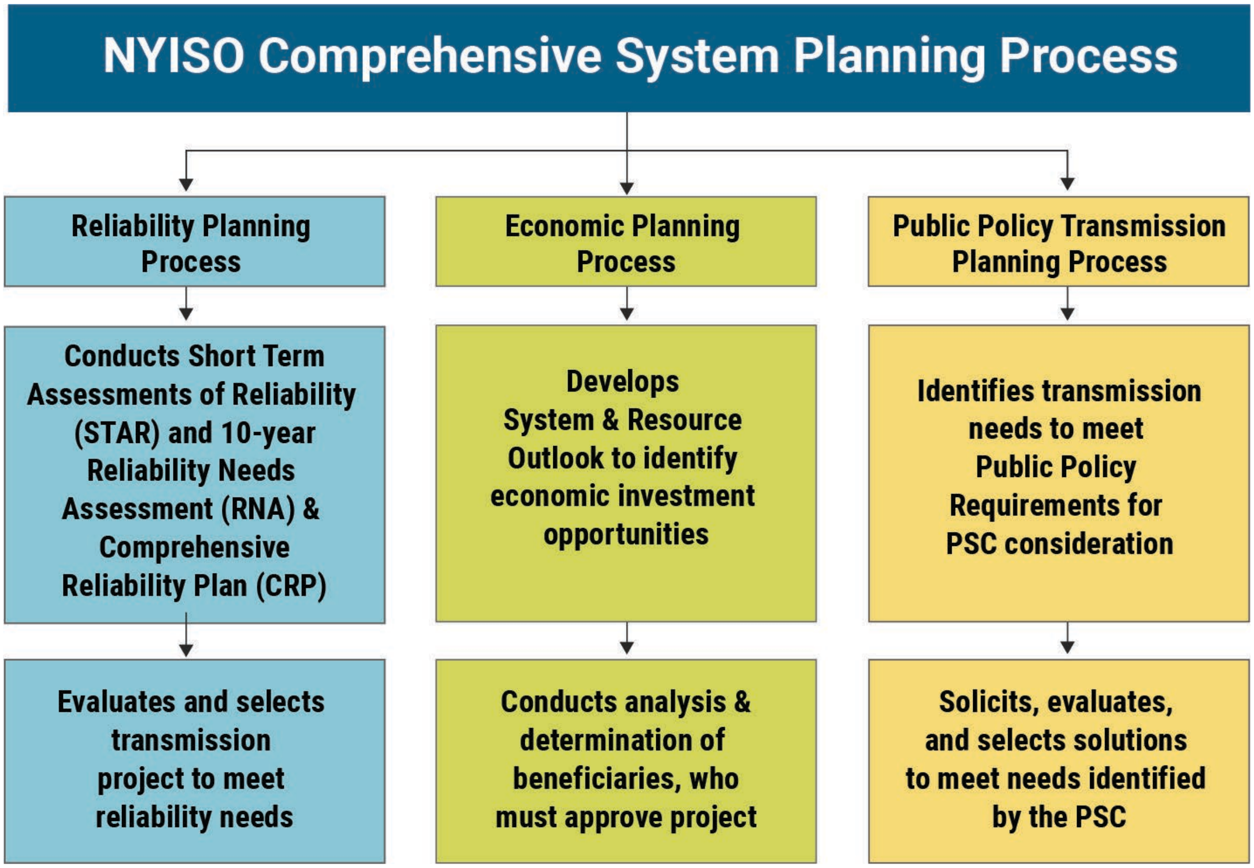
Understanding the impacts of state public policy initiatives to the generation, transmission, and load components of the bulk electric system is critical to understanding the challenges to reliable electric service in the coming years. The NYISO is evolving its CSPP to match the pace of change on the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

The CSPP establishes the specific rules by which the NYISO solicits, evaluates, and selects 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.

[10] https://chpexpress.com/

[11] https://www.cleanpathny.com/

**Figure 8: NYISO Comprehensive System Planning Process**




## 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 reliability planning studies into a ten-year reliability for New York.

Together, these processes enable the NYISO to identify reliability needs through a continuous study process ranging from localized needs to broader statewide needs arising over the next decade.

The *2021-2030 Comprehensive Reliability Plan* (CRP)[12] completed the NYISO's 2020-2021 cycle of the Reliability Planning Process. The 2020 Reliability Needs Assessment (RNA)[13], approved by the NYISO Board of Directors in November 2020, was the first step of that process. The CRP followed the 2020 RNA and post-RNA updates and incorporated findings and solutions from the quarterly Short-Term Reliability Process. The CRP 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-mark 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 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, which may also be constrained by transmission congestion.

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 reducing renewable resource output. The scope of planned battery storage alone, given its current capabilities and technological advancements, however, will not meet system needs to balance intermittent resources when renewable resources are unavailable.

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 fueled generation, which currently serves as the primary balancing resource. Long-duration, dispatchable, and emission-free resources will

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

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

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 their successful development will be critical to future grid reliability.

The *2022 Reliability Needs Assessment (RNA)* is currently being performed and will leverage data from the Outlook to identify commitment and dispatch trends and related bulk power system reliability impacts as policy goals are approached.

### Public Policy Transmission Planning Process

The Public Policy Transmission Planning Process (PPTPP) is conducted 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 stakeholder input regarding transmission needs driven by Public Policy Requirements, and the NYSPSC identifies transmission needs and defines additional evaluation criteria. The NYISO holds a technical conference and then solicits solutions to address the identified needs. After receiving the submissions, the NYISO determines which ones are viable and sufficient to meet the public policy need. In Phase II, the NYISO evaluates the viable and sufficient transmission solutions that decide to proceed 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 stakeholder input 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.

The Long Island Power Authority Board of Trustees identified a transmission need for offshore wind onto and exported from Long Island to the rest of New York State to meet state climate change law requirements. Based on this referral and input from the NYISO and other interested parties, the NYSPSC issued an order declaring that offshore wind goals are driving the need for additional transmission facilities to add at least one transmission cable to deliver at least 3,000 MW of offshore wind output from Long Island to the rest of New York State, along with local transmission system upgrades on Long Island itself. 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 NYISO is evaluating those projects to recommend to the Board of Directors the more efficient or cost-effective project to meet the need, with results expected in 2023.

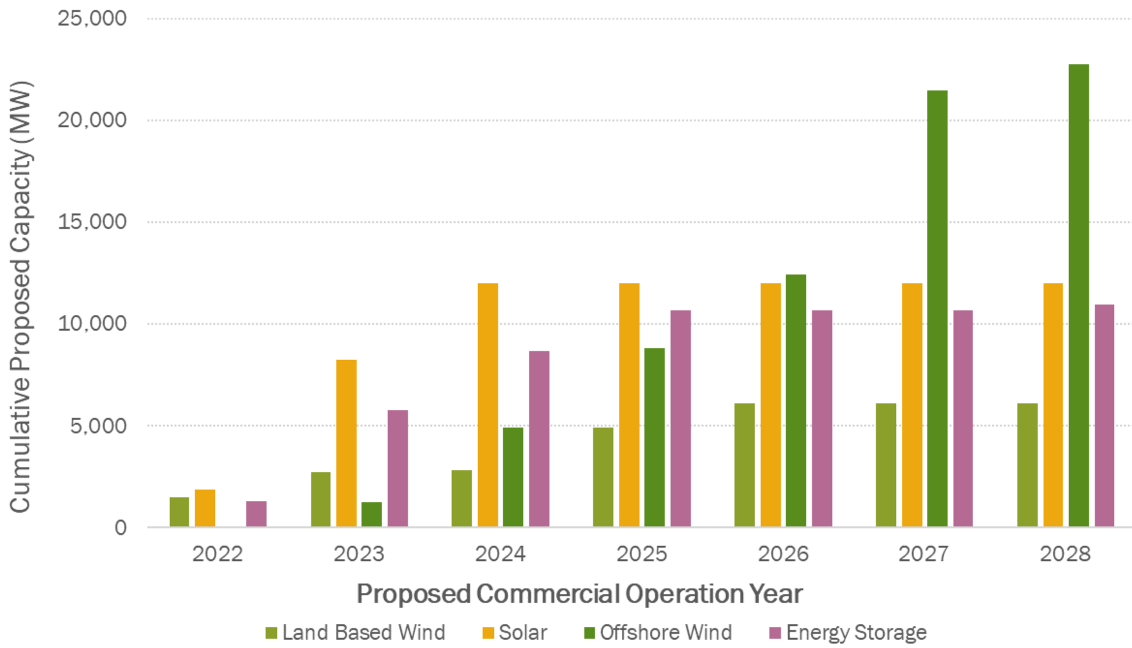
The 2022-2023 cycle of the Public Policy Transmission Planning Process will commence in August 2022 with a request for proposed transmission needs being driven by Public Policy Requirements. Following the 60-day request window, the NYISO will file the proposals with the PSC for their consideration to identify Public Policy Transmission Needs.

### Interconnection Studies

The NYISO's interconnection processes[14] are crucial to facilitating the development and interconnection of proposed generation, transmission, and load facilities to the NYCA system. The interconnection process supports grid reliability by identifying potential adverse impacts due to proposed projects, and requires coordination between the NYISO, developers, and associated transmission owners throughout the process as well as consultation with affected external regions. 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 9 to help address these policies.

14 https://www.nyiso.com/interconnections

**Figure 9: Proposed Renewable Energy Capacity in the NYISO Interconnection Queue (as of 06/01/2022)**




Like other NYISO planning studies, the NYISO's interconnection process is key to the generation and load assumptions in the *2021-2040 System & 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 (Baseline, Contract, and Policy Cases) for purposes of generation placement within New York. The Baseline 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, the Interconnection Queue was one of many sources of information 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 system modeling. Additional information on the generator placement process for the Policy Case is provided in Appendix E.3.

## Contracted Renewable Resources

The policies and laws mandated by the CLCPA are driving an unprecedented change in New York's power sector as it transitions to an emissions-free electric system. While the transition is being implemented by many different entities, NYSERDA plays a key role. Through an annual request for proposals, NYSERDA solicits bids from eligible new large-scale renewable resources and procures Renewable Energy Certificates (RECs) from these facilities. These credits enable an entity to sell the renewable attribute of their electrical output and thereby procure financing for their projects. The Contract Case evaluated in this Outlook adds approximately 9,500 MW of new contracted renewable resources, including 4,262 MW of solar, 899 MW of land-based wind, and 4,316 MW of offshore wind. The addition of these resources to the Baseline system representation provides insights regarding their impact on system performance in the future.

The analysis performed focuses on transmission congestion and how patterns change through time as New York State contracted renewable projects are added to the system. This section begins with the Baseline Case to establish a reference point then advances to the Contract Case to calculate the impact of contracted resources. It is important to note that neither the Baseline nor the Contract Case models generation additions or retirements beyond what was included in the 2021-2030 Comprehensive Reliability Plan or what has been contracted by the State.

### Baseline Assessment

The Outlook Baseline 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.[15] The strict inclusion rules limit the number of new projects that are assumed to be completed 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).

#### Key Assumptions

The *2021-2040 Outlook* study period aligns with the ten-year planning horizon for the *2021-2030 Comprehensive Reliability Plan* plus an additional ten years to extend to 2040. Study assumptions are based on any conditions that met the NYISO's inclusion rules as of the lock-down date for data inputs into the Outlook. The NYISO chose August 1, 2021, as the Baseline Case lock-down date as it aligns with the most recent reliability case lockdown date for the *2021-2030 Comprehensive Reliability Plan*. The proposed

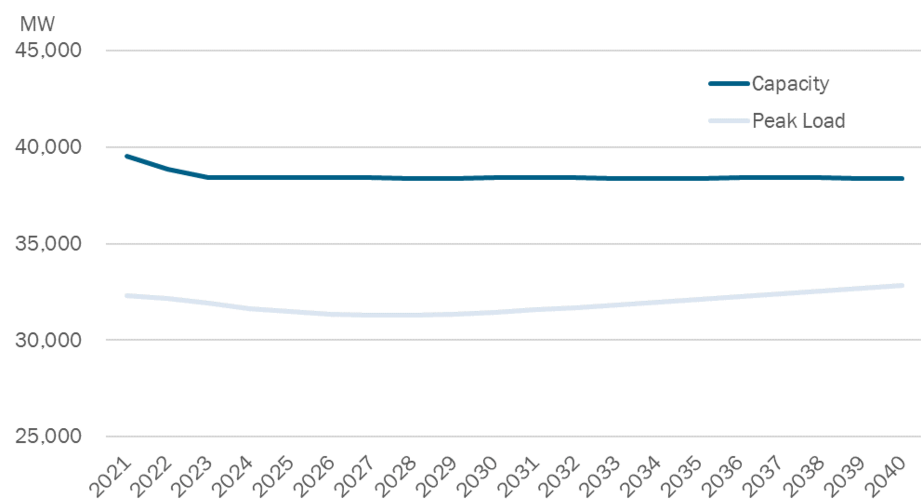
[15] See Reliability Planning Process Manual, Manual No. 36, § 3.2.

generator status changes related to the DEC Peaker Rule are included according to each unit's compliance plan[16].

Appendix C and D include a detailed description of the assumptions utilized in the Outlook analysis. Some key assumptions for the Baseline 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.

**Figure 10: Baseline Case NYCA Capacity and Peak Loads**




- The network configuration aligns with the 2021 Reliability Planning Process 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. The model uses transfer limits and actual operating limits from the 2021 Reliability Planning Process case.
- 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 combination of each unit's planned and forced outage rates.

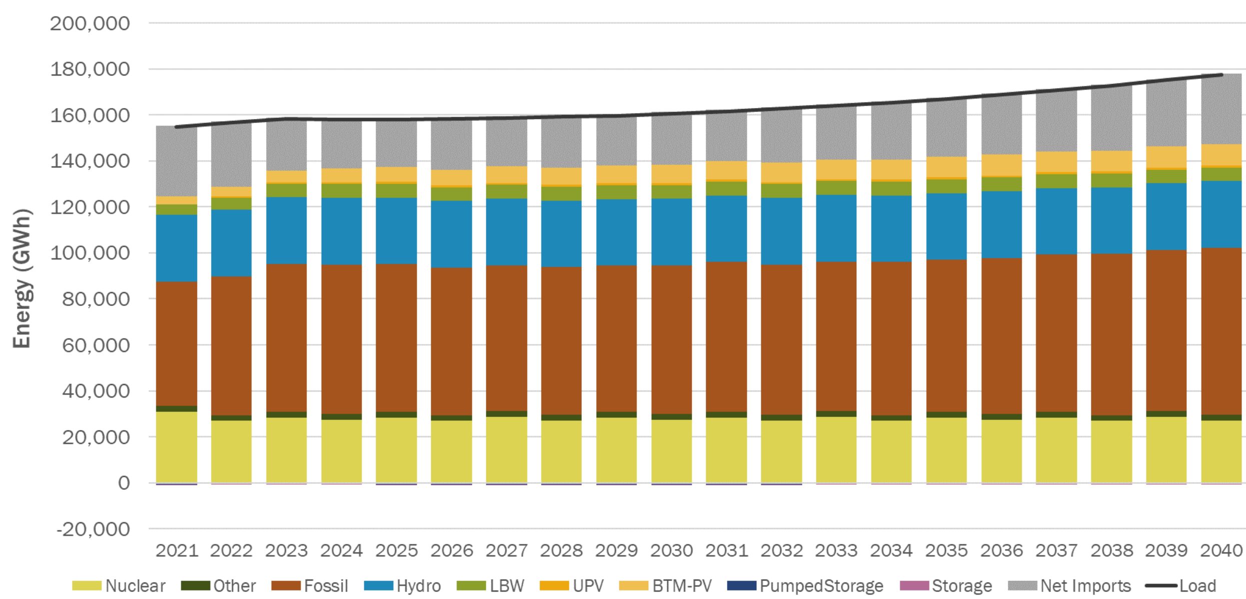
[16] Table VI-6, Proposed Generator Status Changes to Comply with DEC Peaker Rule, 2022 Gold Book.

