New York ISO
Independent System Operator

Executive Summary

2023-2042 System & Resource Outlook

A Report from the New York Independent System Operator

Draft for June 7, 2024, ESPWG

New York State's power system has been continuously evolving to adapt to policy and economic drivers. In 2019, New York State's Climate Leadership and Community Protection Act (CLCPA) was signed into law, which accelerated changes in electricity generation, transmission, and demand. Along with other state economic and clean energy policies, New York's energy landscape will continue to change rapidly. The evolving system requires continuous re-examining of how to efficiently and cost-effectively balance resources and demands.

The New York Independent System Operator's (NYISO) Comprehensive System Planning Process includes numerous assessments, evaluations, and plans that are developed and relied upon by the NYISO to reliably serve forecasted New York demand, address transmission needs driven by public policies, and identify economic opportunities for an array of possible future system conditions. This *2023-2042 System & Resource Outlook* (the "Outlook"), conducted by the NYISO in collaboration with stakeholders and state agencies, provides a comprehensive overview of potential resource development over the next 20 years and highlights opportunities for transmission investment driven by economics and public policy in New York State. The *2023-2032 Comprehensive Reliability Plan*, which was published in November 2023, and the *2024 Reliability Needs Assessment*, which is expected to be published by the end of 2024, leverage data from the current and prior Outlook to identify generation capacity and operation trends and related bulk power system reliability impacts as the grid evolves.

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

- Postulates possible resource mixes that achieve New York's public policy mandates, while maintaining reserve margins and capacity requirements;
- Identifies regions of New York where renewable or other resources may be unable to generate at their full capability due to transmission constraints;
- Quantifies the extent to which these transmission constraints limit delivery of renewable energy to consumers; and
- Highlights 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 expansion to achieve New York's climate change policy requirements. This Outlook examines five potential futures, which expands the number of scenarios that the NYISO examined in the prior Outlook. Specifically, this Outlook first evaluates a Baseline Case as a future with little change from today.

The second potential future, or the "Contract Case," evaluates the impact of approximately 16 GW of additional renewable capacity either currently or previously procured by New York State. Finally, three "Policy Case" scenarios postulate and examine three separate futures that meet New York policy mandates—a "State Scenario," higher demand, and lower demand.

The State Scenario is new to this Outlook and serves as a postulated future based on inputs specified by the New York State Department of Public Service (NYDPS), New York State Energy Research and Development Authority (NYSERDA), and Joint Utilities.[1] The intent of the State Scenario is to support the initial cycle of the Coordinated Grid Planning Process (CGPP), which the New York State Public Service Commission (NYPSC) directed, to address the Joint Utilities' local transmission and distribution planning to achieve the mandates of the CLCPA. The assumptions in the State Scenario are closely aligned with NYSERDA's CLCPA Integration Analysis and continue to be developed through the CGPP. This report includes the preliminary capacity expansion results that can be used by the Joint Utilities in the CGPP for directional awareness.

By examining these potential futures in the Outlook, the NYISO staff identified key findings, which are grouped based on the main drivers of the changes to the system, as follows: demand, resources, and transmission.

Key Findings: Demand

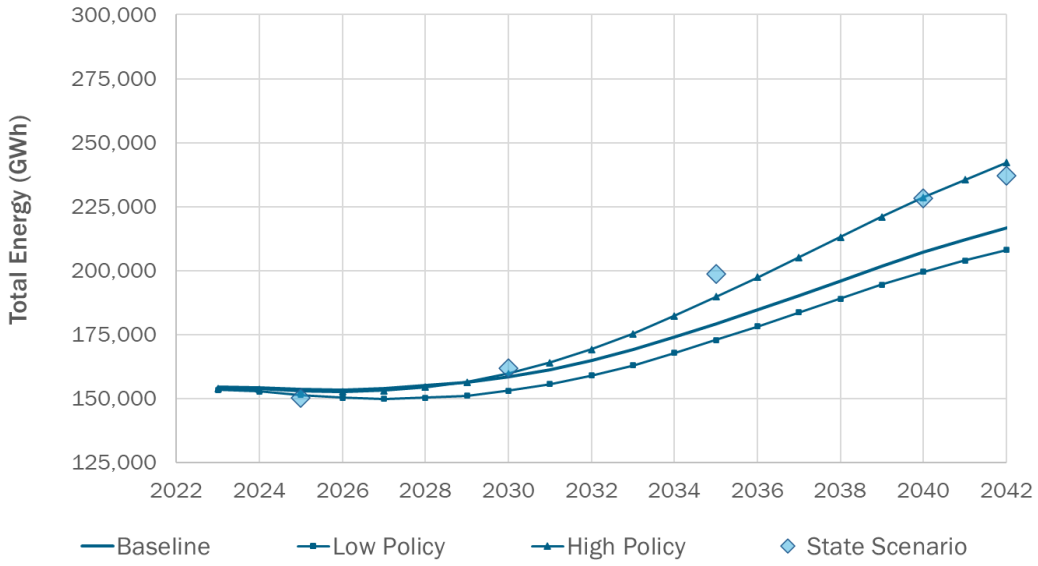
- ✓ **In response to the decarbonization energy policies, electric energy consumption is projected to increase significantly. Resources and the transmission system necessary to meet the changing energy demand need to evolve accordingly.**

