2022 Master Plan [DRAFT]

Reliability and Markets for the Grid of the Future

A Report by the
New York Independent System Operator

Draft September 20, 2022

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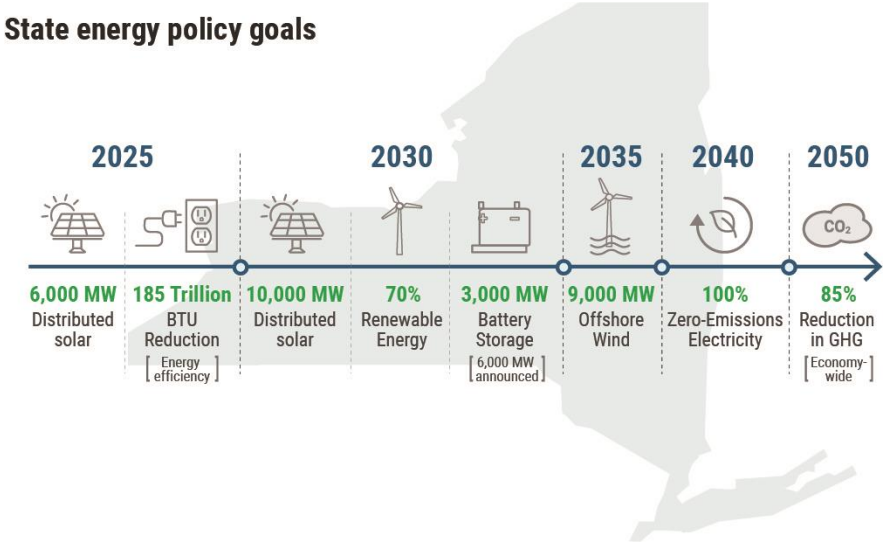
Introduction

The NYISO is an independent, not-for-profit corporation responsible for operating the state's bulk electricity grid, administering New York's competitive wholesale electricity markets, conducting comprehensive long-term planning for the state's electric power system, and advancing the technological infrastructure of the electric system serving the Empire State. The NYISO's role in providing grid reliability and competitive markets brings economic and environmental benefits to all New Yorkers.

Since their inception, competitive wholesale electricity markets have successfully facilitated efficiency gains on the grid by reducing fuel consumption and lowering consumer costs. Over time, markets have worked to influence investment in more efficient and flexible generation and other investments in the grid that further enabled energy production from cleaner resources. The NYISO wholesale markets are an effective platform for reflecting public policy and technological influences in an economically efficient manner to reliably meet consumers' energy needs. However, changes to the bulk electric power system due to state policies and new technologies create an imperative to continue to improve the wholesale markets.



In 2019, New York adopted the Climate Leadership and Community Protection Act (CLCPA) to address climate change and put in place a plan to reach a decarbonized electric system by 2040.[1] The NYISO is committed to a continued strong partnership with lawmakers, policymakers, market participants and industry stakeholders to address the priorities and goals set forth under the state's CLCPA while

[1] www.climate.ny.gov

maintaining electric system reliability at least cost to consumers. This commitment guides us as we plan and continue working to achieve the grid of the future through innovation and competition.

Competitive electricity markets are fundamental to providing consumers reliable, lowest cost power and an essential platform for achieving public policy objectives. To transparently indicate priorities, each year the NYISO works through its shared governance process to develop a multi-year plan of projects that support market evolution. The plan reflects the approved 2023 project plan as well as expected projects out to 2027. This Master Plan for the NYISO wholesale markets outlines the next five years of planned competitive market enhancements that will help maintain the reliability, flexibility and economic efficiency of the grid, while supporting both private investment and the public policies of the State of New York.

2022 Grid in Transition Update

The primary role of the grid operator is to maintain a continuous balance between supply and demand of electricity, while adhering to all applicable reliability rules. That balance must be maintained both during normal conditions and after disturbances. The NYISO maintains this balance at least-cost to consumers by operating a market that rewards the most efficient and reliable resources to provide energy and reserves. Competitive power markets have been able to attract cleaner resources and retain sufficient resources that have the flexibility to follow dispatch instructions to reliably serve consumers during all seasons and all hours of the day.

The market solution used by the NYISO accounts for unplanned disturbances to the grid as the system is operated to constantly maintain a reliable and resilient balance of supply and demand. Markets procure operating reserves necessary to balance supply and demand while meeting operational reliability requirements, including fast-start resources that can provide additional energy to the grid quickly. Long-term system reliability is established through planning processes that forecast peak demand and establish appropriate reserve margins, or capacity requirements, that can be met by Installed Capacity Suppliers in the NYISO's market. The market design must provide both short and long-term incentives for suppliers to provide energy, operating reserves, and installed capacity.

In the past, resources counted on to meet demand were mainly predictable and operated independent of one another. Fuel supply was generally available and the failure of any single element, such as a generator, was assumed to be uncorrelated with the failure of any other element of the power system, thus leading to near continuous control of power balance. Fundamentally, the operation of the power system, like that of any intelligent machine, is a cycle of Sense-Plan-Act. For each time horizon, the role of

the NYISO is to sense the environment, apply a set of logic rules to plan a response, act based on those plans, and then sense the new environment. The new measurement will inform the next plan and the next act, and so on every minute of every day.