### Supply and Demand Analysis

A production cost simulation is performed to provide a projection of the types of generation to meet energy demand through time on an hourly basis, like today's day-ahead energy market.

Figure 11 shows the annual projection of generation by unit type, along with the forecast of net imports and load.

**Figure 11: Projected NYCA Energy Generated by Fuel Type, Baseline Case**




Under Baseline conditions, demand is projected to continue to be served primarily by fossil generation. Only a small percentage of generation is sourced from solar and wind generation. The increase in demand through the study period is met by incremental energy produced by existing fossil generation and imports.

### Transmission Congestion Assessment

The Outlook includes the development of a twenty-year projection of future costs of transmission congestion (demand$ congestion). This projection is combined with the past five years of historic congestion to identify significant and recurring congestion on the New York transmission system. A detailed assessment of historic and projected congestion is located in Appendix I.

The identified congested elements from the twenty-year projection 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 25-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 25-year period.

The demand congestion is projected to reduce significantly in the Baseline Case. The key drivers include: the addition of the Western New York and AC Transmission Public Policy Transmission Projects, and the retirement and refurbishment of nuclear generators in Ontario as well as an increase in forecasted energy demand in that region. As a result, the 20-year total projected total demand congestion on Central East interface is a fraction of the 5-year historical total. Figure 12 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 12: Ranked Elements Based on the Highest Present Value (2021 $M) of Demand$ Congestion over the 25-Year Aggregate (Baseline Case)[17]**

| Congested Transmission | Historic Total (5 Years) | Projected Total (20 Years) | Historic + Projected Total (25 Years) |
|---|---|---|---|
| Central East Interface | 3,487 | 1,061 | 4,548 |
| Dunwoodie - Long Island (Y49 & Y50) | 733 | 467 | 1,200 |
| Edic - Marcy 345 kV | 359 | 0 | 359 |
| Leeds - Pleasant Valley 345 kV | 266 | 5 | 271 |
| North Waverly - East Sayre 115 kV | 0 | 251 | 251 |
| Greenwood Load Pocket | 203 | 22 | 225 |
| Dunwoodie - Motthaven 345 kV | 164 | 35 | 199 |
| Packard - Huntley 230 kV | 184 | 0 | 184 |
| Elwood - Pulaski 69 kV | 0 | 161 | 161 |
| Chester - Shoemaker 138 kV | 34 | 101 | 135 |
| Volney - Scriba 345 kV | 7 | 107 | 114 |
| New Scotland - Knickerbocker 345 kV | 0 | 73 | 73 |
| UPNY - ConEd Interface | 10 | 58 | 67 |
| Sugarloaf - Ramapo 138 kV | 0 | 59 | 59 |
| Northport - Pilgrim 69 kV | 0 | 55 | 55 |
| Greenbush - Stephentown 115 kV | 0 | 49 | 49 |

The historic and future congestion analysis shows that several of the most severe bulk-level transmission constraints, such as Central East, will decline compared to historic levels. Three of the top four congested elements will decline directly due to the AC transmission projects.

### Contracted Renewable Generation Assessment

Through an annual request for proposals, NYSERDA solicits bids from eligible new large-scale

[17] North Waverly – East Sayre 115 kV tie line between First Energy East and NY may be opened in real-time operation in accordance with NYISO and PJM Operating Procedures provided that this action does not cause unacceptable impact on local reliability in either system. Congestion reported in this table is a result of securing the line for N-1 contingency in production cost simulations.

renewable resources and procures Renewable Energy Certificates (RECs) from these facilities.[18] The Contract Case builds off the Baseline Case and additionally models the awarded generation units through NYSERDA's 2020 Solicitation that have not yet met the inclusion rules of the Outlook Baseline 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.[19] On June 2, 2022, NYSERDA released the results of the 2021 REC Solicitation, announcing contracting with 22 new solar projects totaling 2,408 MW, which were not included in this assessment as they were announced after the analysis was complete.[20]

**Figure 13: Zonal Renewable Generation Additions in the Contract Case (MW)**

| Zone | | Resource Addition (MW) | | | | LBMP Impact ($/MWh) | |
|---|---|---|---|---|---|---|---|
| | | Solar | Land Based Wind | Offshore Wind | Total | 2030 LBMPs | Reduction from Baseline Case |
| A | West | 290 | 339 | | 629 | $38.32 | $5.86 |
| B | Genesee | 1,330 | 200 | | 1,530 | $37.90 | $6.02 |
| C | Central | 852 | 147 | | 999 | $39.51 | $6.25 |
| D | North | 180 | | | 180 | $36.13 | $4.78 |
| E | Mohawk Valley | 739 | 213 | | 952 | $36.71 | $6.72 |
| F | Capital | 730 | | | 730 | $40.34 | $3.69 |
| G | Hudson Valley | 140 | | | 140 | $40.76 | $3.82 |
| J | New York City | | | 2,046 | 2,046 | $41.85 | $3.55 |
| K | Long Island | | | 2,270 | 2,270 | $40.81 | $6.97 |
| Total | | 4,262 | 899 | 4,316 | 9,476 | $39.61 | $4.96 |

#### Supply and Demand Analysis

Similar to the Baseline, a production cost simulation is performed to provide a projection of the types of generation utilized to meet energy demand through time on an hourly basis, like today's day-ahead energy market.  Future energy production from renewable projects is modeled based on historical production patterns as well as data from National Renewable Energy Laboratory. The figure below shows the annual energy generation by each resource type in the Contract Case.

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

[19] 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/

[20] https://www.nyserda.ny.gov/All-Programs/Clean-Energy-Standard/Renewable-Generators-and-Developers/RES-Tier-One-Eligibility/Solicitations-for-Long-term-Contracts/2021-Solicitation-Resources

**Figure 14: Projected NYCA Energy Generated by Fuel Type, Contract Case**

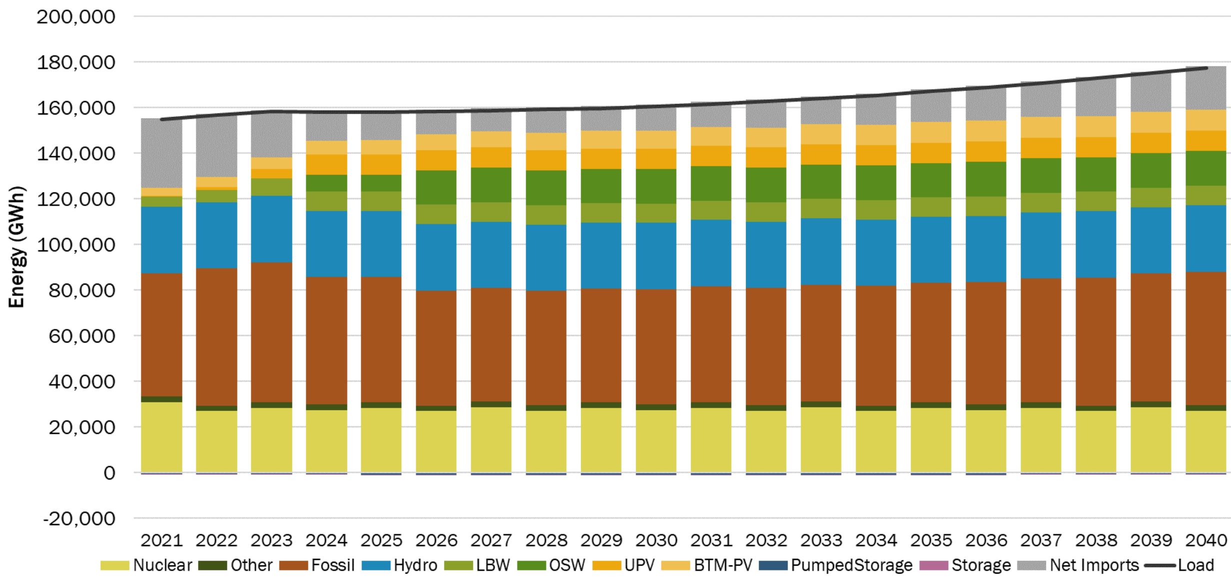
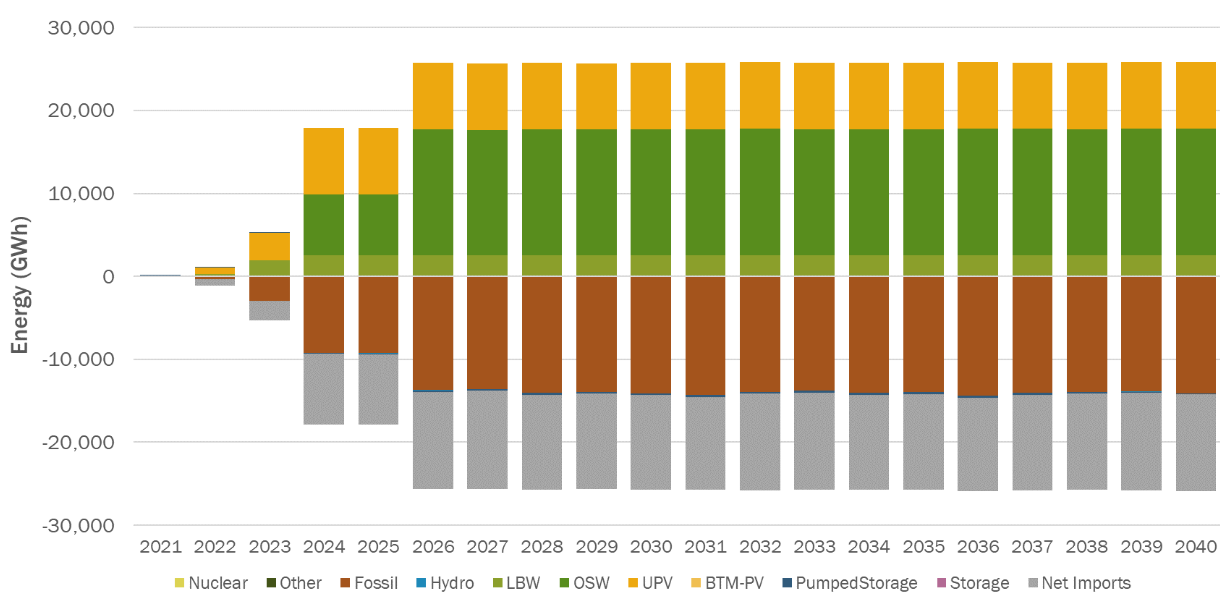



Figure 15 shows the changes in projected NYCA generation from the Baseline Case to the Contract Case, by fuel type. As renewable energy from wind and solar increases, it displaces in-state fossil-fueled generation and net imports from neighboring regions. The addition of over 9 GW of renewable capacity produces over 20 GWh of energy annually.

**Figure 15: Projected Change in NYCA Energy Generated by Fuel Type, Contract Case – Baseline Case**




### Transmission Congestion Assessment

Bulk level constraints that are historically binding remain among the most congested elements. Over time, generation from fossil fueled plants in the model is replaced with output from land-based wind and solar renewable energy resources additions located upstate and away from load centers in Southeast New York. Some constraints could become more congested and new constraints might appear due to resource shifts in the system.

The NYISO observes the most significant increase in congestion in in Southeast New York due to the addition of offshore wind resources. The constraints with the most prominent increases in congestion are Sugarloaf to Ramapo, New Scotland to Knickerbocker, Central East Interface, and Dunwoodie to Long Island (Y49 & Y50 lines).

**Figure 16: Number of Congested Hours by Constraint, Baseline and Contract Cases, Year 2030[21]**

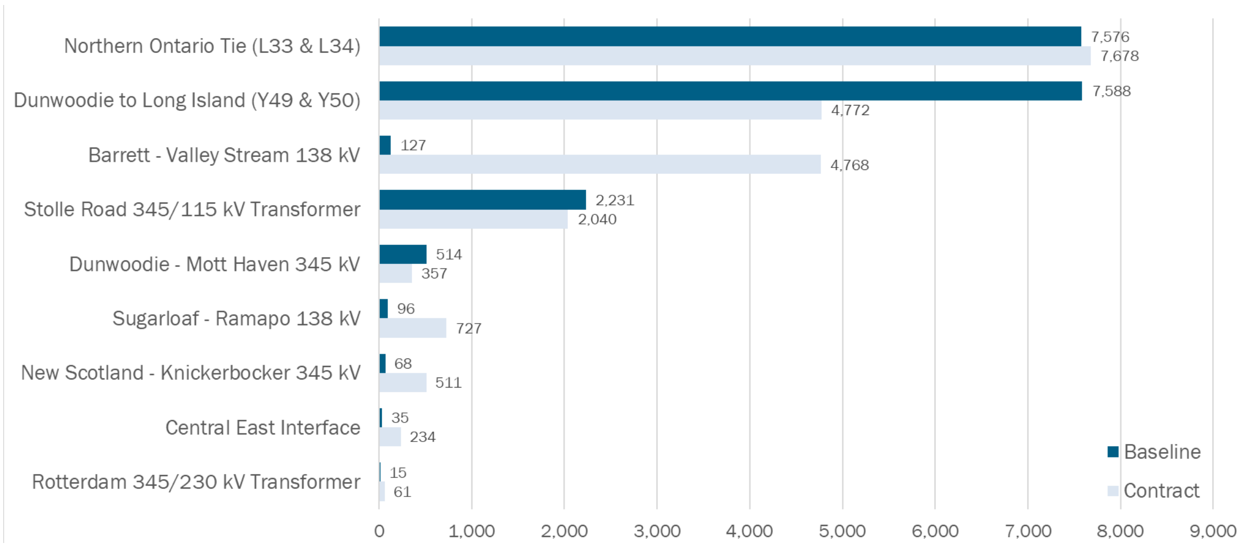



Figure 16 shows the number of hours that bulk level constraints are congested in the year 2030. Because most of the contracted resources are scheduled to be in-service by this time, using 2030 as the reference year for comparison between the Baseline and Contract cases is particularly meaningful. The number of 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, or over, its limit in a specific year.

Historically congested paths such as the *Central East Interface* show very low numbers of congested hours in the Baseline Case as well as the Contract Case. This can be attributed to the following major factors: (1) the completion of AC Transmission Public Policy Projects scheduled for December 2023, (2)

[21] Congestion reported on Northern Ontario Tie may not reflect actual operation of PAR controlled interface, which operates at a fixed schedule to reduce congestion on either side of the interface. Projected congestion reported here is a result of securing the interface in production cost simulation analysis. The Stolle Road 345/115 kV transformer congestion reported is a result of a contingency that may not reflect actual topology in the Stolle Road substation.

lower imports from Ontario due to nuclear refurbishments and retirements there, and (3) higher loads overall in upstate New York compared to prior study cycles due to new proposed large load projects. The *Dunwoodie to Long Island* interface (Y49 & Y50 lines), which is highly congested in the Baseline Case, is congested for fewer hours in the Contract Case as a result of offshore wind resources injecting into Long Island and counteracting flow through the Y49 and Y50 lines. The *North Tie: Ontario-NY interface,* which is comprised of the St. Lawrence L33 and L34 PARs on the New York to Ontario border, remains highly congested in both cases.