New York is projected to increase electric energy consumption by roughly 50% - 90% and become a winter peaking system over the next 20 years. This drastic change is largely driven by the electrification of essential energy-consuming systems, primarily building heating and electric vehicle charging. Influenced by behind-the-meter resources, such as rooftop solar, the demand that needs to be served via the grid by the in-front-the-meter resources is also expected to evolve accordingly.

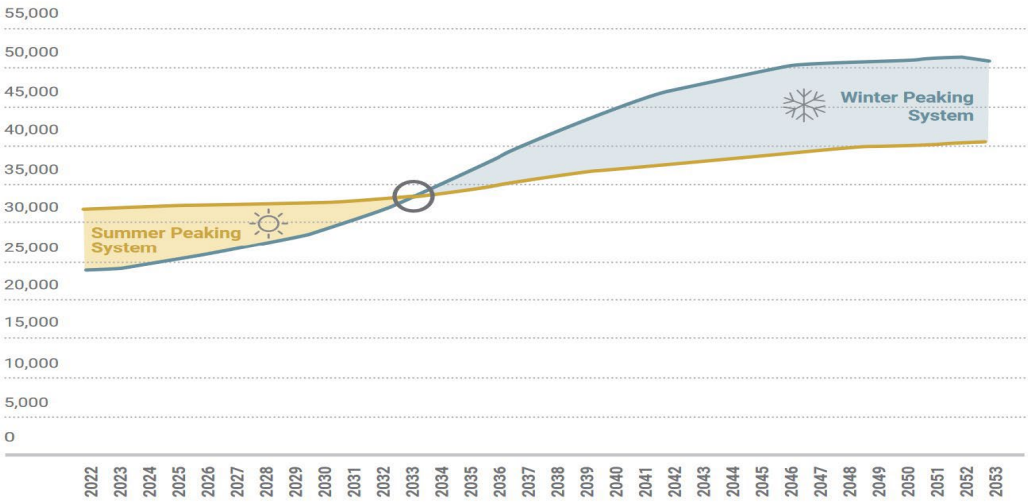
Beyond the CLCPA's zero-emissions electricity energy mandate in 2040, demand will continue to increase through 2050 as multi-sectoral electrification continues in order to meet the CLCPA's

[1] The Joint Utilities are commonly referenced to include: Central Hudson Gas & Electric Corporation, Consolidated Edison Company of New York, Inc., Long Island Power Authority, Niagara Mohawk Power Corporation d/b/a National Grid, New York State Electric & Gas Corporation, Orange & Rockland Utilities, Inc., Rochester Gas and Electric Corporation)

mandate to achieve 85% greenhouse gas emission reduction below 1990 levels by 2050.