Sense: Metering and SCADA/EMS systems operated by the NYISO and the New York Transmission Owners estimate the system state. Forecasting systems estimate expected power demand and renewable generation in the next intervals.

Plan: Market Management System operated by the NYISO calculates optimal operating points for system resources to maintain system balance at least cost, while ensuring the transmission system is secure.

Act: Dispatchable resources are moved to desired operating points to balance power demand.

Maintaining this uninterrupted cycle is critical in real-time operations. Improvements in technology allow the NYISO not only to monitor the power output of generators and the power flows over the electric grid, but also to better forecast the output of renewable generators, such as wind and solar. Relying on weather-dependent generation requires accurate sensing and predictions of the weather. The NYISO is undertaking efforts to continually improve both the accuracy and robustness of solar and wind forecasts in the coming years. Improvements in computing and optimization technology allow the NYISO to compute an operating plan more quickly and accurately. The NYISO finished upgrading its Market Management System in 2019 and continues to upgrade components to allow integration of new resources without degrading overall performance.

Adapting these systems and the markets for an increasing reliance on renewable resources in New York is now more critical due to the mandates in the CLCPA, among other requirements such as the increased targets for distributed solar energy[2] and energy storage[3] technologies that were announced this year. Reaching all of New York's clean energy objectives will require profound changes in how energy is produced, delivered, and consumed in New York. Another State policy requirement is the Department of Environmental Conservation (DEC) Peaker Rule. The Peaker Rule will affect approximately 3,300 MW of simple-cycle turbines located mainly in the lower Hudson Valley, New York City, and Long Island. While some of these units will be capable of complying with the rule's stricter emissions limits, approximately 1,600 MW of capability is expected to be unavailable by the summer of 2025 based on filed compliance

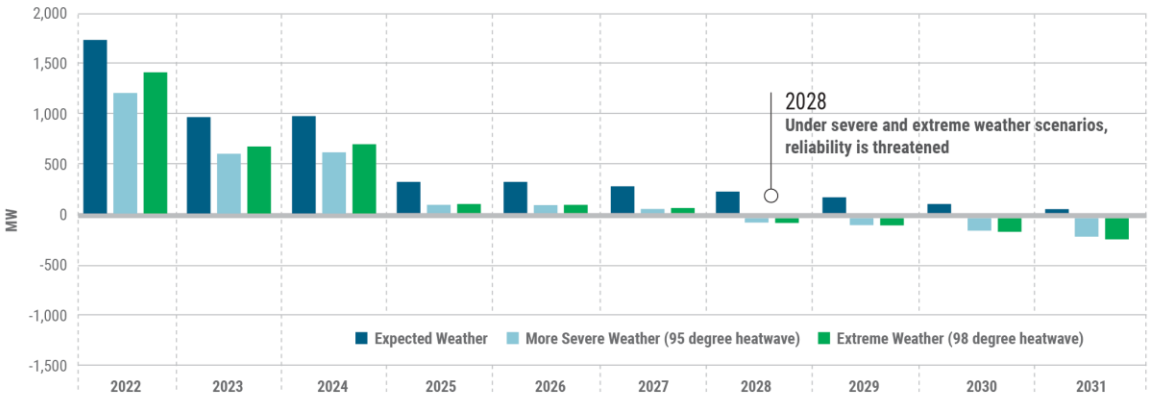
[2] Governor Hochul Announces Approval of New Framework to Achieve at Least Ten Gigawatts of Distributed Solar by 2030 - NYSERDA

3 2022 State of the State Book.pdf (ny.gov)

plans. These fast-start generators provide a flexible and reliable source of operating reserves. The NYISO is actively assessing the implications of these compliance plans in its Reliability Planning Process, particularly via the *2022 Reliability Needs Assessment* (RNA) and ongoing quarterly *Short-Term Assessments of Reliability* reports.[4]

Several natural gas distribution systems in New York require gas-fired generators connected to its system to have the capability to run on an alternate fuel. These dual-fuel units are considered critical to maintaining electric reliability in and around New York City during periods of high winter demand when gas pipeline capacity is limited. The New York State Reliability Council (NYSRC) has a minimum oil-burn requirement rule intended to maintain electric system reliability in the event of gas supply interruptions. New York City passed legislation in December 2017 prohibiting the combustion of fuel oil number 6 beginning in 2020 and fuel oil number 4 beginning in 2025. The rule is expected to impact 2,946 MW of generation in New York City. While oil accounts for a relatively small percentage of the total electricity production in New York State, it is often called upon to fuel generation during critical periods, such as when severe cold weather limits natural gas availability for electric generation use.