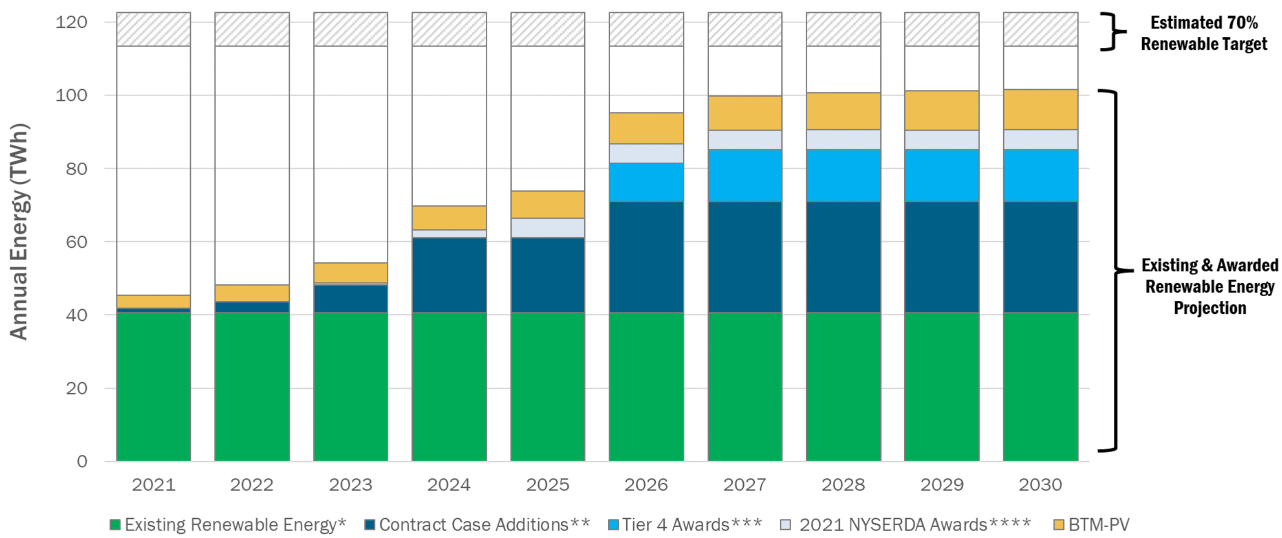
The two parallel 138 kV lines from Barrett to Valley Stream on Long Island are some of the most congested elements in the system in the Contract Case. Congestion on these lines results from the injection of offshore wind energy interconnected to the Barrett substation. This study does not model the proposed Long Island Offshore Wind Export Public Policy Transmission, nor does it include system interconnection upgrades that are yet to be determined for contracted resources in the NYISO Interconnection Process.

The NYISO is currently evaluating the viable and sufficient project proposals to the Long Island Offshore Wind Export Public Policy Transmission Need (Long Island PPTN), based on the Order issued by the NYPSC on March 19, 2021. If a more efficient or cost-effective solution is selected to meet the Long Island PPTN, the congestion is expected to be reduced significantly.

#### Policy Implications of Renewable Contracts

Renewable resource projects included in the Contract Case further the progress toward meeting the 70% renewable energy and 100% emission-free CLCPA targets. In addition to the contracted projects, policy achievement also depends on maintaining current levels of existing renewables such as currently operating hydro resources:  Given that renewable resources were added through the 2020 REC Solicitation, the policy targets are not expected to be attained with current contracts alone. As shown in Figure 17, the renewable energy percentage projected to be greater than 60% when considering the projects modeled in the Contract Case as well as more recently announced renewable procurements.

**Figure 17: 70x30 Policy Progress Estimate**[22]




While policy targets are not met through the assumed amount of renewable generation in the Contract Case, $CO_2$ emissions decrease significantly. Figure 18 shows the projected change in $CO_2$ emissions due to additional contracted renewables as represented in the Contract Case.

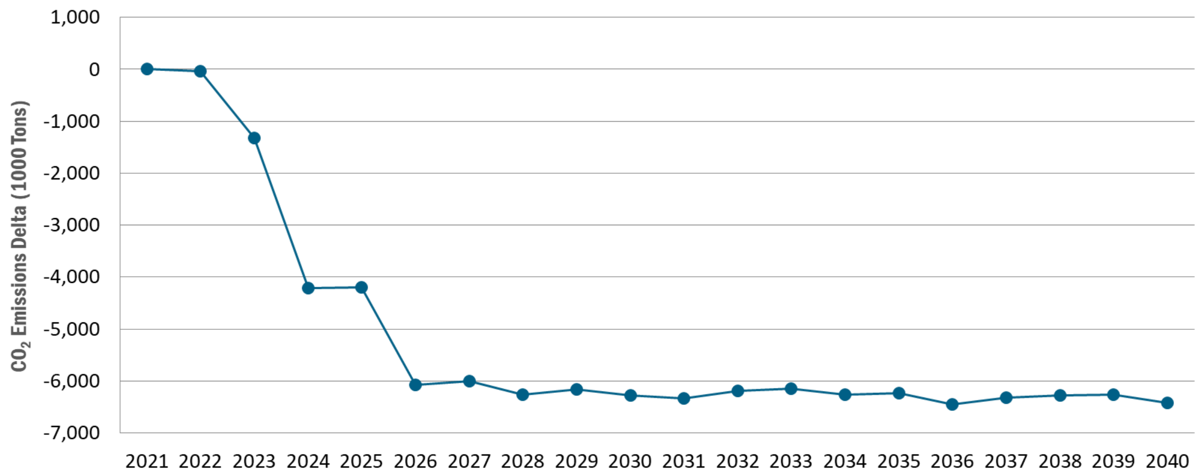
[22] *Estimated 2021 renewable energy per NYSERDA CES Compliance Report for 2020 compliance year: https://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7bFAA057E2-4684-440A-BF60-AED5E49D5640%7d

**Renewable energy modeled from projects included in the Outlook Contract Case, which represent NYSERDA awarded projects through the 2020 Tier 1 solicitation, full list include here: https://www.nyiso.com/documents/20142/26278859/System_Resource_Outlook-Contract_Case_Renewables.xlsx/8703b05f-a075-a6ae-7f3b-87f0e7717b10

***Tier 4 awards exclude associated renewable projects with existing Tier 1 awards: https://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId={4DB09036-1CEF-42CB-B9E0-F0ED88848311}

****Max annual contract quantity of renewable energy from projects awarded in the 2021 NYSERDA Tier 1 solicitation: https://www.nyserda.ny.gov/All-Programs/Clean-Energy-Standard/Renewable-Generators-and-Developers/RES-Tier-One-Eligibility/Solicitations-for-Long-term-Contracts/2021-Solicitation-Resources

**Figure 18: Projected Change in $CO_2$ Emissions, Contract Case**




New York State sees an annual reduction of approximately 6 million tons of carbon dioxide over most of the study period.

### Baseline System and Contracted Renewables: Key Takeaways

- In the Baseline Case (business-as-usual), demand congestion declines sharply in the first five years of the study period across the Central East interface. The key drivers include the addition of the NYISO-selected public policy transmission projects (Western New York and AC Transmission Segments A and B), retirement and refurbishment of nuclear generators in Ontario, and an increase in forecasted energy demand in Ontario that diminishes available surplus power. As a result, the projected 20-year total congestion on the Central East interface is a fraction of the five-year historical total.
- New proposed large loads, including new cryptocurrency mining facilities located in Western, Central, and Northern New York (Zones A, C, and D, respectively) are served primarily by increased output from fossil fueled generation located upstate. As a result, $CO_2$ emissions and zonal demand congestion increase as such large demand centers are added to the grid.
- Curtailment of resources and congestion patterns are highly dependent on the type of resources added, 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 offshore wind resources connected to Long Island account for the majority of curtailment in the Contract Case. Injecting large amounts of power into a transmission system not designed to handle such levels causes curtailment.

# Road to 2040

The Climate Leadership and Community Protection Act establishes several policy requirements to materially change the resource mix and system demand of the New York electric grid. Over the next twenty years, the CLCPA mandates that New York be served by 70% renewable energy by 2030 (70 x 30), includes specific technology-based targets for distributed solar (6 GW by 2025, additional 4 GW by 2030), storage (3 GW by 2030), and offshore wind (9 GW by 2035) and ultimately establishes that the electric sector will be carbon free by 2040. These policies will likely result in the acceleration of conventional generation retirements well in advance of the 2040 target year. As part of the Outlook, the NYISO assesses a range of future scenarios to understand the breadth of challenges and potential system risks.

The dramatic transformation of New York State's energy industry aimed at mitigating the effects of climate change is primarily driven by public policies and is being undertaken by branches of the New York State government. The climate change related policies in the electric sector are being implemented through many initiatives, including the development of renewable generation and storage, reductions in $CO_2$ emissions, and specific technology-based targets. Each goal or target drives project procurement decisions made by NYSERDA. The Contract Case includes projects with existing contracts implemented through the 2020 REC Solicitation. That case represents the current outlook of the system with contracts in hand at the time assumptions were locked down on December 1, 2021. Recognizing that resources incorporated in the Contract Case alone do not yet satisfy the State policies with solicitations expected to continue for the next five years, the NYISO has established a Policy Case to evaluate future scenarios that expand renewable resource capacity meet those policy objectives.

### Policy Case Process Overview

The assessment of the Road to 2040 has the following major components; (1) resource assessment via capacity expansion simulation, (2) transmission congestion assessment via production cost simulation, and (3) an evaluation of policy attainment.

Given the significant uncertainty that exists surrounding the path to achieving policy objectives, the NYISO has modeled capacity expansion in the Economic Planning Process to evaluate many alternative paths to achieving the renewable resource buildout. The capacity expansion model optimizes future generation buildout to minimize capital and operating costs while also achieving each specific policy modeled (e.g., 70 x 30 and zero-emissions by 2040 targets).

The capacity expansion optimization was limited to the NYCA system only, and does not include imports or exports, except that the contributions from Tier 4 projects are included as soon as the projects are assumed to be in-service. Due to the CLCPA requirement of a zero emissions grid by 2040, the NYISO modeled all fossil-fueled generation as retired by that time. Existing zero-emitting generation, such as nuclear, hydro, land-based wind, and utility-scale solar generation, remains operational in the system through 2040.

The placement of future renewable generation will likely be limited by the footprint requirement of each technology. In this study, maximum allowable capacities are enforced for applicable generator types by zone based on 2040 limitations consistent with the assumptions of the Climate Action Council Draft Scoping Plan.[23]

The key input assumptions that drive the types and quantities of resource addition and replacement in the capacity expansion analysis are peak demand forecast, energy demand forecast, capital, operation, and maintenance cost associated with each technology, age of the existing fossil-fueled and nuclear fleet, and energy output from existing resources. The details are included in Appendices C and D.

The correlation between a generator's energy output and the energy demand forecast affects both the amount and the type of capacity built. For instance, the energy contribution from solar is nonexistent at night, which greatly impacts the decision as to whether it gets selected for generation expansion in the capacity optimization.

Generation expansion is enabled at the zonal level, such that one representative generator per type is allowed for each applicable NYCA zone. The generator buildouts determined by the capacity expansion optimization are then translated to discrete generators with specific substation level placements in the production cost modeling for the Policy Case to show how a selected buildout operates on an hourly basis within a networked transmission system.

The existing interconnection queue was leveraged as a starting point to identify probable points of interconnection for new resource additions in the Policy Case. The NYISO used the proposed project capacity from the interconnection queue to calculate the proportion of total zonal capacity (from capacity expansion results) to be added to the project location.

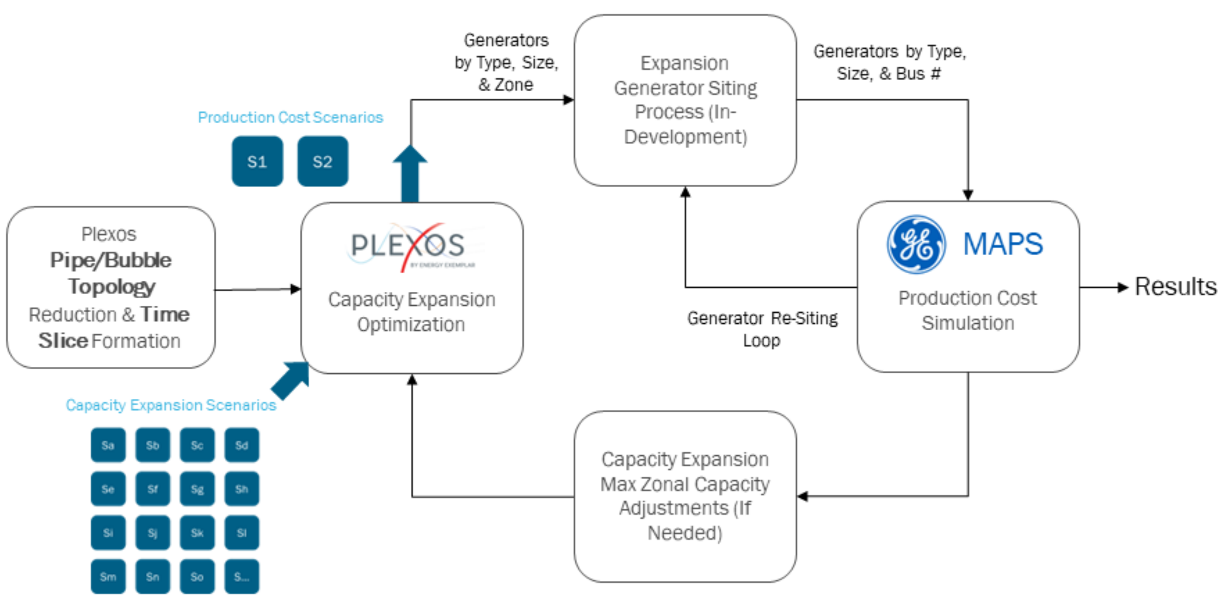
In addition to generation expansion, the capacity expansion optimization allows for generator retirements when their deactivation does not trigger a reliability need. The resulting retirement decisions from the capacity expansion scenarios are then translated to the production cost model. The higher resolution production cost models enable a deeper evaluation of the transmission and operational challenges related to adopting high levels of intermittent renewable generation. In addition, Scenario 2

[23] Climate Action Council Draft Scoping Plan: https://climate.ny.gov/Our-Climate-Act/Draft-Scoping-Plan

includes an age-based retirement criteria that retires steam turbines at 62 years and gas turbines at 47 years of age, based on industry trends for the age at which 95% of the specified generation type historically retires.

The capacity estimated to achieve New York's energy policies was forecasted through capacity expansion optimization via a model that was developed, tested, and validated through the NYISO stakeholder process. The generation capacity mix determined by the capacity expansion optimization was then incorporated into production cost simulation models, and the projected transmission constraints were identified for the Policy Case. The model data-flow diagram in Figure 19 below highlights the process used in translating the capacity expansion model results to the production cost model.

**Figure 19: Policy Case Modelling Process Diagram**




The capacity expansion simulation adds generation capacity to meet the assumed CLCPA targets in the Policy Case. Leveraging the resulting capacity expansion buildouts, the production cost simulation identifies the potential challenges associated with actual system operations.