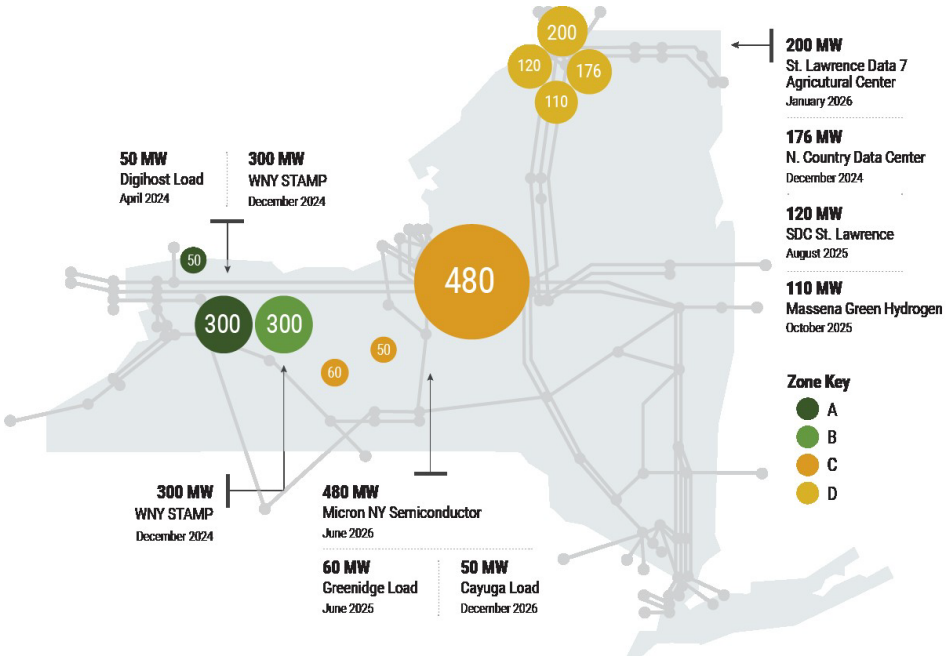


The timing of the switch to a winter peaking system is uncertain and mainly influenced by the timing and composition of heating electrification. The changing demand patterns, as well as the scale of demand increase, will impact the future generation capacity mix and resulting power flows across the system.



- ✓ **Siting large loads in electrical proximity to renewable resources, or siting resources near large loads, may benefit both the loads and the resources.**

In anticipation of the electrification efforts and economic development over the next two decades, numerous new large loads are expected to interconnect into New York, particularly in the upstate and Capital regions. Most of these new loads consist of manufacturing facilities and data centers, as well as potential hydrogen production operations. The following diagram highlights the large loads that are assumed to be connected in the Base Case:



Interconnecting these potential economic development projects requires an extensive assessment to best leverage and develop a region's strength and reinforce its value proposition, such as accessibility to labor and land, promotion of job creation, and achievement of environmental mandates. Access to renewable resources and a robust transmission network should increasingly be an integral part of the consideration. Moreover, market forces and policy incentives should remain aligned to ensure that large load projects are located to access low-cost renewable energy while minimizing the burden on the transmission system.

When located in close proximity to renewable resources, future large loads can benefit from

more direct access to renewable energy while the renewable resources themselves can benefit from higher utilization rates. Load that is located close to generation reduces the use of the transmission network whereas load located further away from generation requires the transmission network to deliver energy and is more susceptible to transmission congestion and loss costs. Furthermore, load located nearby renewable resources can more readily absorb excess energy resulting in lower curtailment levels.

The consideration of renewable energy accessibility when siting large load can also potentially reduce the required generation capacity buildout to meet policy mandates. Siting large loads in electrical proximity to renewable resources, or siting resources near large loads, may benefit both the loads and the resources. For every one megawatt (MW) of peak load flexibility enabled, the amount of renewable capacity required is reduced by at least one MW and potentially much more.

Key Findings: Resources

Consistent with the prior Outlook, the NYISO estimates that the generation capacity required to achieve CLCPA energy mandates will be about three times the capacity of the current New York generation fleet, while the electric energy consumption is expected to increase by roughly 50% - 90%. Such new generation capacity must be obtained from a combination of renewable generation, battery storage, and other generation facilities referred to as dispatchable emission-free resources (DEFRs).

- ✓ **Dispatchable Emission-Free Resources must be developed to provide the capacity, energy, and other essential grid services required to achieve the policy mandate for a 100% emission-free grid by 2040.**

As the resource mix shifts from fossil generators to emission-free resources, essential grid services, such as operating reserves, ramping, regulation, voltage support, and black start, must still be available to provide New York a reliable electric system. The intermittency of the renewable resources contributes to the disproportional increase between load and generation. Today, the grid largely relies on fossil generators to provide the aforementioned reliability attributes. To achieve an emission-free grid, a collection of generation technologies, referred to as DEFRs, must be developed and deployed throughout New York to provide, in the aggregate, sufficient grid services to maintain reliable electric service for all New Yorkers. The importance of DEFRs continues to be a critical factor as identified in the prior Outlook.

In the Outlook, DEFRs are added to the postulated future resource mix to supply essential

characteristics, such as dispatchability and flexibility capabilities to support a high renewable system. Several examples of potential DEFR technologies include long-duration batteries, small modular nuclear reactors (SMRs), hydrogen-powered generators, and fuel cells. This Outlook projects that at least 20 gigawatts (GW) of DEFR capacity would be needed by 2040 to replace the current 25.3 GW of fossil generation to support the achievement of CLCPA mandates.

While DEFRs represent a broad range of potential options for future supply resources, two technology pathways commonly discussed as potential options for commercialization are: 1) utilization of low- or zero-carbon intensity hydrogen (typically generated by electrolysis derived from renewable generation) in new or retrofit combustion turbine or fuel cell applications, and 2) advanced small modular nuclear reactors. The DEFR assumptions in this Outlook were developed considering the cost and operating characteristics of these potential technology options. One DEFR assumption is low capital cost with high operating cost (e.g., hydrogen-fueled combustion turbine), while the second assumption is high capital cost with low operating cost (e.g., small modular nuclear reactor). In combination with other types of technologies, the aggregation of various potential options could satisfy the characteristics necessary to support the achievement of New York's energy mandates.