While statewide system margins are expected to remain sufficient for normal weather and normal power transfer criteria, the loss of existing resources is tightening reserve margins in some regions of the state, as shown in the New York City Transmission Security Margin from the Comprehensive Reliability Plan.[5]

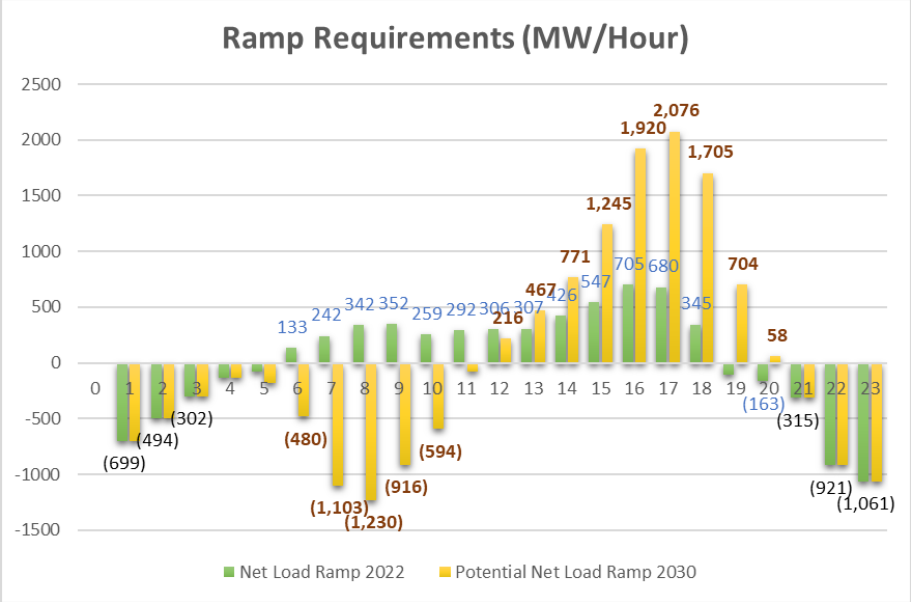


Maintaining reliability on the grid of the future will require significant amounts of on-demand, flexible resources that can adjust for the intermittency of renewable resources. Absent investment in clean, dispatchable resources, reliability margins will shrink in the upcoming years.

[4] www.nyiso.com/cspp

[5] 2021-2030-Comprehensive-Reliability-Plan.pdf (nyiso.com)

Other State and local policies combined with technological change will also impact how New Yorkers will consume energy. The New York City Council passed Local Law 97 in 2019, which mandates that any building 25,000 square feet or larger reduce its greenhouse gas emissions, with compliance starting in 2024. For New York State to reach its CLCPA mandates of an 85% reduction in greenhouse gases, a large portion of residential and commercial space heating, industrial processes and transportation is expected to be electrified. As most space-cooling is already electrified, the largest gains in demand are expected to be in the winter, as shown in NYISO's most recent long-term demand forecast.[6] Increasing amounts of distributed solar are reducing overall demand for grid electricity but changing the net load shape in New York.[7] The roughly 3,000 MW (3 GW) of solar already installed have flattened the summer load curve and reduced the amount of ramp (change in generation over time required) in the mornings.[8] However, as the state reaches its goals for 6 GW of solar by 2025 and then 10 GW by 2030, the need for total summer afternoon ramp may reach 9 GW at a rate that may begin to exceed 2 GW per hour. While renewable resources are capable of providing down ramp by reducing output, they are not capable of providing up ramp without investment in storage or other control technologies. Therefore, the 9 GWs of up ramp must be met by either investing in dispatchable resources or retaining some existing resources. The uncertain output of variable energy resources, manifested as differences between forecasted output and actual output, can also increase ramping needs.



The NYISO will need to schedule sufficiently flexible resources that are available and can be called on short notice to respond to variable demands. With many conventional resources slated to retire due to emissions restrictions, market incentives must be sufficient to fund investments to develop new

[6] NYISO 2022 Load & Capability Data ("Gold Book")

[7] "Net Load" here refers to the amount of consumer demand, less ("net of") solar generation

[8] Profiles are based on June 5, 2022 load and behind the meter solar. Solar output this day peaked at an estimated 2,661 MWs at hour beginning 12:00

technologies, such as long-duration batteries, or the utilization of alternative fuels, such as hydrogen. The NYISO's 2021-2040 System and Resource Outlook report estimates that between 27,000 and 45,000 megawatts of dispatchable emissions-free resources will be needed to maintain system reliability while reaching state clean energy goals. Transparent market prices are needed to provide the marketplace with both incentive and information to support the investment in the most valued locations and capabilities.

Many market initiatives in this Plan target proper compensation for both new internal and existing resources that provide flexibility, while advancing consumer benefits from competition among suppliers. These resources include storage that will be needed not only to provide ramp and energy during peaks, but also during lulls in renewable output, which can last several days. The NYISO's Independent Market Monitor finds that current market revenues do not justify investment in 4-hour and 6-hour batteries because the amount of intermittent resources is currently not sufficient. The deployment of more renewable resources, changes to ancillary services markets, and the retirement of conventional generators can be expected to make storage more economic over time.[9]

During the transition to 100% clean energy, the NYISO's markets must also retain some resources needed for reliability until suitable replacements are operational. Here, again, energy and ancillary service market prices can point policymakers and investors to the resources that provide critical grid services and need to be retained to support an efficient pathway to decarbonization. As New York increases the amount of clean energy resources, while also increasing demand for electricity, the pace of deactivation of current fossil-fueled resources must not exceed the pace of development and deployment of new, non-emitting supply resources that can provide comparable reliability services. This means that fossil fuel-based resources will continue to be needed until non-emitting dispatchable resources can effectively replace them.[10] Some of the market initiatives described in this Plan are targeted specifically at properly compensating services that can be provided by existing resources, such as ramp and reserves. Some initiatives are targeted at new technologies, such as Internal Controllable Lines that can flexibly move power across the state. The need for dispatchable resources will also create opportunities for distributed resources to participate more directly in the wholesale market. NYISO market design must provide proper incentives to new and existing resources that can respond and follow dispatch signals in all types of conditions, harnessing competition to minimize consumer costs while achieving policy goals.