### System Resource Mix Scenarios

The NYISO utilized a capacity expansion model to estimate possible system resource mixes over the next 20 years.[24] Two specific generation buildout scenarios were selected from the multitude of capacity

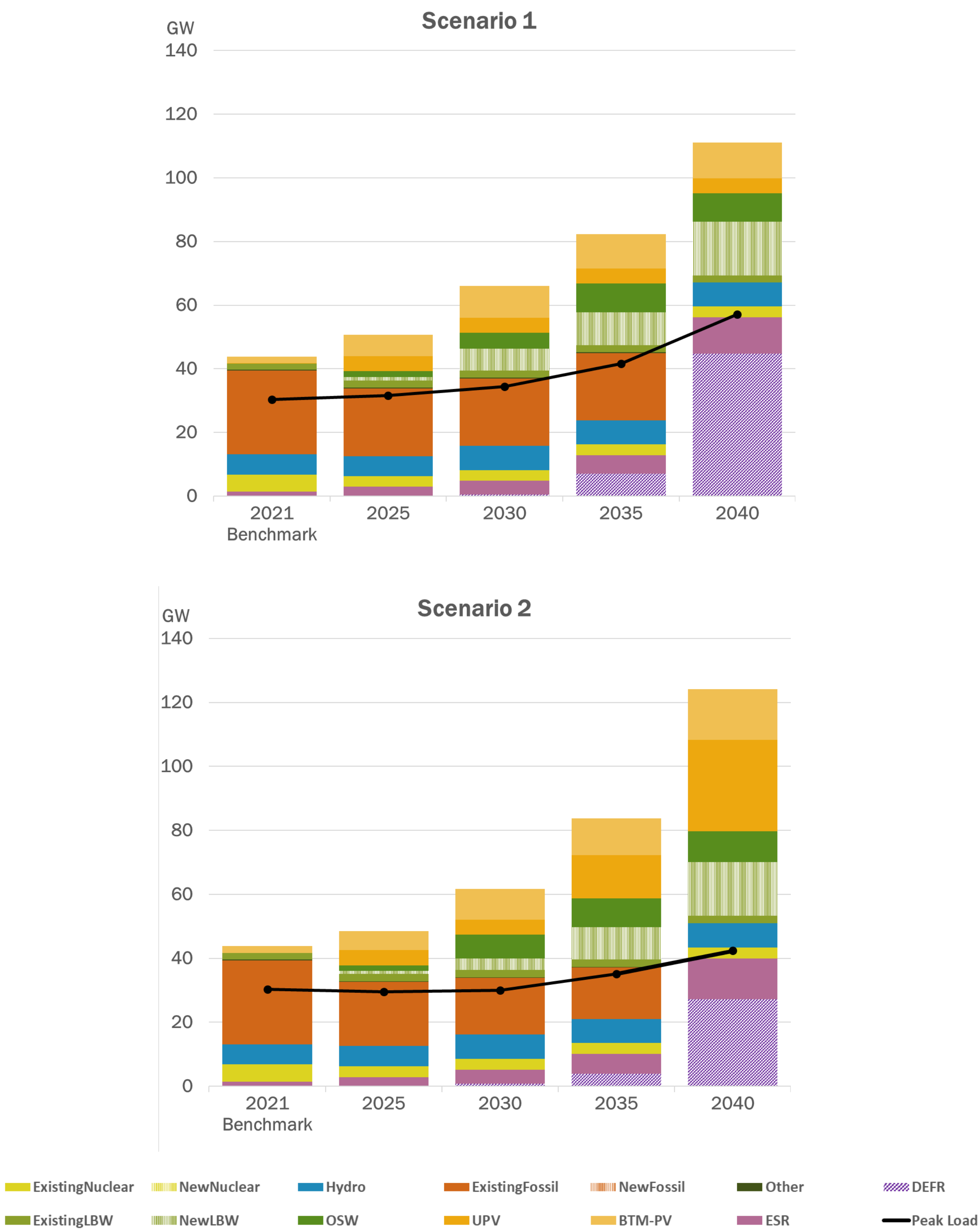
24 The capacity expansion results in this study do not endorse outcomes under any specific set of assumptions. Instead, the results inform future transmission and generation planning.

expansion simulations performed to reasonably bound impacts and formulate a detailed nodal production cost simulation model.

- **Scenario 1 (S1) -** Utilizes industry data and NYISO load forecasts, representing a future with high demand (57,144 MW winter peak and 208,679 GWh energy demand in 2040) and assumes less restrictions in renewable generation buildout options.
- **Scenario 2 (S2) -** Utilizes various assumptions more closely aligned with the Climate Action Council Integration Analysis and represents a future with a moderate peak but a higher overall energy demand (42,301 MW winter peak and 235,731 GWh energy demand in 2040).

Projected resource mixes for Scenario 1 and Scenario 2 are provided in Figure 20 below.

**Figure 20: Policy Case New York Capacity Expansion Results, Installed Capacity**



In both Policy Case scenarios, a significant amount of land-based wind capacity was built by 2040. The model selected land-based wind due to its assumed capital cost, energy output, and capacity ratings. In both scenarios, land-based wind capacity builds to the assumed capacity build limits imposed (~16 GW).

In both scenarios, a significant amount of capacity from renewable generation and dispatchable emission free resources (DEFRs) is projected by 2040, with the most installation forecasted in the last five years, to help offset the projected fossil-fueled generation retirements. Dispatchable emission free resources are a proxy generator type assumed for generation expansion in the Policy Case to represent a yet unavailable future technology that would be dispatchable and produces emissions-free energy (*e.g.*, hydrogen, RNG, nuclear, other long-term season storage, etc.). As noted above, all existing fossil-fueled generation (~26 GW) was modeled as retired by 2040 due to the CLCPA requirement of a zero emissions grid by 2040. In addition, in Scenario 2 the age-based retirement assumption captured the retirement of 12 GW, nearly half the fossil fleet. The models expanded to approximately 111 GW of total capacity for Scenario 1 and 124 GW of total capacity for Scenario 2, inclusive of NYCA generators, BTM-PV, and qualifying imports from Hydro Québec. This level of total installed capacity would be needed in 2040 to satisfy the state policy, energy, and resource adequacy constraints for Scenario 1 and Scenario 2, respectively. Of this total, approximately 85 GW to 100 GW represent generation expansion for Scenario 1 and Scenario 2, respectively, beyond the 9.5 GW planned through state contracts.[25] For comparison, the Contract Case has approximately 51 GW of total installed capacity by 2040.

In general, resources take years from development to deployment. By year 2030, roughly seven years from the publication of this report, an estimated 20 GW of additional renewable generation needs to be in-service to support the energy policy target of 100% zero-emission generation by 2040. For reference, 12.9 GW of new generation has been developed since wholesale electricity markets began more than 20 years ago in 1999. Over the past five years, 2.6 GW of renewable and fossil-fueled generators came on-line while 4.8 GW of generation deactivated[26]. This Outlook demonstrates the need for an unprecedented pace of project deployment, which will require significant labor and materials available for New York over a long period of time.

Offshore wind capacity buildout remains near the 9 GW policy objective through 2040 for both scenarios. This outcome results primarily from the assumed high capital cost of offshore wind technology in the model, which was the highest cost renewable technology available. Additionally, considering the declining marginal capacity reliability value curves assumed, offshore wind at the levels modeled is an

[25] 2040 BTM-PV installed capacity in Scenario 1 was 11 GW and nearly 16 GW in Scenario 2.
[26] The Path to a Reliable Greener Grid for New York, NYISO, June 2022.

inefficient resource to meet peak capacity needs and Locational Capacity Requirements because the capacity contribution of intermittent renewable resources declines as more are added to the system.

Overall, results for Scenario 2 showed a higher level of renewable buildout than Scenario 1, most notably in utility-scale solar capacity, and had a different projection of the capacity expansion throughout the study period as compared to Scenario 1 for all generator types. The main factors for these differences are the assumptions for load forecasts and differences in generator types eligible for capacity expansion as well as the maximum allowable capacity builds by technology type modeled between the two scenarios. One major difference in Scenario 2 is that a reduced land-based wind capacity limit was used, which changed the projection of capacity builds for all types. Notably, the projections for offshore wind were higher earlier in the model horizon (e.g., 2030) in Scenario 2 as compared to Scenario 1 to help achieve the 70 x 30 target.

Two primary drivers are attributable to increased renewable resources in capacity expansion: (1) high operating cost of dispatchable generators, and (2) low capital costs for renewable generators. High fuel (e.g., natural gas prices, clean DEFR fuel prices) and/or high $CO_2$ emissions prices result in significant decrease in fossil generation and subsequent increase in renewable generation earlier than otherwise projected. Low capital costs for renewable generators result in capacity builds much earlier than otherwise projected, and often an increase in the total amount of capacity built.

In terms of the zonal location for capacity buildouts determined by the capacity expansion model, limitations were imposed on the zonal level as to which generator type(s) could build in each zone. For instance, land-based wind was eligible for expansion in upstate regions (Zones A-G), utility-scale solar was eligible for expansion in upstate regions and Long Island (Zones A-G and Zone K), and offshore wind was eligible for expansion in New York City and Long Island (Zones J and K). Dispatchable emission free resource (DEFR) technologies and battery storage were included as generation resource options in all NYCA zones.

Historical zonal capacity by type is shown in Figure 21 for comparison to the Policy Case results for Scenario 1 and Scenario 2, which are provided in Figure 22.

**Figure 21: 2021 Actual Installed Capacity By Zone**

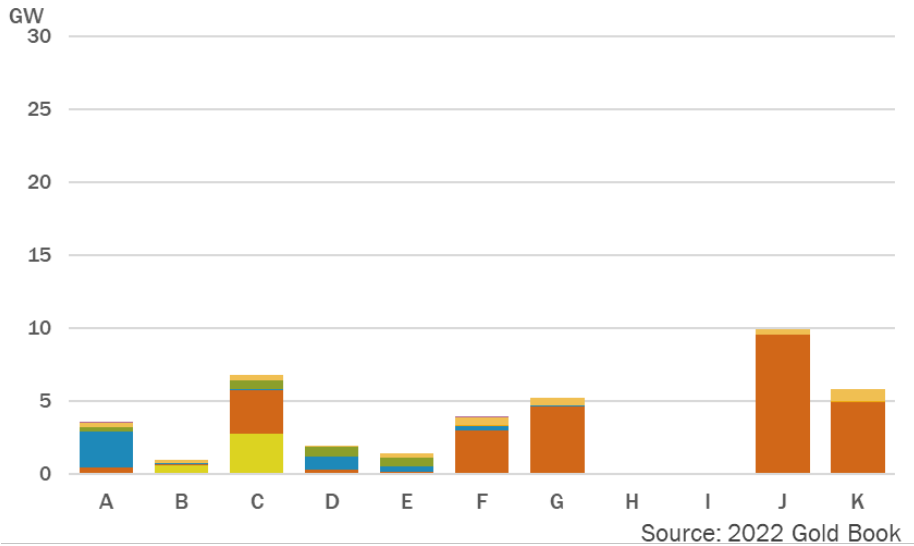
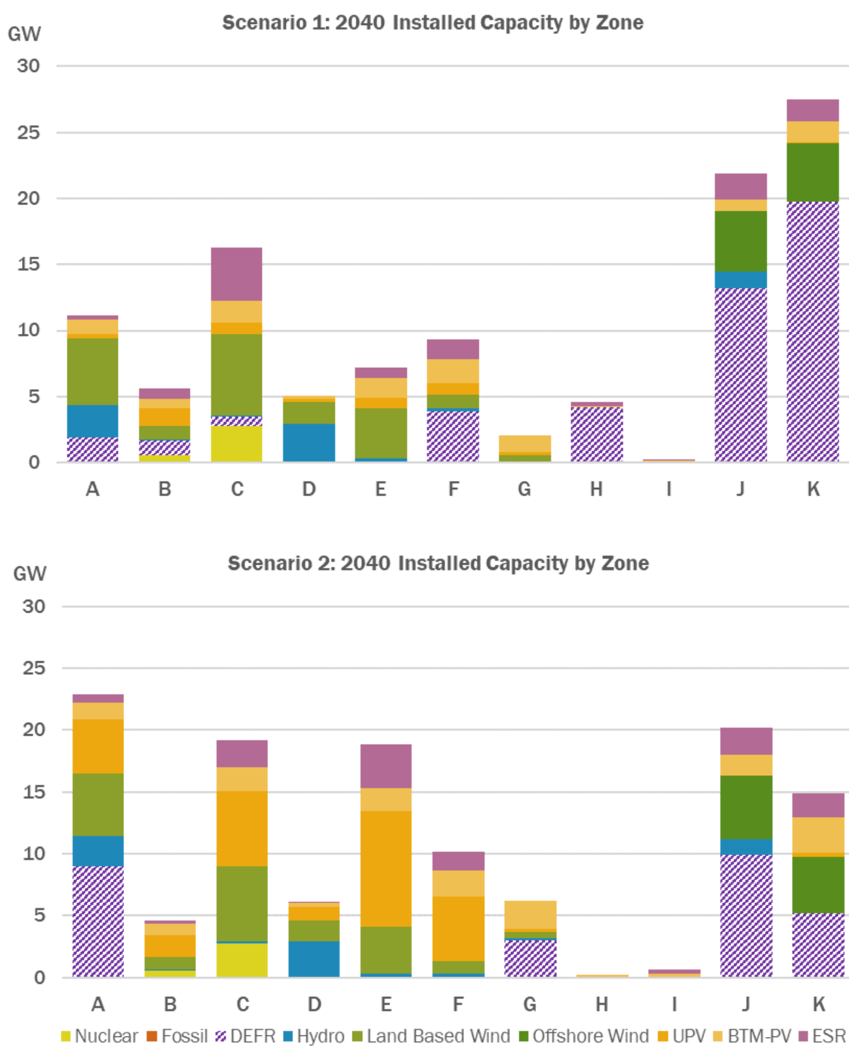



**Figure 22: Policy Case 2040 Installed Capacity by Zone**



Capacity reserve margins significantly contribute to the types and quantities of generation selected by the capacity expansion model. For example, the majority of DEFR buildouts occur in New York City and Long Island between year 2035 and 2040, which have an explicit locational capacity requirement. Because DEFRs have a near 100% capacity contribution, they are effective in meeting capacity requirements despite having a higher cost than other renewable generation types and storage. Furthermore, many of the DEFRs in these zones operate at a very low annual capacity factor in the model, indicating that they were selected to meet capacity needs rather than energy needs. Of note, an evaluation of the physical space feasibility for DEFR technologies to be constructed in New York City and Long Island was not performed as part of this analysis. In Scenario 1, over two times the amount of DEFR capacity is required in these zones compared to fossil generation capacity today.

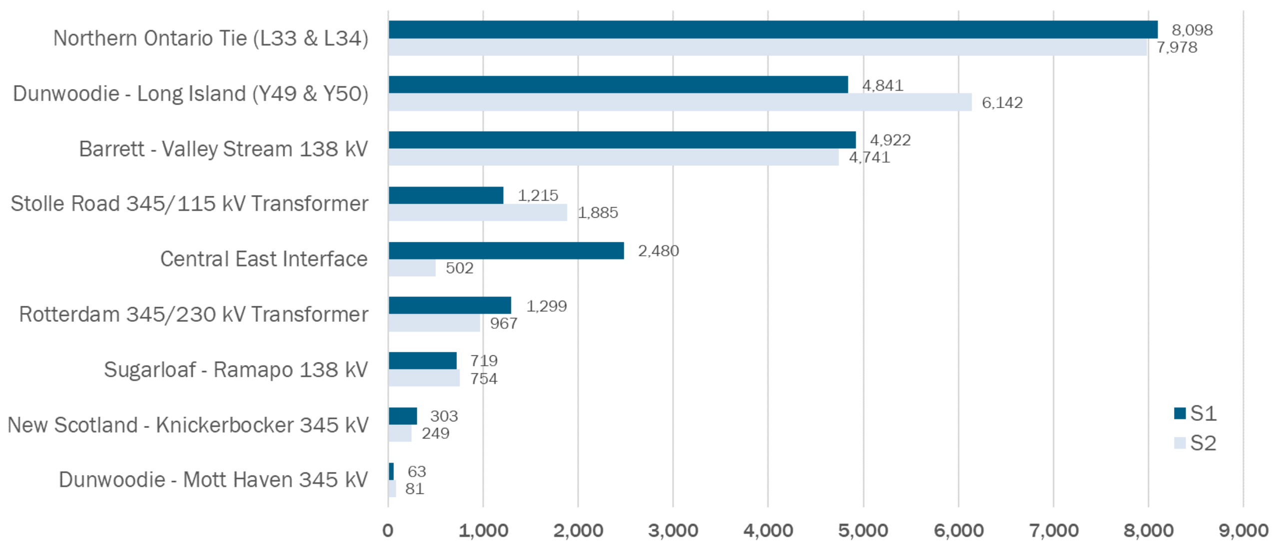
Given the reliance on DEFR technologies in the model, these technologies must be developed and deployed to meet policy objectives, reliability margins, and local capacity requirements. Without substantial amount of dispatchable resources to provide reliability benefits, a significant amount of excess renewable resources and/or battery storage would be required to meet capacity requirements. There are multiple potential paths to achieving policy targets. As the current system continues to evolve, the NYISO's modeling capabilities can evaluate a multitude of expansion scenarios to help in identifying paths to a greener and reliable future grid.