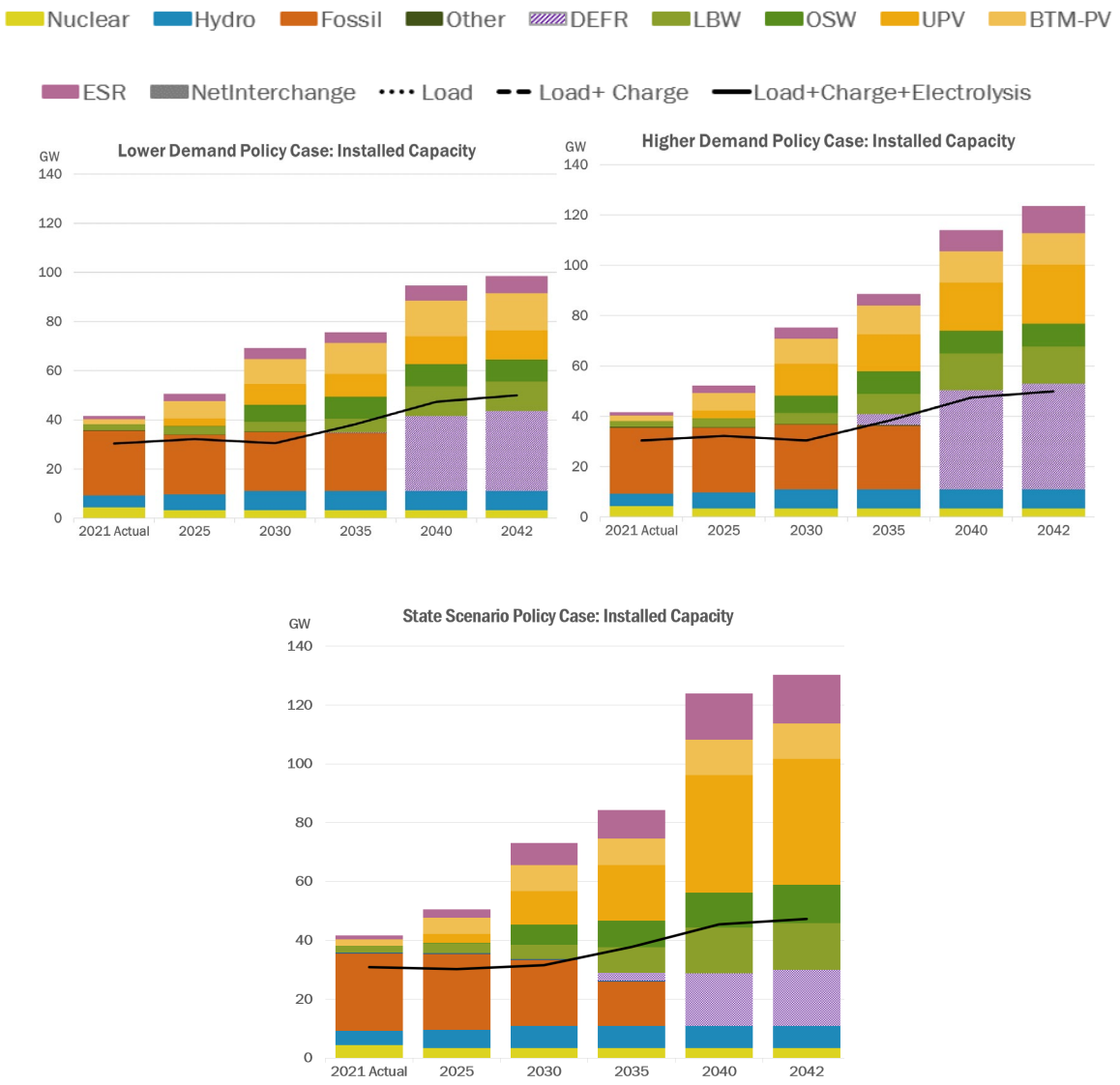
While essential to the grid of the future, such DEFR technologies are not commercially viable today at the necessary scale. Even assuming that they are commercially viable, there remains significant work in implementation and logistics that must be overcome to economically justify transitioning the dispatchable fleet to some combination of new technologies in the next 15 years. The research, development, and construction lead times necessary for these technologies may extend beyond policy mandate dates, in which case other existing generation technologies may be required to remain in operation to continue to maintain a reliable system.