[9] Potomac Economics, 2021 State of the Market Report for the NYISO Markets

[10] NYISO, 2022 Power Trends

Project Initiatives

This Master Plan focuses on the balance required to decarbonize an electric grid while promoting competition, minimizing consumer costs, and satisfying the most stringent reliability standards in the nation. It discusses the various NYISO efforts planned over the next five years that will better position the competitive wholesale markets and grid operations to address these challenges. The projects included within this Master Plan are described in more detail in the project candidate descriptions that are posted as part of the annual project prioritization process.[11]

Consistent with the challenges described above, projects are aimed at meeting one or more of the following goals:

- incentivizing capability for flexibility to balance intermittency;
- valuing reliability attributes appropriately;
- opening markets for new technologies; and
- retaining existing resources when needed.

The Master Plan ties these initiatives into a cohesive five-year plan for our wholesale market platform, and is organized into three sections: Energy Market, Capacity Market and New Resource Integration. With the help and input of our stakeholders, this document discusses the NYISO's recommendations for evolving the wholesale markets that the NYISO administers.

Energy Market

The wholesale energy market effectuates the sale and procurement of electrical energy on a least-cost basis through a competitive bid-based process. The resulting market prices provide the primary incentive for generators, dispatchable loads, storage devices, and other resources to perform in real-time and respond to rapidly changing system conditions. Energy prices also transparently identify grid conditions and thus provide important information to all stakeholders, for example, on more effective locations for new investment.

An important element of the energy market is the ancillary services market, which rewards availability and flexibility, necessary for the efficient and reliable delivery of energy to consumers. Ancillary services help maintain grid frequency and voltage, provide short-notice on-demand power should the sudden loss

[11] 2023 Market Project Candidates (nyiso.com)

of supply or transmission occur, and allow for balancing of supply and demand.

The key challenges that arise in the energy and ancillary services markets with significant penetration of weather-dependent resources are balancing intermittency and improving price formation. The grid of the future will require resources that can balance intermittency for extended periods of time, resources that can quickly turn on and are flexible in dispatch, and resources able to meet the sharp and occasionally sustained ramping needs created by the sudden disruption in solar or wind output. Market products will not only secure the attributes necessary to balance intermittency but also minimize the cost of doing so.

As the level of intermittent resource generation increases, the grid will need sufficient flexible and dispatchable resources to balance variations in intermittent resource output for both short durations, as a result of changing weather conditions, and for prolonged periods (daily/seasonally) of renewable output lulls. Depending on the duration of need, enhancements to various market design aspects may be required, including reserves, regulation, load forecasting, and potentially a ramp product. To maintain grid reliability in all timeframes, balancing intermittency is a key challenge that needs to be addressed through various market design improvements. During the transition to a 100% clean energy system, it will be necessary to retain the right amount of conventional resources that provide these services currently and will be needed until replacement technologies are ready.

Markets for the Future

A resource mix with an increasing amount of intermittent and energy limited resources places flexibility (fast starting, ramping, and load following capabilities) at a premium. As both the net load and forecasted supply will tend to become more volatile and uncertain, resources available for balancing the grid need to be flexible and able to address the risks to reliability through time. Using the work completed to date across various NYISO studies and initiatives, including the Reliability and Market Considerations for a Grid in Transition work, Grid in Transition project work, and any relevant external studies on the ramp and flexibility needs of the future, the ***Balancing Intermittency*** project will examine NYISO market structures and market rules to determine if changes or additions are needed to maintain reliability. This effort will also assess whether market rules properly incentivize attributes such as ramping or new reserve products, or other market changes needed to support reliability now and in the future. A grid characterized by high levels of intermittent renewable resources and energy storage resources may require different real-time market structures and rules to balance intermittency and uncertainty while continuing to efficiently schedule energy transactions and commit short-lead-time resources. The ***Review of Real-time Market Structure*** project will assess the existing real-time market structure and settlements to determine if changes are needed to maintain reliable operation in real time, including a longer look-ahead reserves

product to manage new uncertainties. The project will review the current real-time market and settlement structure, the risks associated with a grid characterized with high levels of intermittent renewable resources and ESRs and will review potential alternative structures. This study will evaluate if the current structure and optimization horizons of the Real-Time Commitment (RTC) and Real-Time Dispatch (RTD) are designed to best manage the challenges of the future grid.