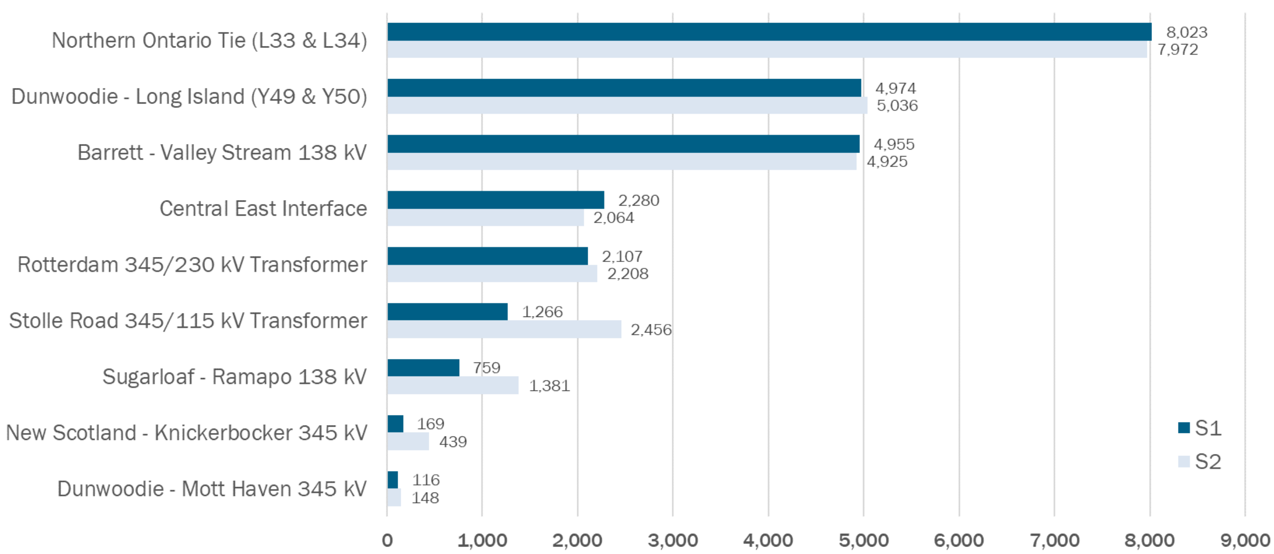
### Bulk Transmission Congestion Through 2035

Bulk power transmission facilities and interfaces in the Policy Cases show the most congestion on the system, owing to their high transfer capabilities to move power from areas of high renewable resource injection to load centers. Some historically congested interfaces such as *Central East* might have different congestion patterns depending on resource buildouts and load levels on either side of the interface. Another interface that is highly dependent on resource buildout is *Dunwoodie* to *Long Island*, which usually transfers power from upstate to Long Island (Zone K). Due to high amounts of offshore wind resources built in the Policy Case, congestion on this interface drops as more resource capacity is added. Overall, the congestion increases on the system as more resources are added and no upgrades are made on the existing transmission system.

The chart below shows the congested hours for the same list of bulk level transmission elements as those mentioned above for 2030 and 2035. The congestion on bulk system mostly increases as the model adds resources and relaxes constraints on the lower voltage system. Some interfaces also can have lower congestion due to congestion on lines further upstream at the bulk level.

**Figure 23: Congested Hours for Bulk Constraints, Years 2030 and 2035**

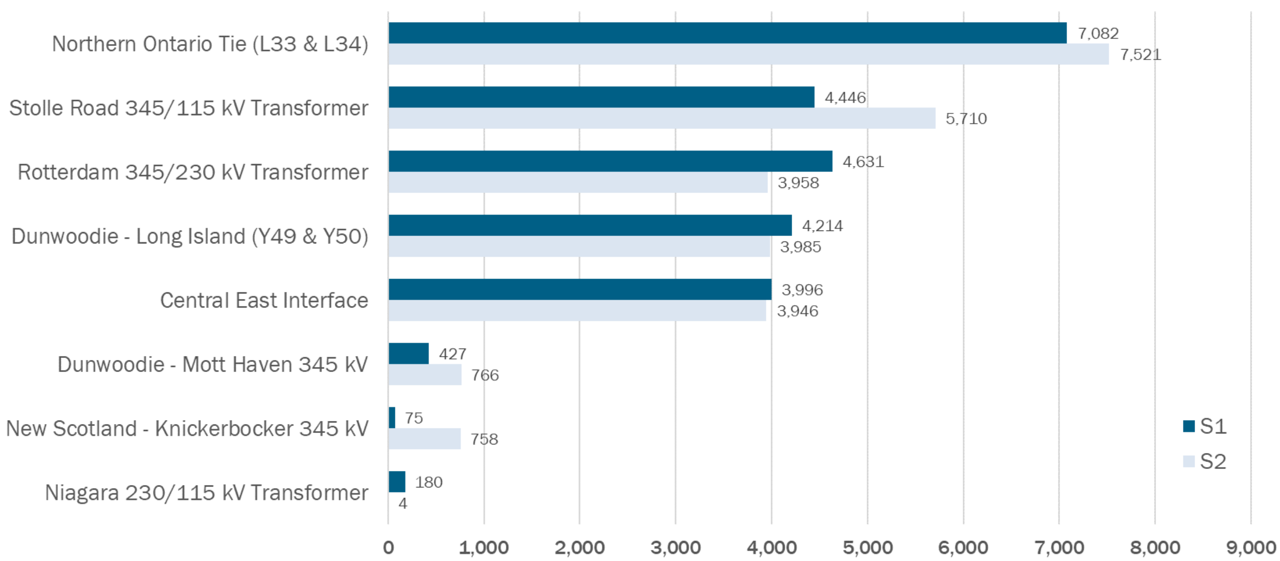


### Bulk Transmission Congestion After Local Transmission Constraints are Resolved

As ordered by NYSPC, the New York transmission owners have developed a comprehensive local transmission & distribution plan filed in November 2020, such as Phase 1, Phase 2 and Areas of Concerns[27], Recognizing the potential system expansion, the local transmission constraints (less than 200 kV) were assumed to be relieved between 2035 and 2040. Most of the renewable resources currently propose to interconnect at this voltage level, and removing these constraints allows for additional energy to reach the bulk level, which moves power over greater distances across the state into load centers. The remaining system constraints at the bulk level are therefore highlighted to signal the bulk transmission development needed to go hand-in-hand with the local transmission and distribution expansion.

**Figure 24: Congested Hours for Bulk Constraints, Year 2040**




The congested hours in 2040 in upstate bulk constraints, such as Central East Interface, significantly increased. This is due to the addition of new resources upstate, and the 2040 case with lower kV lines relaxed highlights the need for additional transmission capability on the bulk system assuming all lower kV level congestion is resolved to fully utilize renewable resources.

The figures below provide a summary of energy production from various fuel sources in upstate and downstate New York. In 2021, zero-emission resources made up 93% of upstate production, while fossil units downstate made up 89% of the production from that region. In 2040, the transition to zero-emission

[27] Case 20-E-0197, Proceeding on Motion of the Commission to Implement Transmission Planning Pursuant to the Accelerated Renewable Energy Growth and Community Benefit Act, Order on September 21, 2021

resources will lead to energy produced only by renewable resources, such as wind and solar, and zero-emission resources, such as nuclear and DEFR.

In upstate New York, approximately 80% of energy is produced from renewable resources and the remaining 20% comes from zero-emission resources. The system condition variations between the two scenarios, such as peak load forecast, energy consumption, and resource buildout does not have a significant impact on the resulting energy production.

In contrast, in downstate, the energy production could vary widely depending on the DEFR buildout required to maintain minimum locational capacity requirement. Up to one third of energy production could come from these resources that have yet to be developed and deployed.

Transmission expansion is critical to facilitating efficient CLCPA energy target achievement. The current New York transmission system, at both local and bulk levels, is inadequate to achieve currently required policy objectives. Renewable generation pockets throughout the State become more constrained as an increasing number of intermittent generation resources connect, necessitating transmission upgrades to make the renewable energy deliverable. A significant portion of projected renewable generation will be built in upstate New York areas that are geographically and electrically distant from the major consumer hubs in downstate New York, in which fossil generation is being retired. Bulk and local transmission constraints on today's grid will limit the effective delivery of renewable energy to consumers throughout the State. Without significant timely transmission expansion to provide access to renewable energy resource rich areas, the renewable energy cannot efficiently traverse New York State and be delivered to consumers.

**Figure 25: Upstate/Downstate Energy Production Comparison by Type for 2021 Actual**

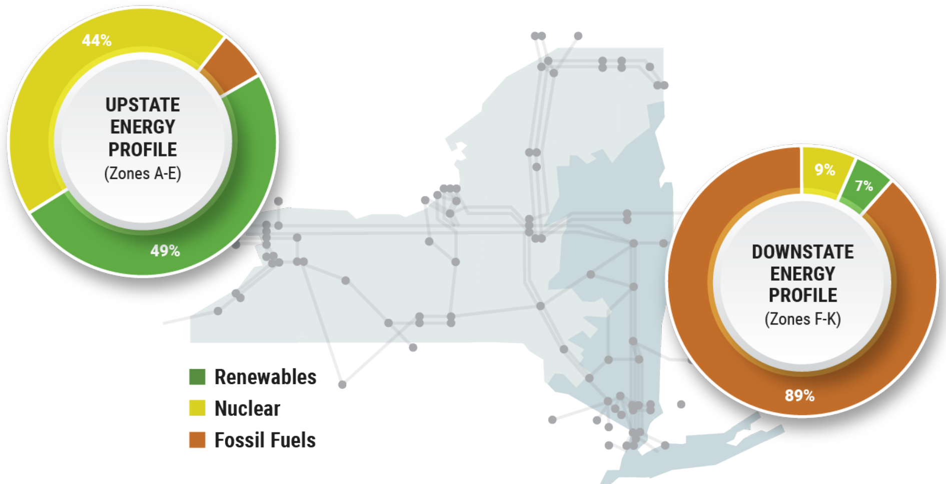



**Figure 26: Upstate/Downstate Energy Production Comparison by Type for Policy Scenario 1**

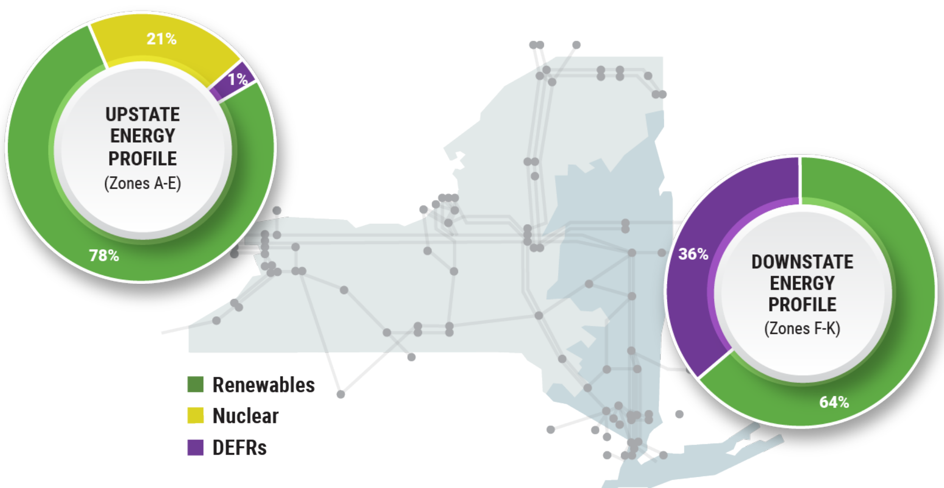
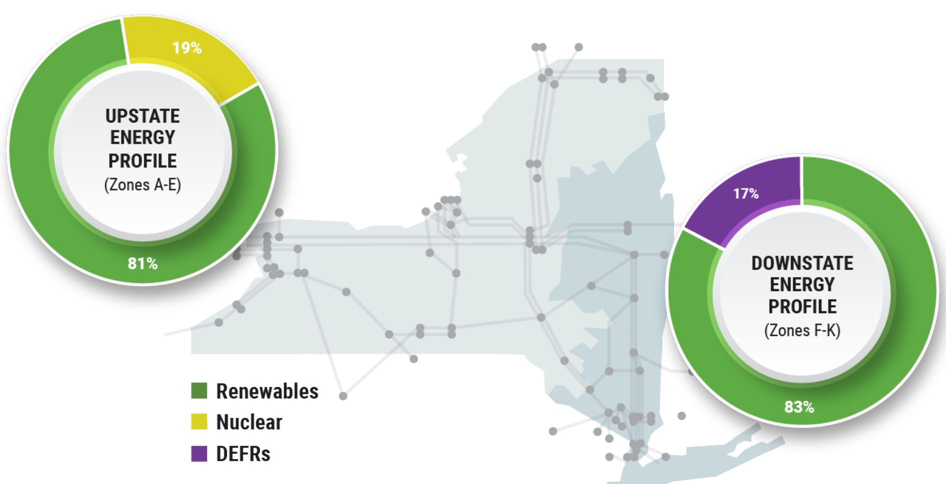



**Figure 27: Upstate/Downstate Energy Production Comparison by Type for Policy Scenario 2**



### System Performance

System and seasonal performance will challenge achieving policy targets and are identified through an operational assessment based on the results of hourly production cost simulations.[28] For example, the spring season experiences the most curtailment of wind, solar, and hydro generation, when there is both lower energy demand, and more supply through higher wind generation, moderately high solar irradiance, and high water flows due to snow melt. These weather characteristics result in significant renewable generation energy while demand is low, which ultimately leads to high levels of curtailment of resources as they are not needed. Scaling up renewable capacity to meet peak demands results in curtailments in other intervals of the year.

The existing fossil fleet currently operates to maintain the supply and demand balance in response to changes in net load, forecast uncertainty, reliability rules, and real-time events. In addition, fossil fueled generators may be called on to provide essential grid services, such as reserves, regulation, and/or other products that help maintain the reliability of the grid. Operations of the combined cycle fleet are most sensitive to increasing penetration of renewable generators.

Fossil fleet operation is at a minimum during the spring and a maximum during the summer season. The dispatchable fleet transitions from requiring maximal operation during the summer peak to during a winter peak in the mid-2030s. This transition continues into 2040 as DEFRs operate at higher levels during winter. Fossil generation online during many spring days has been committed for reliability purposes and represents the minimum potential fossil dispatch. No additional reliability constraints were imposed on DEFR units, which may impact their modeled operation, because the evolution of these requirements through 2040 is unknown.