The Outlook results show a greater need for grid energy to be supplied from dispatchable resources (e.g., fossil fuel or DEFR) compared to past evaluations. In the *2021-2040 System & Resource Outlook*, DEFRs were primarily included to address peak demand and, therefore, would produce energy in very few hours. The results in this Outlook, however, show an increased reliance on these resources to provide both peak capacity and hourly energy to support a high renewable system. This increased reliance is driven by the forecasted hourly profile of demand and the limitations on the duration of energy storage resources. In this Outlook, hydrogen-powered DEFRs are generally included to provide firm peak capacity and, therefore, only produce energy for a few hours due to their high operating costs, while low-operating-cost DEFRs, such as small modular

reactors, generally provide needed energy and other attributes throughout the year.

✓ **New York will require <u>three times</u> the capacity of the current New York generation fleet to meet projected future electricity demands.**

The total installed generation capacity to meet policy mandates within New York is projected to range between 100 GW and 130 GW by 2042. This conclusion is consistent with the findings from the prior Outlook. The following diagrams show the installed capacity required for each of the three policy scenarios. Each color represents a different resource type as follows:



As demonstrated by the three different futures, the level of total installed capacity needed in 2040 to satisfy the state policy mandates, projected demand, and estimated capacity reserve margins is significant. Each future, however, contains differences in timing and the type of

resources to meet the projected range of installed capacity. The differences among the futures are mainly due to demand growth assumptions and the type of generators that serve as resources in the future, as well as their associated costs.

In all three policy scenarios, a significant amount of capacity from renewable generation and DEFRs is projected to be in service by the early 2040s, with the majority of the facilities assumed to be operational after 2035. Such capacity will be necessary to offset the projected fossil-fueled generation retirements.

- ✓ **The coordination of new generator additions and existing generator retirements is essential to maintain the reliability of the New York power system while simultaneously pursuing achievement of CLCPA.**

To maintain reliability and achieve policy mandates, coordination of generation additions and retirements will be essential. For instance, coordinating the integration of renewable energy resources, the development and commercialization of DEFRs, the operation of fossil fuel generators, and the staged deactivations of fossil fuel generators over the next 15 years will be critical to facilitate a reliable transition of the grid. This concern was identified in the prior Outlook and remains a challenge going forward.

The NYISO's 2023 Quarter 2 Short-Term Assessment of Reliability (STAR) highlights the importance of coordinating generator additions and existing generator retirements. The 2023 Quarter 2 STAR found a short-term reliability need beginning in summer 2025 within New York City primarily driven by a combination of forecasted increases in peak demand and the assumed unavailability of certain generation in New York City affected by the New York State Department of Environmental Conversation (DEC) "Peaker Rule."[2]

In the absence of viable and sufficient solutions, the NYISO identified dual-fuel generators on the Gowanus 2 and 3 and Narrows 1 and 2 barges as the temporary solution for this reliability need. While those generators are subject to the requirements of the Peaker Rule and originally identified to be out of service from May through September starting on May 1, 2025, the NYISO's designation of them as necessary for reliability will allow them to remain in operation for a period of time beyond May 1, 2025. This additional time is necessary to allow a permanent solution to be pursued and brought into service. In this case, a transmission project—Champlain Hudson Power Express (CHPE)—is expected to enter service in spring 2026, providing 1,250 MW of hydropower from

[2] In 2019, the New York State Department of Environmental Conservation adopted a regulation to limit nitrogen oxides (NOx) emissions from simple-cycle combustion turbines, referred to as the "Peaker Rule." The regulation is available here.

Quebec to the New York City area. This project is expected to address the short-term reliability need and improve reliability margins.

The NYISO continues its ongoing efforts to evaluate and plan for the addition and deactivation of generation resources. Through the quarterly STAR studies, the NYISO continues to evaluate reliability by, among other things, assessing the continued need for the plants subject to the Peaker Rule, the progress of the new additions to the system, and other laws and regulations that affect the continued operation of resources, such as fossil fuel generators. While the quarterly STAR studies, and other NYISO-conducted reliability studies, are well situated to evaluate and identify needs due to the addition and deactivation of resources in the 10-year planning horizon, coordination of these efforts in the longer term will be necessary.

- ✓ **Uncertainty in siting new renewable generation could lead to delays in or inefficient expansion of the transmission and distribution systems.**