Large additions of renewable resources will also impact the amounts of contingency reserves the NYISO needs to carry in the future. Currently, the NYISO procures fixed quantities of reserves in specified regions across the state. The NYCA-wide reserve requirement is based on the largest single source contingency (a static value). This static modeling approach uses a pre-determined value to procure reserves, which potentially reduces the flexibility of the market model to reflect current grid conditions (*e.g.,* generation commitments and electrical flows on transmission), and to maintain system reliability with a least cost solution. Operationally, the largest contingency could change based on the current commitment of generation. The static modeling of locational reserves requirements does not optimally account for the real-time transmission flows and available transmission capability that could be used to deliver reserves from a more cost-effective reserve region.

Dynamic Reserves is a novel approach that is exploring more efficient scheduling of operating reserves based on system conditions and transmission system capability. This will not only allow for appropriate reserves to be procured to cover the largest source contingency that could potentially occur under the current system conditions, but it will also allow for more reserves to be scheduled in cost-effective regions. Resources capable of providing reliability services where they are needed due to transmission constraints or large amounts of renewable generation will be compensated more commensurate with their locational value.

As intermittent generation grows in certain import-constrained areas, the amount of reserves carried in such areas may need to be increased to address the loss of supply. As part of the ***More Granular Operating Reserves*** effort, the NYISO is exploring the implementation of reserve requirements within certain constrained load pockets in New York City that would better represent the value of short-notice on-demand resources in desirable locations. The Dynamic Reserves project is an enabling technology for More Granular Operating Reserves.

In addition to reserves, other ancillary services such as regulation, voltage control, and inertial response are essential to maintain grid reliability and resilience. As the grid needs evolve, incentives change, and the renewable generation technology advances, continued review of the potential grid services that renewable generators are capable of providing to maintain grid reliability should be undertaken. The

2021 *Grid Services for Renewables* study examined relevant reliability rules, as well as the necessary upgrades to typical inverters and controls that can enable renewable generators to provide additional grid services. Additionally, the study considered potential enhancements to current market designs to allow renewable generators to provide all of the grid services they are capable of providing. Specifically, the study identified an opportunity to expand the provision of Regulation Service from generators (both renewable and non-renewable) by separating regulation "up" and "down" products. The project ***Separating Up and Down Regulation Service*** will investigate bifurcating the regulation market, which could increase resource participation and competition to provide the services and reduce the overall costs of procuring regulation service. The transformation of the current regulation product into two products would potentially expand participation from renewable generators, but it would also have implications for other resource types that currently provide Regulation Service.

Increased flexibility is essential as the penetration of intermittent renewable resources increases. Currently, Real-Time Dispatch (RTD) schedules a significant portion of internal generation on a five-minute basis. However, interchange with external control areas is scheduled either on a 15-minute or an hourly basis by the Real-Time Commitment (RTC) software. Scheduling external transactions with our neighboring control areas on a five-minute basis would increase flexibility in the energy and ancillary services markets and improve reliable grid operations. The ***5-Minute Transaction Scheduling*** initiative will evaluate how best to schedule external transactions every five-minutes with neighboring areas that are able to support a reduced scheduling horizon, aligning the scheduling of external interchange with internal resources and improving the options for maintaining grid reliability. This project also has the potential to increase price convergence between the RTC and the RTD, thus reducing the volatility of real-time prices.

Future changes to New York's fuel supply mix as well as the expected increases in winter peak loads due to electrification may challenge the ability to meet electric system demands under stressed system conditions, such as a prolonged cold weather event and/or natural gas supply/transportation disruptions. Citing the loss of firm load in ERCOT and SPP in 2021[12] due to fuel constraints during an extreme cold weather event, FERC issued a Notice of Proposed Rule Making[13] to require reporting on climate vulnerability, including fuel security. NERC, NPCC and NYSRC are all currently considering new mandatory standards in this area. The ***Enhancing Fuel and Energy Security*** study will examine potential

[12] https://ferc.gov/news-events/news/final-report-february-2021-freeze-underscores-winterization-recommendations

13 *One-time Informational Reports on Extreme Weather Vulnerability Assessments.* FERC Docket RM22-16-000, issued July 16, 2022.

new reliability standards and the changing nature of the supply mix and load patterns and quantify the amount and type of resources that will be required to reliably meet demand based on a wide range of potential grid resilience risks, including extreme weather and climate change impacts.

In general, there is an increasing demand from power marketers and their customers to know the source emission profile of the energy they are consuming. The emissions rates associated with the production of electricity in New York vary widely from hour to hour and location to location, but specific emissions rates are not transparent to the market. The project ***Emissions Transparency*** envisions that the NYISO would publish marginal and average emissions rates concurrent with the release of Locational Based Marginal Pricing (LBMP) data. Doing so would inform end users, load-serving entities, generators, energy service companies, marketers, aggregators, and other market participants seeking to optimize their use, production, storage, or purchase of electricity based on emissions. In addition, providing such data to the market would enable consumers to evaluate the emissions associated with the energy they consume and could inform decision-making related to implementation of state policies and environmental initiatives.

The CLCPA also encourages the addition of new transmission elements. There is a planned Phase Angle Regulator (PAR) installation on the Long Mountain-Cricket Valley intertie between NYISO and ISO-NE by Q4 2023, which is an upgrade from the AC Public Policy Segment B project.[14] The NYISO does not currently have an operating agreement with ISO-NE for this PAR. Tariff revisions will be required to efficiently incorporate the new device into grid and wholesale energy market operations. The objective of the project ***Long Mountain PAR Operating Protocol*** is to develop a new operating protocol with ISO-NE.