The model observes reduced combined cycle generator output and an increase in the number of starts for these generators moving from 2025 through 2035. Meanwhile, the simple cycle combustion turbine fleet, which typically operates less frequently, increases in both annual output and number of starts as these generators are used more often to fill in shorter intervals in the net load requirements. Although the steam turbine fleet has a more muted response to renewable additions, due to the less flexible nature of these generators, the model reveals both an increase in starts and decrease in output across the fleet.

Ramping behavior of the dispatchable fleet increases due to larger diurnal load swings driven by electrification and the increasing level of weather dependent intermittent renewable resources added. New resources with increased ramping capabilities will be needed to balance load with supply across the

[28] The full set of hourly seasonal dispatch charts for both Scenario 1 and Scenario 2 details are available in Appendix F.3.5, and more information on the utilization of the fossil and DEFR fleets can be found in Appendix F.3.6.

system and during different operating conditions. Notably, these resources are not commercially available at this time. New technological innovation and successful development will be required in the intervening period.

The reliance on imported and exported energy to meet system demands changes by season, and the pattern of energy flow changes along the advancement of energy policy attainment. The magnitude of interchange, both imports and exports, increases through time in both scenarios as more variable renewable resources are added to the system. Historically, New York has imported energy from neighboring regions. In 2021, 37.6 TWh was imported while 10.4 TWh was exported, which resulted in a net import of 27.2 TWh. In this analysis, with the significant renewable buildout in New York to meet CLCPA[29], New York becomes an exporter up to year 2035, but then imports between 10 to 15 TWh by year 2040 when all fossil-fueled generation is assumed to deactivate.

The 2022 Grid in Transition study will leverage data from the Outlook to continue analysis surrounding potential grid needs and inform market designs for the future grid.

#### Tier 4 HVDC Transmission Impact Analysis

The Champlain Hudson Power Express and Clean Path New York Tier 4 HVDC transmission project were not included in the Baseline or Contract Cases but were included in both Policy Case scenarios with the assumption that both projects contribute to achievement of the 70 x 30 and 100 x 40 policies. Both transmission projects are assumed to contribute both in capacity and energy, and the projects were modeled as follows:

- The Champlain Hudson Power Express HVDC transmission project from Québec, Canada to New York City was modeled as importing 1,250 MW for all hours of the year from Québec to the Astoria 345kV substation in New York City. The project was assumed to provide 1,250 MW of capacity in the summer and zero in the winter toward the locational capacity requirements in the Lower Hudson Valley and New York City capacity localities. The line is assumed to be fully available and scheduled based on the economic exchange of energy.
- The Clean Path New York HVDC transmission project from Fraser 345 kV substation in Delaware County, New York to Rainey 345 kV substation in New York City was modeled as controllable transmission capable of flowing 1,300 MW from upstate to downstate. The line flows from upstate to downstate based on minimizing production cost of the system and generally transacts energy when the marginal energy price at the upstate sending end is lower than the downstate receiving end. For the purpose of this assessment, the project is assumed to provide 650 MW of capacity toward the locational capacity requirements in the Lower Hudson Valley and New York City capacity localities. [30]

[29] No additional renewable buildout was included for external areas.

[30] The NYISO is currently developing the market participation rules for internal controllable lines. The scheduling and operation of Clean Path New York will abide by these rules. The assumptions for this study were developed to provide directional analysis.

Results from the hourly production cost model show the performance of the Tier 4 transmission projects in Scenario 1 and Scenario 2. Figure 28 below shows the annual energy flows and utilization percentage for each project.

**Figure 28: Tier 4 HVDC Transmission Performance**

| | | Champlain Hudson | | Clean Path New York | |
|---|---|---|---|---|---|
| Case - Year | | Energy (GWh) | Utilization (%) | Energy (GWh) | Utilization (%) |
| S1 | 2030 | 10,944 | 100% | 3,409 | 30% |
| | 2035 | 10,512 | 96% | 4,031 | 35% |
| | 2040* | 10,458 | 95% | 8,435 | 74% |
| S2 | 2030 | 10,925 | 100% | 1,596 | 14% |
| | 2035 | 10,759 | 98% | 4,465 | 39% |
| | 2040* | 10,596 | 96% | 9,439 | 83% |

* Assumes sufficient transmission expansion occurs between 2035 and 2040 to relieve transmission constraints at lower voltage levels, resulting in greater renewable energy available for transfer across the bulk system.

For both Scenario 1 and Scenario 2, the annual energy transacted and utilized for the CHPE project decreases through time. This trend results from increased competition from offshore wind in New York City. The CPNY transmission project, which flows based on the price differential between Upstate and Downstate, increases in utilization but remains less than 40% through 2035. However, assuming transmission expansion takes place by 2040 to relieve renewable generation pocket constraints, the utilization of the Clean Path project increases significantly.

### Road to 2040: Key Takeaways

The Policy Case provides insight into the challenges that New York power system will face as the renewable resource and CO2-emission free electric system policy objectives progress. The NYISO has identified several important insights during the analysis of Policy Case simulations and data:

- Significant new resource development will be required to achieve CLCPA energy targets. The total installed generation capacity to meet policy objectives within New York is projected to range from 111 GW and 124 GW of total generation capacity by 2040. At least 95 GW of this capacity will consist of new generation projects and/or modifications to existing plants[31], and still may not be sufficient to fully meet CLCPA requirements[32] while maintaining the reliable electricity supply that New York consumers have come to rely on. The sheer scale of resources needed to satisfy system reliability and policy requirements within the next 20 years is unprecedented.

[31] Including the in-front-of the meter and behind-the-meter renewable generation addition after consideration of the deactivation of existing fossil-fire units by 2040.

[32] This report does not attempt to identify the resources needed to achieve full policy attainment.

- Every incremental advancement towards policy achievement matters on the path to a greener and reliable grid in the future, not just at the critical milestone years such as 2030 and 2040. In general, resource and transmission expansion take many years from development to deployment. By year 2030, roughly seven years from the publication of this report, an estimated 20 GW of additional renewable generation needs to be in-service to support the energy policy target of 100% zero-emission generation by 2040. For reference, 12.9 GW of new generation has been developed since wholesale electricity markets began more than 20 years ago in 1999. Over the past five years, 2.6 GW of renewable and fossil-fueled generators came on-line while 4.8 GW of generation deactivated. This Outlook demonstrates the need for a substantial number of new resources and an unprecedented pace of project deployment, which will require significant labor and materials available for New York over a long period of time.
- Transmission expansion is critical to facilitating efficient CLCPA energy target achievement. The current New York transmission system, at both local and bulk levels, is inadequate to achieve currently required policy objectives. Renewable generation pockets throughout the State become more constrained as an increasing number of intermittent generation resources connect, necessitating transmission upgrades to make the renewable energy deliverable. Bulk and local transmission constraints on today's grid will limit the effective delivery of renewable energy to consumers throughout the State. A significant portion of projected renewable generation will be built in upstate New York areas, which are geographically and electrically distant from the major consumer hubs in downstate New York, while downstate fossil generation is being retired. Without significant timely transmission expansion to provide access to renewable energy resource rich areas, the renewable energy cannot efficiently traverse New York State and be delivered to consumers.
- This Outlook identifies many transmission needs expected to arise over the next 20 years driven by public policy requirements, most notable the New York State climate mandates enacted in 2019 and 2020. The most notable and urgent transmission needs include:
    - **Long Island offshore wind export**- The NYISO is currently evaluating the viable and sufficient project proposals to the Long Island Offshore Wind Export Public Policy Transmission Need (Long Island PPTN), based on the Order issued by the NYSPSC on March 19, 2021. If a more efficient or cost-effective solution is selected to meet the Long Island PPTN, the congestion in Long Island is expected to be reduced significantly. However, offshore wind resource additions of up to 20 GW that are under discussion[33] may necessitate additional transmission to deliver offshore wind energy to New Yorkers.
    - **The Watertown/Tug Hill Plateau renewable generation pocket (X3)** - The 115 kV network is expected to limit the availability of the already-contracted wind and solar generation in this area, and the limitation will become more severe when more renewable resources are interconnected. Additional transmission is necessary to

[33] New York State Climate Action Council Draft Scoping Plan, December 30, 2021, available at: https://climate.ny.gov/Our-Climate-Act/Draft-Scoping-Plan.

provide the resources access to the bulk grid.

- **Southern Tier renewable generation pocket (Z1, Z2)** - The land and natural resource availability in this region (wind and solar) support renewable generation buildout in this area. Transmission expansion from this pocket to the bulk grid would benefit New York consumers statewide.

- To achieve an emission-free grid, dispatchable emission-free resources (DEFRs) must be developed and deployed throughout New York to replace the various electrical attributes that are provided today by fossil generation. DEFRs that provide sustained on-demand power and system stability will be essential to meeting policy objectives while maintaining a reliable electric grid. While essential to the grid of the future, such DEFR technologies are not commercially viable today and will require committed public and private investment in research and development efforts to identify the most efficient and cost-effective technologies with a view towards the development and eventual adoption of commercially viable resources. The scale and technology of DEFRs necessary to meet state energy needs will also depend upon the buildout of the transmission and distribution grids.
- The incremental reliability contribution of intermittent renewable resource capacity declines as more are added to the system. The limited contribution of incremental resources to system reliability inhibits the ability of renewable resources to effectively contribute to mandatory resource requirements and to serve load in hours in which renewable generation is limited or unavailable.
- Coordination of renewable energy additions, commercialization, and development of DEFRs, and fossil fuel plant operation over the next 18-years will be essential to facilitate an orderly transition of the grid. The large amount of renewable energy additions required to achieve the CLCPA mandates will impact the operations of the existing fossil fuel fleet in the remaining 18-year transition to an emission-free grid. There will be a greater need for resources that can operate more flexibly to meet the increased variability associated with wind and solar generation. This Outlook demonstrates that flexible units will dispatch more frequently during the transition.
- Essential grid services, such as operating reserves, ramping, regulation, voltage support, and black start, must be continued to provide New Yorkers with reliable and predictable electric system that consumers require. This means that new resources will need to provide these services prior to the exit of existing resources.
- Resource buildout to meet minimum capacity requirements is not sufficient to efficiently achieve the state’s climate change requirements. This study shows that if new resources are not built-in excess of reserve requirements to serve loads reliably, New York will likely rely on importing a significant amount of external energy that may or may not be renewable. New York is fortunate to have strong interconnections with neighboring areas and has enjoyed reliability and economic benefits from such connections. As the energy policies in the neighboring areas evolve independently, the amount of imports and exports could vary significantly due to the resulting resource and load shifts in the neighboring areas. Balancing the need to serve loads reliably while achieving New York’s emission-free target will require

continuous monitoring and collaboration with our neighboring states.

- When dispatched effectively, energy storage would help to increase the utilization of the renewable generation, but energy storage alone cannot completely resolve the transmission limitations in the pockets analyzed.
- Peak load management should be further integrated as a measure to facilitate CLCPA energy target achievement. Thanks to the peak load management measures already announced and implemented, New York is expected to see peak load forecast gradually decrease over the next few years. However, in the long term, the demand is likely to increase beyond the historical level due to electrifying buildings and transportation. By lowering the peak load and avoiding system buildout to serve the highest demand hour, less DEFR buildout would be needed, and during the transition fossil fueled plants could be utilized less to meet lower peaks.
- Electrification from other sectors, such as building and transportation, into the power sector should be monitored and managed closely. Electrification is one of the largest factors driving peak and annual energy demand. Electrification must be in lock step with new resource additions and resource retirements. While other sectors, such as transportation, currently account for a larger share of greenhouse gas emissions, unmanaged electrification of the energy sector could lead to higher power sector emissions, wholesale electricity costs, and reduced reliability.

## Renewable Generation Pockets

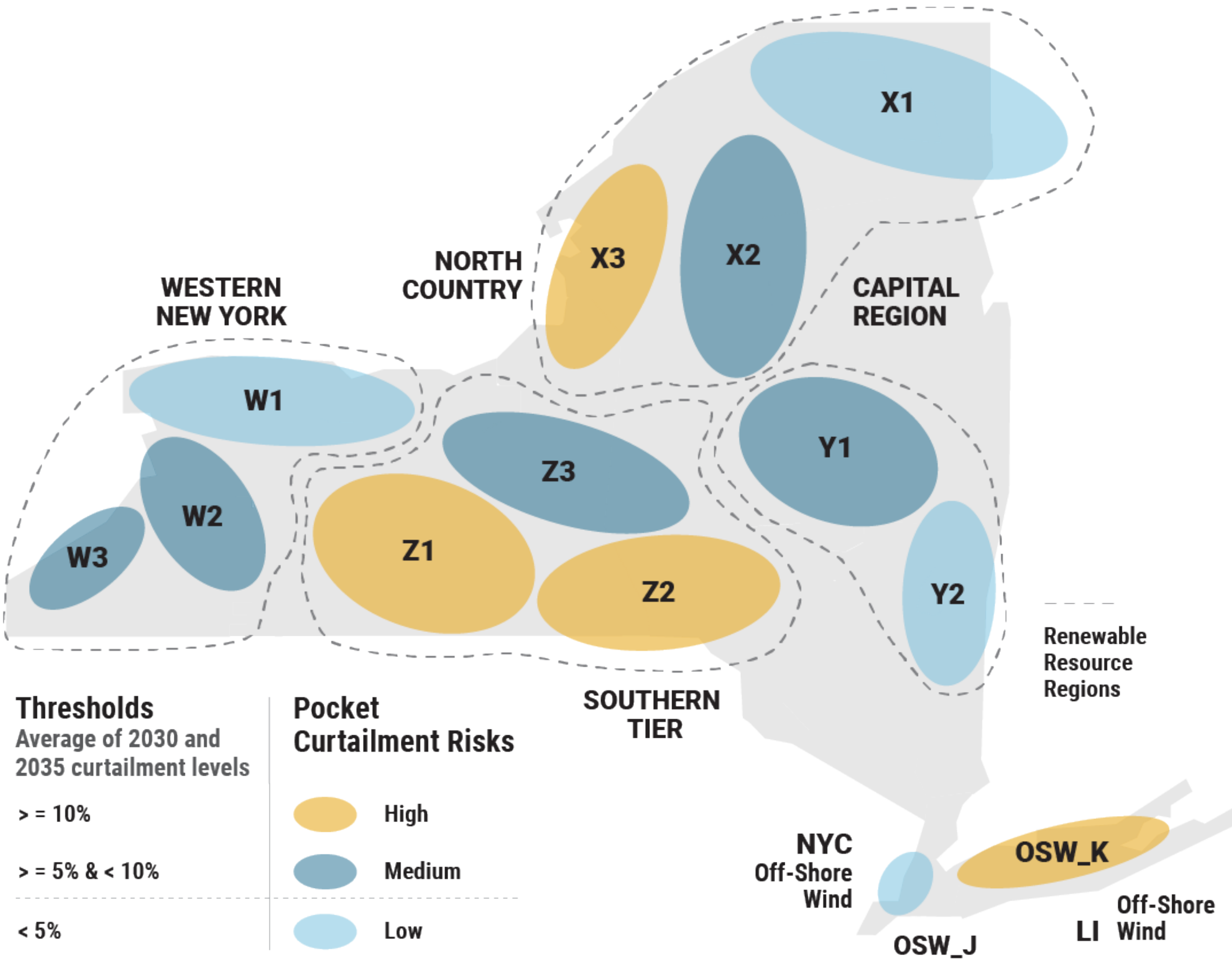
The concept of renewable generation pockets was introduced in the NYISO's 2019 economic planning study. The pockets were developed to visualize geographic regions of New York State where renewable generation projects are being deployed and to readily quantify the impact of those projects on the surrounding transmission network.