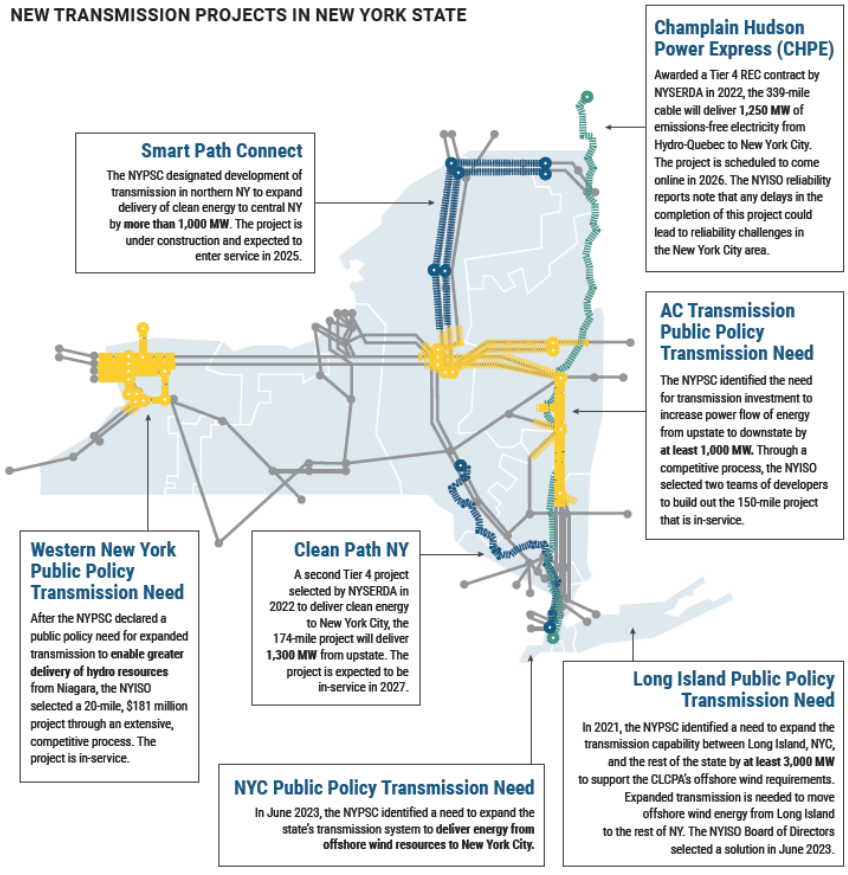
The footprint of renewable generation resources can be much more substantial than fossil fuel generators. Combined with the large amount of total power that must be derived from new renewable generation under CLCPA mandates, the potential acreage required to install these resources will be significant and likely will result in siting uncertainty. For example, a utility-scale solar plant typically needs approximately between 3 to 5 acres of land per MW of generating capacity and land-based wind typically needs approximately 15 acres per MW, while 25 acres of land could accommodate a 1,000 MW (1 GW) combined cycle power plant. Siting of renewable generation, therefore, requires not only a location with an abundance of the natural resources to serve as fuel (i.e., solar or wind) but also sufficient access to land to accommodate the footprint of the facility. Such uncertainty in locating real property and siting new renewable resources could be significant and affect the ability of developers to secure specific connection points of new renewable generation and DEFR projects, especially in the longer term (i.e., 2035 and beyond) as New York approaches its emission-free mandate.

Transmission development goes hand-in-hand with the placement of generation on the system. Optimal placement of generation or storage resources can help with balancing the need for new transmission expansion that is required to integrate renewable resources. However, where transmission expansion is required, uncertainty associated with siting of those resources may impact the efficient and timely build out of the transmission and distribution systems.

Key Findings: Transmission

✓ **Historic levels of investment in the transmission system are happening but more will be needed.**

The Outlook shows that the recently completed transmission projects that the NYISO Board of Directors selected through the Public Policy Transmission Planning Process have significant benefits to the system and toward the achievement of New York policies. The two transmission projects selected to address the AC Transmission Public Policy Transmission Needs (i.e., Segment A and Segment B) have significantly increased the ability of the New York grid to deliver power across the state and provide ratepayers with efficient access to resources. In June 2023, the NYISO Board of Directors selected another transmission project for purposes of addressing the Long Island Offshore Wind Export Public Policy Transmission Need identified by the NYPSC. The selected transmission project will provide transmission capability to deliver at least 3,000 MW from offshore wind projects—advancing the state closer to its mandate of 9,000 MW of offshore wind energy by 2035. The Outlook shows that this transmission project also efficiently relieves renewable pocket congestion previously identified in prior NYISO analysis.