Improving Price Formation

Efficient, transparent, and reasonable pricing of all products and services in the day-ahead and real-time markets provides proper incentives for resources to offer flexibly and to be responsive to real-time system changes, particularly as conditions transition between when supply is ample and when it is scarce. Renewable resources also have zero or very low variable costs, which reduces energy prices when these resources are marginal. With an increase in penetration of renewable resources, energy prices will be lower on average and a greater percentage of the time. This reduction in energy market revenue due to lower energy prices places a greater emphasis on price formation to maintain efficient marginal incentives and to avoid reliance on out-of-market actions and uplift payments. Robust energy and ancillary services price formation will provide incentives for resources to respond to real-time needs and to signal investment in resources with the necessary capabilities to support grid reliability. It will also encourage

[14] Dover PAR Station

the entry of flexible resources that will be needed to balance intermittency of the future grid.

Currently, reserve providers in the Long Island (LI) reserve region are paid based on the clearing prices for the larger Southeastern New York (SENY) reserve region due to market power concerns and operating constraints in Long Island. To meet NYS's renewable energy targets, large developments of off-shore wind projects are anticipated in the LI zone. It will be essential to have enough reserves within LI along with sufficient transmission capability to recover from the loss of intermittent output that is used to meet load on LI. To accomplish this, the wholesale markets will need to establish reserve prices for LI that properly reflect the value and associated cost of the reserves being procured. The ***Long Island Reserve Pricing*** project will evaluate whether revisions to current compensation rules are warranted to provide additional availability incentives for Long Island suppliers. This modeling enhancement is intended to better reflect the value of reserve capability on Long Island. This project is dependent upon the Dynamic Reserves project.

In addition to enhancing scheduling and pricing of operating reserve products, effective pricing and modeling of transmission constraints is necessary for improved price formation. While sufficient generation capability and operating reserves may be available to the system, without the required transmission capability or efficient modeling of transmission constraints, serving load effectively is a challenge. Currently, the NYISO's software accounts for the energy that can flow from one location to the next on the bulk electric system by accounting for transmission facility and line limits. The current transmission pricing logic relaxes certain transmission constraints assigned a zero-value constraint reliability margin (CRM) without using a graduated pricing mechanism to resolve it. A 2018 study concluded that enhancements to the current transmission constraint pricing logic would be beneficial.

Constraint Specific Transmission Shortage Pricing will deploy a new pricing construct, under which transmission demand curve prices will increase with the severity of transmission overloads, including extension of a graduated pricing mechanism to internal facilities that are currently assigned a zero value CRM. Additionally, it will enable new graduated transmission demand curves (GTDC) to provide relief for flows on each facility in a quantity that matches the associated CRM. This will result in fewer occurrences of constraint relaxation and increased use of a graduated transmission demand curve mechanism to establish pricing values for shortages that exceed applicable CRM values. This project will better reflect the costs of meeting transmission constraints in locational prices. Improved transmission shortage pricing outcomes can further incentivize investment in resources and transmission in locations that would benefit the system.

Efficient scheduling and pricing of operating reserves becomes increasingly important to reliably operate

the system when intermittent resource output is unavailable.

The ***Improve Duct Firing Modeling*** project has evaluated market software enhancements required to better reflect the operating characteristics of a combined cycle generator in the duct-firing range. Completion of this future enhancement is intended to enable more efficient scheduling of a combined-cycle resource for both energy and operating reserves. Furthermore, this enhancement could provide more accurate dispatch decisions in real-time by more accurately reflecting the operating characteristics of such resources.

Under current market rules, many offline 10-minute gas turbines (GTs) are treated by the dispatch software as if they can follow real-time dispatch signals, even when the resources may not be able to respond within the 5-minute timeframe. This leads to periods of under-generation and causes a divergence between market schedules and actual outputs. Therefore, prices may not adequately reflect real-time system conditions. The ***Eliminate Offline GT Pricing*** initiative will develop market rule enhancements necessary to better reflect system conditions and encourage investment in more flexible, dispatchable resources.

Financial Instruments for Energy Markets

Electricity markets, and markets generally, function most effectively when market participants can buy and sell electricity across a range of physical and financial markets. Certain marketplaces were created during the initial development of wholesale electricity markets, for example Day-Ahead markets and Transmission Congestion Contracts. As the electricity grid and market participants' needs have changed, so too have the characteristics of the markets themselves. The evolution of associated financial markets goes together with the evolution of the physical markets.

Balancing the system with a large amount of weather-dependent generation resources will also require a significant increase in Energy Storage Resources (ESRs). New York State has announced increased energy storage goals (6000 MW by 2030) as a step towards achieving the requirements of the CLCPA. The ability for an ESR to procure charging energy from specific generators, particularly renewable generators, would enhance the ability to provide customers with energy that is sourced from certain resources. The software revisions that would be pursued under the project ***Evolving Financial Transaction Capabilities*** will enable developers of ESRs to represent to potential customers that the energy stored in their facilities is sourced from renewable and emission-free generators. This is especially important in Zone J, where much of the generation operates using fossil fuels. Allowing developers to enter into bilateral contracts to charge their energy storage projects will facilitate financing and development, as it will allow ESR

operators to meet the needs of customers who prefer acquiring emission free energy. Broadly, facilitating efficient contracting, hedging, and other voluntary market activity adds to the depth and value of markets.