### Renewable Pocket Definitions

Prior NYISO economic planning studies[34] examined the formation of renewable generation pockets driven by transmission congestion and constraints. These pockets illustrated transmission constraints that, if unaddressed, will prevent full utilization of renewable resources within the area. A similar analysis was performed for this Outlook. The renewable generation pockets first identified in 2019 were utilized as the starting point to identify constraints and generators within the pockets in the Contract Case and Policy Case scenarios. The renewable generation pocket map for this Outlook is shown in the figure below. The shaded areas summarize the findings by identifying the pockets as having a "low" "medium" or "high" risk for curtailment. The pockets with a "high" risk were determined to have both persistent and significant renewable generation curtailment within the pocket.

[34] 2019 CARIS Phase 1 Study: https://www.nyiso.com/documents/20142/2226108/2019-CARIS-Phase1-Report-Final.pdf

**Figure 29: Renewable Generation Pocket Map**




The generation pocket assignments are defined by two main considerations: renewable generation buildout location and the 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 discrete local areas.

- **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**: Tug Hill Plateau Wind & Solar (mainly 115 kV in Lewis County)

3) **X3**: Watertown 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)

### Pocket Analysis

The pockets are a grouping of congested lines and generators which are likely to be curtailed within a localized area. Pocket definitions and locations are the same between the Contract Case and Policy Case scenarios. The new Policy Case resources identified in Scenario 1 and Scenario 2 significantly increase the renewable energy resources on the system compared to the Baseline and Contract Cases.

Curtailment of renewable generation occurs when a transmission line would become overloaded if renewable generation were not dispatched to a lower output level. The decision to curtail a specific renewable generator is dependent upon both electrical location and energy market bids. A second form of renewable generation re-dispatch, termed "spillage," can also occur. Spillage of renewable energy can occur when all relevant dispatchable resources have been set to minimum levels and energy export limits have been reached, which would necessitate a reduction in renewable generation output to balance the system. Spillage conditions are projected to occur as early as 2030 and would be most prevalent during the spring season when electricity demand is low and renewable generator production is high.

In order to capture the constraints and energy deliverability at various voltage levels, the NYISO conducted the pocket analysis using a detailed transmission system representation for years 2030 and 2035. For 2040, the NYISO assumed sufficient transmission expansion occurs between 2035 and 2040 to relieve transmission constraints at lower voltage levels and recognizes the efforts of transmission owners to meet CLCPA[35]. This allows the NYISO to examine the impact of the addition of the new resources on the

[35] Case 20-E-0197, Proceeding on Motion of the Commission to Implement Transmission Planning Pursuant to the Accelerated Renewable Energy Growth and Community Benefit Act

bulk power system constraints, which may be masked by the local system constraints that exist today. This highlights the bulk transmission expansions that will still be necessary to efficiently deliver energy to consumers.

The new resource additions from the capacity expansion simulations were placed at available points of interconnection identified in the NYISO Interconnection Queue for new wind and solar facilities. These locations represent the probable sites for new resource additions and provide likely interconnection points on the existing system. Most of the additional resources are located inside the general pocket locations identified in the Contract Case. A study of local congestion within these pockets illustrates expected obstacles in the transmission system to transmit power out of the pockets to serve loads elsewhere. A detailed look at each individual pocket and associated metrics is provided in Appendix J of this report.

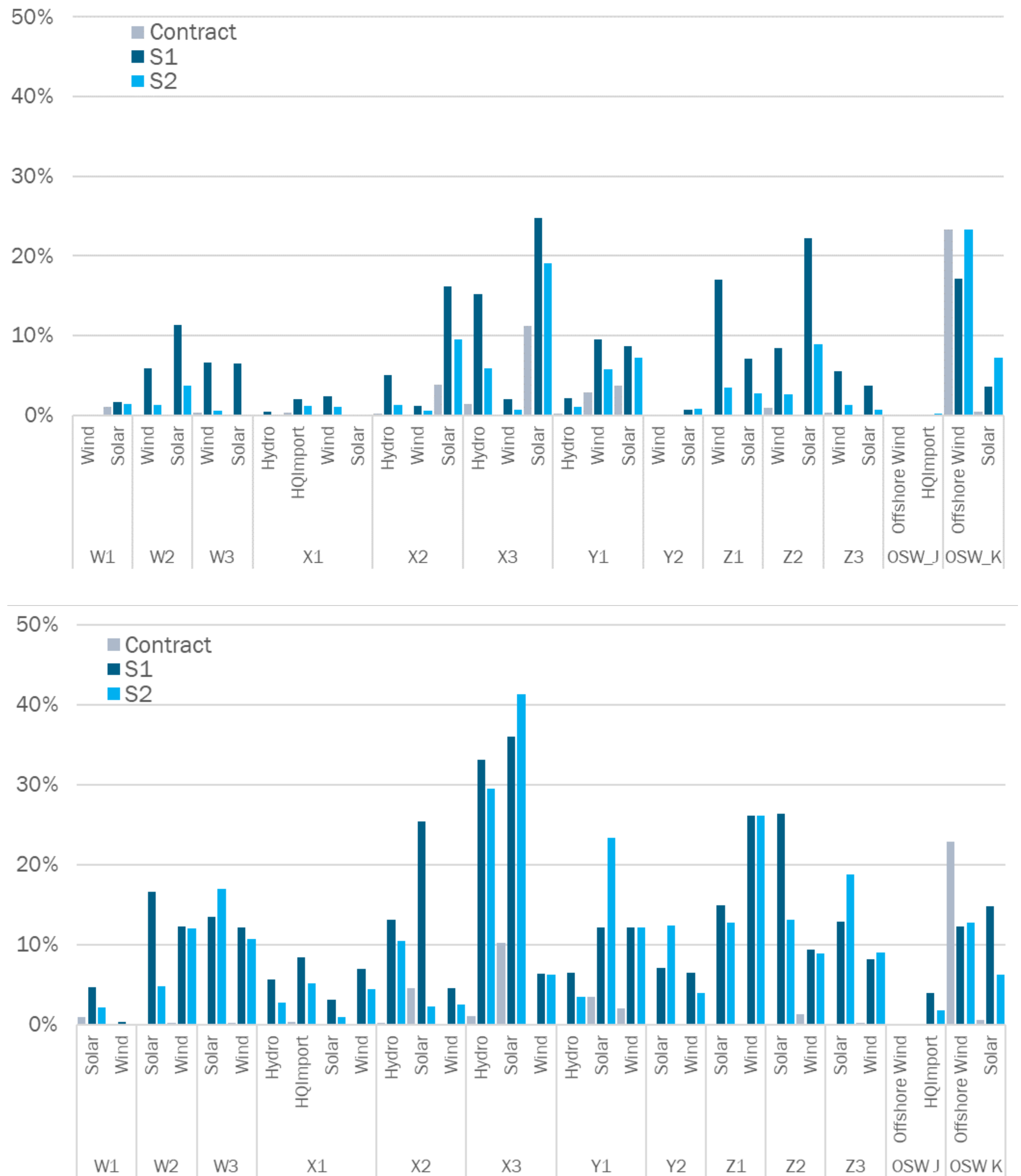
The pocket analysis indicates potential areas where transmission constraints could lead to curtailment of nearby renewable resources. The renewable curtailments identified could result from a combination of drivers, including: (1) resource siting location, (2) size of renewable buildout, (3) the congestion pattern of transmission constraints, (4) existing thermal unit operations and the need to meet certain regulatory requirements, and (5) zonal load level and shape. Renewable generation located upstream of transmission constraints is more likely to be curtailed compared with renewables located downstream of the constraints. In general, renewable curtailments caused by transmission constraints include constraints inside generation pockets, tie line constraints, and constraints outside of generation pockets.

Offshore wind makes up the majority of renewable generation added in New York City and Long Island (Zones J and K). Upstate renewable generation is a mix of utility-scale solar and land-based wind resources. The existing Hydro-Québec (HQ) imports into Northern New York (Zone D) are considered qualifying renewable generation injecting into the X1 pocket.

The majority of curtailment occurs in Long Island for offshore wind. This results in a low energy deliverability percentage compared to other pockets and resource types. Constraints that lead to significant curtailment of offshore projects and any associated upgrades will be studied as part of the current NYISO Public Policy Transmission Planning Process addressing the Long Island Offshore Wind Export Public Policy Transmission Need. Some solar generation curtailment is observed in the North Country and Capital Region (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.

Energy deliverability levels in four pockets, in particular, will benefit from transmission expansion: Finger Lakes (Z1), Southern Tier (Z2), Watertown (X3), and Long Island. Without investment in transmission, these areas of the New York grid will experience persistent and significant limitations to deliver the renewable power from these pockets to consumers in the upcoming years.

**Figure 30: Renewable Generation Pocket Curtailment Rates by Generation Type, 2030 and 2035**



### Energy Deliverability

Energy deliverability for a generation pocket is defined as the total energy utilized to serve demand from a group of resources in that pocket. It is expressed as the ratio of energy generated to total scheduled energy for those resources. The energy deliverability metric illustrates how much of the total potential energy was delivered to the grid and how much was curtailed. The tables below show the Energy Deliverability metric by pocket and resource type for the Contract and Policy Cases in 2030 and 2035.

Complete details on the capacity, energy, curtailment, and energy deliverability by pocket for each of the scenarios in 2035 can be found in Appendix J of this report.

**Figure 31: Contract Case Energy Deliverability for 2030 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% |
| | Solar | 1,130 | 2,214 | 2,189 | 25 | 99% |
| W2 | Wind | 813 | 2,029 | 2,028 | 2 | 100% |
| | Solar | 60 | 84 | 84 | 0 | 100% |
| W3 | Wind | 305 | 700 | 698 | 2 | 100% |
| | Solar | 290 | 448 | 448 | 0 | 100% |
| X1 | Hydro | 1,049 | 7,929 | 7,929 | 0 | 100% |
| | HQImport | 1,930 | 11,498 | 11,456 | 41 | 100% |
| | Wind | 678 | 1,441 | 1,441 | 0 | 100% |
| | Solar | 180 | 367 | 367 | 0 | 100% |
| X2 | Hydro | 250 | 1,405 | 1,402 | 3 | 100% |
| | Wind | 505 | 1,154 | 1,153 | 0 | 100% |
| | Solar | 35 | 54 | 52 | 2 | 96% |
| X3 | Hydro | 155 | 771 | 760 | 11 | 99% |
| | Wind | 80 | 179 | 179 | 0 | 100% |
| | Solar | 369 | 609 | 541 | 69 | 90% |
| Y1 | Hydro | 30 | 114 | 114 | 0 | 100% |
| | Wind | 74 | 179 | 174 | 5 | 97% |
| | Solar | 961 | 1,801 | 1,735 | 66 | 96% |
| Y2 | Wind | - | - | - | - | - |
| | Solar | 250 | 421 | 421 | 0 | 100% |
| Z1 | Wind | 720 | 1,628 | 1,627 | 0 | 100% |
| | Solar | 405 | 711 | 711 | 0 | 100% |
| Z2 | Wind | 213 | 696 | 689 | 7 | 99% |
| | Solar | 60 | 97 | 97 | 0 | 100% |
| Z3 | Wind | 76 | 136 | 136 | 0 | 100% |
| | Solar | 150 | 280 | 280 | 0 | 100% |
| OSW_J | Offshore Wind | 2,046 | 8,366 | 8,364 | 2 | 100% |
| | HQImport | - | - | - | - | - |
| OSW_K | Offshore Wind | 2,270 | 8,891 | 6,815 | 2,076 | 77% |
| | Solar | 99 | 159 | 158 | 1 | 100% |

**Figure 32: Contract Case Energy Deliverability for 2035 by Pocket and Resource Type**

| Pockets | Type | Capacity (MW) | Energy (GWh) | Scheduled Energy (GWh) | Curtailed Energy (GWh) | Energy Deliverability (%) |
|---|---|---|---|---|---|---|
| W1 | Solar | 1,130 | 2,219 | 2,241 | 22 | 99% |
| | Wind | 200 | 393 | 393 | 0 | 100% |
| W2 | Solar | 60 | 84 | 84 | 0 | 100% |
| | Wind | 813 | 2,030 | 2,033 | 3 | 100% |
| W3 | Solar | 290 | 449 | 449 | 0 | 100% |
| | Wind | 305 | 702 | 703 | 1 | 100% |
| X1 | Hydro | 1,068 | 7,929 | 7,929 | 0 | 100% |
| | HQImport | 0 | 11,478 | 11,517 | 39 | 100% |
| | Solar | 180 | 367 | 367 | 0 | 100% |
| | Wind | 678 | 1,443 | 1,443 | 0 | 100% |
| X2 | Hydro | 249 | 1,405 | 1,407 | 2 | 100% |
| | Solar | 35 | 54 | 56 | 3 | 95% |
| | Wind | 505 | 1,153 | 1,153 | 0 | 100% |
| X3 | Hydro | 156 | 774 | 782 | 8 | 99% |
| | Solar | 369 | 609 | 678 | 70 | 90% |
| | Wind | 80 | 178 | 178 | 0 | 100% |
| Y1 | Hydro | 30 | 114 | 114 | 0 | 100% |
| | Solar | 961 | 1,804 | 1,869 | 66 | 96% |
| | Wind | 74 | 181 | 185 | 4 | 98% |
| Y2 | Solar | 250 | 421 | 422 | 0 | 100% |
| | Wind | - | - | - | - | - |
| Z1 | Solar | 405 | 711 | 711 | 0 | 100% |
| | Wind | 720 | 1,627 | 1,627 | 0 | 100% |
| Z2 | Solar | 60 | 97 | 97 | 0 | 100% |
| | Wind | 213 | 693 | 702 | 9 | 99% |
| Z3 | Solar | 150 | 280 | 280 | 0 | 100% |
| | Wind | 76 | 136 | 136 | 0 | 100% |
| OSW J | Offshore Wind | 2,046 | 8,340 | 8,342 | 2 | 100% |
| | HQImport | - | - | - | - | - |
| OSW K | Offshore Wind | 2,270 | 6,831 | 8,861 | 2,030 | 77% |
| | Solar | 99 | 159 | 160 | 1 | 99% |

**Figure 33: Policy Case Scenario 1 Energy Deliverability for 2030 by Pocket and Resource Type**

| Pocket | Type | Capacity (MW) | Scheduled Energy (GWh) | Dispatched Energy (GWh) | Curtailment (GWh) | Energy Deliverability (%) |
|---|---|---|---|---|---|---|
| W1 | Wind | 1,543 | 4,890 | 4,890 | 0 | 100% |
| | Solar | 1,130 | 2,239 | 2,203 | 36 | 98% |
| W2 | Wind | 1,491 | 4,263 | 4,012 | 251 | 94% |
| | Solar | 60 | 84 | 74 | 10 | 89% |
| W3 | Wind | 916 | 2,713 | 2,534 | 179 | 93% |
| | Solar | 290 | 448 | 420 | 29 | 94% |
| X1 | Hydro | 1,049 | 7,929 | 7,894 | 35 | 100% |
| | HQImport | 1,930 | 11,498 | 11,264 | 234 | 98% |
| | Wind | 876 | 2,062 | 2,013 | 49 | 98% |
| | Solar | 180 | 367 | 367 | 0 | 100% |
| X2 | Hydro | 250 | 1,407 | 1,336 | 71 | 95% |
| | Wind | 598 | 1,441 | 1,425 | 17 | 99% |
| | Solar | 35 | 56 | 47 | 9 | 84% |
| X3 | Hydro | 155 | 782 | 663 | 119 | 85% |
| | Wind | 790 | 2,515 | 2,463 | 52 | 98% |
| | Solar | 369 | 678 | 510 | 168 | 75% |
| Y1 | Hydro | 30 | 114 | 112 | 2 | 98% |
| | Wind | 101 | 273 | 247 | 26 | 90% |
| | Solar | 961 | 1,868 | 1,705 | 163 | 91% |
| Y2 | Wind | 255 | 857 | 857 | 0 | 100% |
| | Solar | 250 | 422 | 419 | 3 | 99% |
| Z1 | Wind | 1,495 | 4,108 | 3,409 | 699 | 83% |
| | Solar | 405 | 711 | 661 | 50 | 93% |
| Z2 | Wind | 803 | 2,620 | 2,400 | 220 | 92% |
| | Solar | 60 | 97 | 76 | 22 | 78% |
| Z3 | Wind | 265 | 750 | 709 | 41 | 95% |
| | Solar | 150 | 280 | 269 | 10 | 96% |
| OSW_J | Offshore Wind | 2,046 | 8,368 | 8,368 | 0 | 100% |
| | HQImport | 1,250 | 10,950 | 10,944 | 6 | 100% |
| OSW_K | Offshore Wind | 2,990 | 11,830 | 9,807 | 2,023 | 83% |
| | Solar | 99 | 159 | 154 | 6 | 96% |