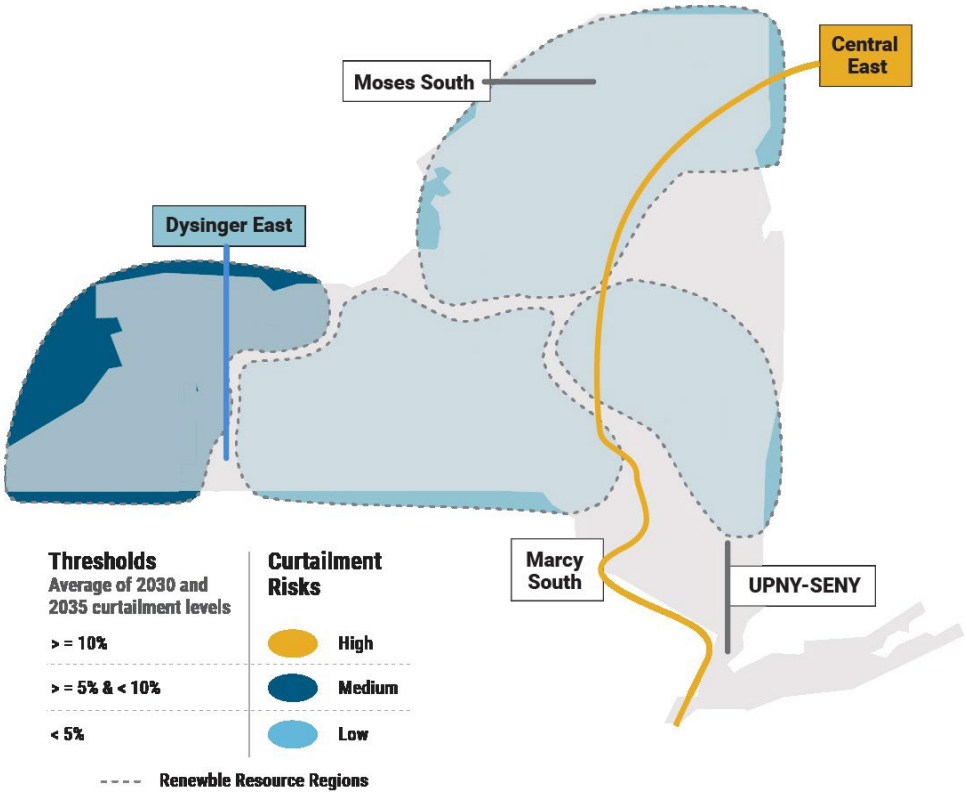
Other transmission and distribution expansions either identified by the local utilities or approved by the NYPSC for development also demonstrate significant benefits. For instance, the NYPSC approved New York utilities' Phase 1 and 2 local transmission upgrades. The Outlook results find these upgrades to be highly effective in increasing energy deliverability of resources and decreasing congestion on the lower voltage system. Renewable energy pockets that the *2021-2040 System & Resource Outlook* identified as high-risk are now shown to be at a reduced risk of renewable curtailment with these upgrades in the near term.

Even with this level of bulk and local transmission expansion investment, which is the most substantial build out of the transmission system in the last 40 years, the Outlook identifies opportunities to expand the transmission system efficiently and cost-effectively to, among other things, achieve CLCPA mandates.

- ✓ **Actionable expansion opportunities: To fully utilize the transmission facilities already in place, additional dynamic reactive power support must be added to the grid in upstate New York to alleviate curtailment over the Central East interface.**

Local transmission projects are effective in solving congestion and curtailment of renewables on a localized basis in the near term. As local constraints are alleviated by local transmission and distribution upgrades, more renewable generation is delivered onto the bulk transmission system and, therefore, able to be transmitted across the state. However, bulk transmission constraints may then become the limitation for efficient delivery of renewable energy across the state in the long term (i.e., beyond 2030).

Continued investment in the bulk electric grid will be required to accommodate the 100-130 GW of emission-free generation resources needed to accomplish New York policy mandates. To achieve policy mandates by 2040, a minimum of 15 GW of new renewable generation is expected to be sited in Western, Central, and Northern New York, which is upstream of the Central East transmission interface. This will lead to continually increasing flows over the Central East interface towards southeast New York as upstate renewable project development progresses. Eventually, the flows would lead to significant curtailment of upstate renewables if the voltage performance of the system is not addressed. The following diagram illustrates the Central East transmission interface.



To fully utilize the transmission facilities already in place, additional dynamic reactive power support must be added to the grid in upstate New York to alleviate curtailment caused by the Central East interface voltage performance. Reactive power supports the overall voltage performance of the grid and may be provided by generators or dedicated fast responding dynamic reactive power devices, such as synchronous condensers or other power electronics (e.g., STATCOMs). This kind of specialized Grid-Enhancing Technologies (GETs) can improve the delivery of electricity via existing transmission lines. As the nearby fossil-fuel synchronous generators are retired and, therefore, unavailable to provide dynamic reactive support services, the full benefits of the Segment A and Segment B transmission projects will be diminished leading to transmission congestion and renewable curtailment.

The Outlook finds that by replacing the dynamic support services from these fossil fuel generators to support the Central East interface voltage performance, the future potential congestion across Central East could be largely eliminated and curtailment of renewable energy reduced by approximately 130-220 GWh in 2035.