Additionally, market participants may wish to voluntarily exchange power in a manner that allows them to identify the resources serving their demand (or purchasing their supply). Internal bilateral transactions accomplish this task and can be used, for example, to demonstrate that low emission generation is the source of supply. Within NYISO, internal bilateral transactions can be accomplished via Trading Hubs. Bilateral transactions may be sourced from an internal generator and delivered (sink) at a zonal trading hub and may also be sourced at the zonal trading hub to deliver energy to other delivery points. One such delivery point can be an internal load bus while another delivery point can be a zonal trading hub.

Currently, a trading hub energy owner must have a balanced megawatt position at each trading hub in order for its trading hub transaction bids to be scheduled. A balanced megawatt position means that the trading hub energy owner must source the same amount of megawatts as it sinks at that zonal trading hub in a given market and hour. Given the variability of intermittent resource output and increasing load pattern variability, allowing unbalanced positions could increase liquidity for bilateral trades. The ***Enhancing Trading Hubs*** project would enable bilateral transactions to occur regardless of whether the purchasers demand profile exactly matches the sellers supply profile.

Capacity Market

Load Serving Entities in the NYISO-administered markets are required to procure enough resource capacity to meet forecasted load plus an Installed Reserve Margin to maintain grid reliability. The Installed Capacity (ICAP) Market is designed to satisfy resource adequacy requirements and enable generators to recover a portion of their fixed costs (*i.e.*, those costs that do not vary with electricity production). Capacity markets, in combination with robust energy and ancillary services markets, provide significantly less volatile investment price signals than an Energy and Ancillary Services (EAS)-only market. As the resource mix transitions with more intermittent renewable and limited-energy resources connecting to the grid, capacity market incentives must be sufficient to encourage resource retention and entry when needed. Need for market entry may be caused by factors such as the retirement of existing, higher-cost resources, reduction in resource fleet capabilities, or expected increases in load with electrification of the transportation and heating sectors.

Capacity Accreditation Measures

It is imperative to value capacity resources accurately based on their contributions to resource adequacy. This allows market compensation for capacity suppliers to be properly aligned with an individual

resource's expected reliability benefit to consumers while maintaining sufficient resources to meet resource adequacy requirements. The ***Improving Capacity Accreditation*** project will expand on the principles established with Expanding Capacity Eligibility and Tailored Availability Metric to all resources in the ICAP Market. This effort will develop enhanced capacity ratings for all supply resources that reflect the marginal contribution to meeting resource adequacy criterion, accounting for system dynamics, resource availability, performance and outage correlations).

As part of the Improving Capacity Accreditation project, numerous enhancements to the existing Resource Adequacy models and methods have been suggested to better represent specific characteristics of resources that may not be adequately captured in the existing models and methods. The ***Modeling Improvements for Capacity Accreditation*** project will examine enhancements to the Resource Adequacy methods and models to more accurately represent restrictions on natural gas resources during peak winter operations, startup notification time for resources that are not routinely operating during peak load conditions, as well as the representation of Special Case Resources.

Capacity Improvements to Support Reliability

Improving the resource adequacy tools and models is critical to efficiently meeting the reliability needs of the evolving grid. The ***Evolving Resource Adequacy Models*** project will look to enhance these tools and models, continuing work from the Improving Capacity Accreditation and Modeling Improvements for Capacity Accreditation projects. Enhancements will need to account for changes in critical operating periods, changing load shapes and load variability, new technology such as energy storage, and consideration of regional conditions that may inhibit shared assistance. The NYISO is working with its stakeholders and the New York State Reliability Council (NYSRC) on enhancements to measuring and modeling load forecast uncertainty and improving the load shapes used in resource adequacy studies that establish New York's Installed Reserve Margin (IRM) and Locational Minimum Installed Capacity Requirements (LCRs).[15] The NYISO is also seeking to improve the modeling of limited duration resources within the resource adequacy tools to better align the study outcomes with operational realities of managing resources that consume electricity in order to deliver that same electricity in a future period (less conversion losses). There is also work underway to enhance the variable generation profiles for wind and solar resources used in evaluating resource adequacy.

The ***Demand Curve Reset*** *(DCR)* process conducted every four years determines the parameters used in establishing the ICAP Demand Curves. The parameters are determined by a hypothetical resource's costs

[15] Methods for Measuring Reliability is an effort steered by the NYSRC and is therefore not part of the NYISO's project plans. The NYISO keeps its stakeholder apprised of any ongoing work with NYSRC.

and estimated energy and ancillary service market revenue earnings. By periodically assessing these parameters, this process allows the ICAP Market continues to send transparent price signals and support resource adequacy. The NYISO and its stakeholders recently completed the DCR process for the curves in effect for May 2021 through April 2025. The next DCR process will start in 2023 to establish the ICAP Demand Curves to be used for May 2025 through April 2029.