**Figure 34: Policy Case Scenario 1 Energy Deliverability for 2035 by Pocket and Resource Type**

| Pockets | Type | Capacity (MW) | Energy (GWh) | Scheduled Energy (GWh) | Curtailed Energy (GWh) | Energy Deliverability |
|---|---|---|---|---|---|---|
| W1 | Solar | 1,130 | 2,135 | 2,241 | 106 | 95% |
| | Wind | 1,621 | 5,137 | 5,155 | 18 | 100% |
| W2 | Solar | 60 | 70 | 84 | 14 | 83% |
| | Wind | 1,633 | 4,154 | 4,736 | 582 | 88% |
| W3 | Solar | 290 | 388 | 449 | 61 | 87% |
| | Wind | 1,012 | 2,666 | 3,034 | 368 | 88% |
| X1 | Hydro | 1,068 | 7,485 | 7,929 | 445 | 94% |
| | HQImport | 1,930 | 10,553 | 11,517 | 964 | 92% |
| | Solar | 180 | 356 | 367 | 12 | 97% |
| | Wind | 1,274 | 3,070 | 3,298 | 228 | 93% |
| X2 | Hydro | 249 | 1,222 | 1,407 | 185 | 87% |
| | Solar | 35 | 42 | 56 | 14 | 75% |
| | Wind | 785 | 1,921 | 2,013 | 92 | 95% |
| X3 | Hydro | 156 | 523 | 782 | 259 | 67% |
| | Solar | 369 | 434 | 678 | 244 | 64% |
| | Wind | 1,313 | 3,954 | 4,224 | 270 | 94% |
| Y1 | Hydro | 30 | 107 | 114 | 7 | 94% |
| | Solar | 961 | 1,642 | 1,869 | 227 | 88% |
| | Wind | 120 | 296 | 337 | 41 | 88% |
| Y2 | Solar | 250 | 392 | 422 | 30 | 93% |
| | Wind | 618 | 1,911 | 2,042 | 132 | 94% |
| Z1 | Solar | 405 | 605 | 711 | 106 | 85% |
| | Wind | 2,160 | 4,596 | 6,217 | 1,621 | 74% |
| Z2 | Solar | 60 | 72 | 97 | 26 | 74% |
| | Wind | 1,257 | 3,702 | 4,084 | 382 | 91% |
| Z3 | Solar | 150 | 244 | 280 | 36 | 87% |
| | Wind | 413 | 1,123 | 1,224 | 101 | 92% |
| OSW J | Offshore Wind | 4,571 | 17,699 | 17,712 | 13 | 100% |
| | HQImport | 1,250 | 10,512 | 10,950 | 438 | 96% |
| OSW K | Offshore Wind | 4,430 | 15,490 | 17,652 | 2,162 | 88% |
| | Solar | 99 | 136 | 160 | 24 | 85% |

**Figure 35: Policy Case Scenario 2 Energy Deliverability for 2030 by Pocket and Resource Type**

| Pocket | Type | Capacity (MW) | Scheduled Energy (GWh) | Dispatched Energy (GWh) | Curtailment (GWh) | Energy Deliverability (%) |
|---|---|---|---|---|---|---|
| W1 | Wind | 735 | 2,180 | 2,180 | 0 | 100% |
| | Solar | 1,130 | 2,239 | 2,207 | 32 | 99% |
| W2 | Wind | 1,074 | 2,891 | 2,852 | 39 | 99% |
| | Solar | 60 | 84 | 81 | 3 | 96% |
| W3 | Wind | 576 | 1,594 | 1,584 | 10 | 99% |
| | Solar | 290 | 448 | 448 | 1 | 100% |
| X1 | Hydro | 1,007 | 7,929 | 7,928 | 1 | 100% |
| | HQImport | 1,930 | 11,498 | 11,364 | 134 | 99% |
| | Wind | 778 | 1,752 | 1,733 | 19 | 99% |
| | Solar | 180 | 367 | 367 | 0 | 100% |
| X2 | Hydro | 240 | 1,407 | 1,389 | 18 | 99% |
| | Wind | 552 | 1,298 | 1,290 | 8 | 99% |
| | Solar | 35 | 56 | 51 | 5 | 91% |
| X3 | Hydro | 152 | 782 | 736 | 46 | 94% |
| | Wind | 417 | 1,288 | 1,279 | 10 | 99% |
| | Solar | 369 | 678 | 548 | 129 | 81% |
| Y1 | Hydro | 30 | 114 | 113 | 1 | 99% |
| | Wind | 86 | 225 | 212 | 13 | 94% |
| | Solar | 961 | 1,868 | 1,733 | 134 | 93% |
| Y2 | Wind | 123 | 413 | 413 | 0 | 100% |
| | Solar | 250 | 422 | 418 | 4 | 99% |
| Z1 | Wind | 1,119 | 2,905 | 2,803 | 102 | 96% |
| | Solar | 405 | 711 | 691 | 20 | 97% |
| Z2 | Wind | 512 | 1,673 | 1,629 | 44 | 97% |
| | Solar | 60 | 97 | 88 | 9 | 91% |
| Z3 | Wind | 173 | 453 | 447 | 6 | 99% |
| | Solar | 150 | 280 | 277 | 2 | 99% |
| OSW_J | Offshore Wind | 5,166 | 19,997 | 19,994 | 3 | 100% |
| | HQImport | 1,250 | 10,950 | 10,925 | 25 | 100% |
| OSW_K | Offshore Wind | 2,270 | 8,891 | 6,818 | 2,073 | 77% |
| | Solar | 99 | 159 | 148 | 12 | 93% |

**Figure 36: Policy Case Scenario 2 Energy Deliverability for 2035 by Pocket and Resource Type**

| Pockets | Type | Capacity (MW) | Energy (GWh) | Scheduled Energy (GWh) | Curtailed Energy (GWh) | Energy Deliverability |
|---|---|---|---|---|---|---|
| W1 | Solar | 2,092 | 3,322 | 3,395 | 72 | 98% |
| | Wind | 1,375 | 4,315 | 4,318 | 2 | 100% |
| W2 | Solar | 349 | 429 | 451 | 22 | 95% |
| | Wind | 1,633 | 4,168 | 4,736 | 568 | 88% |
| W3 | Solar | 574 | 656 | 790 | 134 | 83% |
| | Wind | 1,012 | 2,711 | 3,034 | 324 | 89% |
| X1 | Hydro | 1,068 | 7,709 | 7,929 | 221 | 97% |
| | HQImport | 1,930 | 10,924 | 11,517 | 594 | 95% |
| | Solar | 355 | 560 | 565 | 5 | 99% |
| | Wind | 1,274 | 3,152 | 3,298 | 146 | 96% |
| X2 | Hydro | 249 | 1,259 | 1,407 | 148 | 89% |
| | Solar | 1,043 | 1,161 | 1,188 | 27 | 98% |
| | Wind | 785 | 1,964 | 2,013 | 49 | 98% |
| X3 | Hydro | 156 | 551 | 782 | 231 | 70% |
| | Solar | 686 | 608 | 1,038 | 429 | 59% |
| | Wind | 1,313 | 3,961 | 4,224 | 263 | 94% |
| Y1 | Hydro | 30 | 110 | 114 | 4 | 97% |
| | Solar | 2,162 | 2,600 | 3,392 | 792 | 77% |
| | Wind | 120 | 296 | 337 | 41 | 88% |
| Y2 | Solar | 626 | 795 | 907 | 112 | 88% |
| | Wind | 618 | 1,962 | 2,042 | 81 | 96% |
| Z1 | Solar | 1,037 | 1,340 | 1,535 | 195 | 87% |
| | Wind | 2,160 | 4,591 | 6,217 | 1,625 | 74% |
| Z2 | Solar | 443 | 484 | 557 | 73 | 87% |
| | Wind | 1,257 | 3,720 | 4,084 | 364 | 91% |
| Z3 | Solar | 303 | 390 | 480 | 90 | 81% |
| | Wind | 413 | 1,114 | 1,224 | 110 | 91% |
| OSW J | Offshore Wind | 5,166 | 19,923 | 19,924 | 1 | 100% |
| | HQImport | 1,250 | 10,759 | 10,950 | 191 | 98% |
| OSW K | Offshore Wind | 3,835 | 13,280 | 15,227 | 1,947 | 87% |
| | Solar | 99 | 150 | 160 | 10 | 94% |

### Renewable Generation Pockets: Key Takeaways

Due to the significant resource additions driven by the CLCPA, new transmission constraints appear across the system as full policy achievement approaches in 2040. To better understand the impacts from these new constraints, generation pockets are identified based on their geographical locations, offering the following key takeaways:

- In many parts of the New York grid, transmission constraints form a perimeter around renewable resource development areas, creating renewable generation pockets. The greater the transmission constraints in the pockets, the greater the renewable generation will be curtailed (i.e., prevented from generating their full potential energy). These pockets result in an inability of renewable resources to deliver the potential energy to the grid and to consumers. More pockets may develop in the system where geographic locations might be suitable for renewable energy development, but existing transmission infrastructure may not be adequate to allow all such renewable generation to operate.
- Transmission limitations prevent full delivery of renewable energy. A minimum of 5 TWh of renewable energy in 2030 and 10 TWh in 2035 are projected to be curtailed due to transmission limitations in renewable pockets. This equates to roughly 5% less renewable energy that can be produced, and thus may not be counted toward the CLCPA targets.
- Transmission expansion is critical to facilitating efficient CLCPA energy target achievement. The current New York transmission system, at both local and bulk levels, is inadequate to achieve currently required policy objectives. Some renewable generation pockets throughout the State already face curtailments, more curtailments will be experienced in the future and will become more constrained as an increasing number of intermittent generation resources connect.
- Four pockets will particularly benefit from transmission expansion. The Finger Lakes (Z1), Southern Tier (Z2), Watertown (X3), and Long Island. Without investment in transmission, these areas of the New York grid will experience persistent and significant limitations to deliver the renewable power from these pockets to consumers in the upcoming years.

# Next Steps and Recommended Actions

## Next Steps

This first Outlook has built upon the data, modelling, and studies developed within the NYISO's System & Resource Planning Department and will serve as another building block for continued analyses and study work both within and outside of the NYISO. The data and findings provided by the Outlook are designed and intended to be used by policymakers, investors, and other stakeholders to identify the challenges and opportunities associated with achieving state policies in an economic and reliable manner.

The *2022 Reliability Needs Assessment* (RNA) will leverage data from the Outlook to identify commitment and dispatch trends and related bulk power system reliability impacts as policy goals are approached. The NYISO's *2022 Grid in Transition Study* will also leverage data from the Outlook to continue analysis surrounding potential grid needs and inform market designs for the future grid.

The 2022-2023 Public Policy Transmission Planning cycle kicks off in August, at which time the NYISO will provide an opportunity for any stakeholders or interested parties to submit comments regarding proposed transmission needs that may be driven by public policy requirements and for which transmission solutions should be requested and evaluated. Interested parties should consider the key findings from the Outlook when submitting comments identifying Public Policy Transmission Needs for consideration by the NYSPSC.

## Recommendations and Observations

The important findings identified in the *2021-2040 System & Resource Outlook* underscore the challenges that must be taken into consideration as the state proceeds with implementation of its clean energy and climate change initiative:

- Many transmission needs will arise over the next 20 years driven by public policy requirements, most notable the New York State climate mandates enacted in 2019 and 2020. The most notable and urgent transmission needs include:
  - **Long Island offshore wind export -** The NYISO is currently evaluating the viable and sufficient project proposals to the Long Island Offshore Wind Export Public Policy Transmission Need (Long Island PPTN), based on the Order issued by the NYSPSC on March 19, 2021. If a more efficient or cost-effective solution is selected to meet the Long Island PPTN, the congestion in Long Island is expected to be reduced significantly. However, offshore wind resource additions of up to 20 GW that are under discussion[36] may necessitate additional transmission to deliver offshore wind

[36] New York State Climate Action Council Draft Scoping Plan, December 30, 2021, available at, https://climate.ny.gov/Our-Climate-Act/Draft-Scoping-Plan.

energy to New Yorkers.

- **The Watertown/Tug Hill Plateau renewable generation pocket (X3)**- The 115 kV network is expected to limit the availability of the already-contracted wind and solar generation in this area, and the limitation will become more severe when more renewable resources are interconnected. Additional transmission is necessary to provide the resources access to the bulk grid.
- **Southern Tier pocket (Z1, Z2)** - The land and natural resource availability in this region (wind and solar) attract renewable generation buildout in this area. Transmission expansion from this pocket to the bulk grid would benefit New York consumers statewide.

- Future uncertainty is the only thing certain about the electric power industry. From policy advancements to the extent and pace of new dispatchable emissions-free resource technology development, the system is set to change substantially and rapidly. Situational awareness of system changes and continuous assessment are critical to ensure a reliable and lower-emissions grid for New York. The Economic Planning databases and models will be continually updated with new information and the Outlook study will be improved and performed on a biennial basis.
- To meet the minimum capacity requirement in 2040, at least 95 GW of new emission-free resources, including approximately 9.5 GW of new contracted renewable resources, will be required to come on-line. Furthermore, to fully achieve the emission-free grid target by 2040, even more resources will likely be needed along with transmission to deliver the clean power to consumers. The scope of the additional renewable resource need is remarkable. Compared to the 2.6 GW capacity entering into service in the past five years while New York experienced a net loss of approximately 2.2 GW, the installation rate in the next 20 years must increase significantly to achieve state law climate change requirements. State agencies should consider releasing a more detailed procurement schedule for renewable resources to guide the long-term system planning and provide clarity to the market.

The challenges identified in the Outlook cannot be solved by any single entity. New York's Climate Action Council has released a Draft Scoping Plan to reduce New York State's carbon footprint across all sectors, make our communities more resilient, and adapt to a changing climate. This report further supports the mission by quantifying the evolving challenges in the electricity sector and identifying challenges that must be addressed to facilitate and support implementation. In addition to much more renewable resources, this report identifies other key factors for success, such as significant transmission expansion, efficient peak load management, and the staged retirement of existing resources. The full set of comprehensive electric system requirements will need participation among policy makers, generator owners, transmission owners, and consumers. Communication and collaboration between stakeholders are — and will continue to be — essential to making progress towards achieving policy objectives while maintaining an efficient power market and reliable power grid.