✓ **Opportunities for further transmission investment in Western and Northern New York should be monitored as resources are developed in those regions.**

As renewable generation buildout continues in Western New York, the transmission corridors that carry significant power from the Niagara and Buffalo areas may experience congestion in the future due to constraints on the 230 kV transmission network associated with the Dysinger East transmission interface. Bulk transmission upgrades on these 230 kV paths, combined with the planned local transmission upgrades, could remove transmission barriers for new renewable resources and DEFRs that are required to meet policy mandates.

Northern New York is experiencing significant growth in both renewable generation projects and transmission expansion. This Outlook finds that most local transmission constraints in the associated renewable generation pockets that were identified in the prior Outlook have been resolved, primarily due to the Smath Path project and planned Phase 1 and Phase 2 upgrades. This Outlook, however, finds that several 115 kV and 230 kV transmission paths may become limiting as more renewable projects are added. Development of local and bulk transmission projects to address these limitations on the 115 kV and 230 kV transmission paths would ensure the energy deliverability of renewable generation resources, including existing hydro generation and imports, in Northern New York.

Western and Northern New York are two renewable resource regions with significant opportunities for additional renewable generation development. Should a shift or increase in new generation siting occur in Western and Northern New York, the need for transmission could be accelerated.

✓ **Planning energy exchange with neighboring regions is becoming more complex and will be increasingly so in the future as each region transitions to more decarbonized systems.**

New York has strong interregional transmission connections to ISO New England, PJM Interconnection, L.L.C., Ontario's Independent Electricity System Operator, and Hydro-Québec. The neighboring regions' independent pursuits of their respective climate policies will fundamentally change the availability of energy for interregional exchange. As these nearby regions approach achievement of the various carbon-free mandates, which is estimated to be generally around 2050, the availability of excess generation for exchange will be highly dependent upon the generation types adopted. Solar, land-based wind, and offshore-wind production is relatively coincident across

the NYISO and its neighboring regions. This, however, may limit the ability of neighboring regions to absorb excess energy from New York or vice-versa as each region seeks pathways towards a more decarbonized grid**.** Alternatively, when weather-driven renewable resource production is low in one region it is probable that renewable production will also be relatively low in surrounding locations. In this situation, each region would need to depend on internal DEFRs or external resources (but only if available) to meet its demand.

At the time of publishing this report, there are several notable efforts evaluating the expansion of interregional transfer capability. For example, North American Electric Reliability Corporation (NERC) is conducting an Interregional Transfer Capability Study that will analyze the amount of power that can be moved or transferred reliably from one area to another area of the interconnected transmission systems. The Department of Energy is also conducting its process to designate geographic areas as National Interest Electric Transmission Corridors where the development of new transmission would advance national interests, such as reliability and reduce consumer costs. The NYISO will continue to monitor these and other efforts, and if appropriate, incorporate the analysis in future studies.

Next Steps

The Outlook has built upon the data, modeling, and studies developed within the NYISO's Comprehensive System Planning Process and serves 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 NYISO stakeholders to identify the challenges and opportunities associated with achieving state policies in an economic and efficient manner.

The *2024 Reliability Needs Assessment*, which is expected to be published by the end of 2024, will leverage data from the Outlook to identify generation capacity and operation trends and related bulk power system reliability impacts as policy mandates are approached.

The 2024-2025 cycle of the Public Policy Transmission Planning kicks off in August 2024, 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. The findings from this Outlook present an opportunity for interested parties to consider and formulate transmission needs based on the transmission opportunities identified in this report and the underlying analysis.

Recommendations and Observations

The important findings identified in the 2023-2042 System & Resource Outlook are the basis for several recommendations to address the challenges revealed by the study:

1. Thanks to recent transmission and distribution expansion, transmission constraints are no longer the major impediment to achievement of the 70% renewable energy by 2030 ("70x30") policy mandate as projects ensure high energy deliverability of renewables. Ensuring the timely construction of the identified transmission projects to enable the integration of renewable energy resources by 2030 is vital to the policy's achievement.
2. 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. Beyond the 100% emission-free energy mandate for 2040, demand will continue to increase as multi-sectoral electrification continues to meet the CLCPA energy mandates to achieve 85% greenhouse gas emission reduction below 1990 levels by 2050. The need for new generation resources will continue well beyond 2040, while the new solar and wind resources will increasingly become ineffective to meet peak load after a significant amount of capacity has already been built at that point.
3. This Outlook identifies the following notable transmission expansion opportunities:
    - **Central East Interface** – act on installing dynamic reactive power support;
    - **Western New York/Southern Tier** – monitor bulk transmission expansion to accommodate future renewable generation development; and
    - **Northern New York** – monitor bulk transmission expansion to accommodate future renewable generation development.