The NYISO worked with stakeholders to design and implement a proposal to set Locational Capacity Requirements (LCRs) based on both the resource adequacy criterion of maintaining a Loss of Load Expectation of no greater than one event-day in 10 years, as well as an economic cost minimization of those requirements based upon a set of Net Cost of New Entry (Net CONE) curves developed based upon the proxy technology underpinning the ICAP Demand Curve Reference Points. This effort, called the Alternative Methods for Determining LCRs, was intended to produce a robust, transparent, and intuitive process for maintaining reliability, while producing a lower cost solution in comparison to the previous method for developing LCRs, called the Tan 45 methodology.

Since the new methodology has been implemented, multiple concerns have been raised about the methodology and the resulting LCRs, specifically pertaining to the stability of the LCRs and the transparency of the optimization function. The ***LCR Optimizer Enhancements*** project will look to minimize these structural inconsistencies and improve the ICAP Market price signals for maintaining resource adequacy. Re-examining this process and the methodology could lead to improvements in the stability and transparency of the LCRs.

As the New York State electric system evolves from a summer peaking system to a winter peaking system, the NYISO's Installed Capacity Market structure will need to be reviewed to assess whether price signals, obligations, and incentives provided by the Installed Capacity Market will continue to be effective under this evolution. The ***Winter Reliability Capacity Enhancements*** project will perform this review, looking at all aspects of the Installed Capacity Market, including the Installed Capacity Load Forecasts, the requirement setting process, the establishment of Installed Capacity Demand Curves, and participation rules for Installed Capacity Suppliers.

The ***CRIS Expiration Evaluation*** project focuses on making the rules for Capacity Resource Interconnection Service (CRIS) expiration more stringent in cases where CRIS is not fully utilized, as well as making modifications to allow for increased flexibility with respect to CRIS transfers. Further enhancements to the CRIS expirations rules will more appropriately address the retention of CRIS by retired facilities and facilities no longer fully participating in the ICAP Market. These changes are intended to more accurately account for the capacity deliverability headroom of the system and potentially lower

the cost of market entry to future facilities seeking to participate in the ICAP Market.

New Resources and Technologies

The NYISO operates an "open access" system and must be able to incorporate new technologies into the existing system. This allows for fair treatment of all resources by valuing the characteristics needed to maintain grid reliability rather than preferring a particular resource type. The operational characteristics of renewable technologies, battery technologies, demand-side technologies and distributed generation technologies may not fit the existing models used to represent supply resources in the wholesale markets. Therefore, refinements to the existing models and the creation of new models are sometimes needed to properly reflect characteristics such as limited energy capabilities or lack of fuel certainty.

Enabling New Resources and Capabilities

New technologies have the potential to diversify the system resource mix, support New York's clean energy and de-carbonization objectives, and make load more dynamic and responsive, providing an opportunity to improve overall system efficiency. Some of these newer resources also depend upon the weather for their fuel. It is imperative to consider investment and innovation in new clean energy technologies with long-duration energy output capabilities that are dispatchable. Integration of new resources will ultimately support New York's clean energy objectives, as well as support compliance with FERC Order Nos. 719, 745, 841, and 2222 and other FERC efforts that explore new resources such as hybrid storage resources. While some new models may be required to fully integrate new resources, looking for opportunities to enhance existing models first will help integrate new resources while minimizing the operational matrix of market rule sets.

As new assets are developed and built, there is an accompanying desire to couple assets of different technology types to participate as a combined resource in the wholesale markets. This desire provides an opportunity to leverage the complementary characteristics of different technology types such as coupling intermittent, renewable generation with energy storage to reduce the generation volatility. Additionally, state and federal programs and procurement initiatives provide incentives for developers to couple storage and intermittent renewable assets. Recognizing these opportunities for developers and the associated benefits to the wholesale market, in 2020, the NYISO developed the *Co-located Storage Resource (CSR) Model* that enables grid-scale wind or solar and energy storage resources to participate as co-located resources behind a single interconnection point.

The NYISO will build on this framework via the ***Hybrid Aggregation Storage Model (HSR)***, which aims to allow energy storage resources to aggregate with one or more Intermittent Power Resources (Solar, Wind

and Landfill gas) and/or Limited Control Run of River Hydro generators that are all co-located behind the same point of interconnection to form a single resource. The resources in this type of aggregation will share a single point identifier (PTID). In addition, the NYISO will update the CSR model to allow Combustion Turbines (CT), Landfill gas, and Limited Control Run of River Hydro generators as additional generator types in the model.

Historically, most electricity demand has been considered inelastic or uncontrollable by system operators. However, as deployments of intermittent resource generation increase, so does the opportunity for more flexible demand. Flexible demand will play a role in both balancing intermittent supply from variable energy resources and in providing ancillary services to the NYISO markets. The ***Engaging the Demand Side*** project seeks to broaden avenues for market participation by flexible loads by informing the demand side about where and when to consume power and improving incentives to follow those instructions. This alignment may require improvements to consumer metering, communication platforms, close coordination with utilities, modifications to retail rate structures or expanded application/availability of retail rate structures reflecting real-time wholesale market prices, and wholesale market enhancements to further enable the participation of flexible load.

Effectively, *Engaging the Demand Side* could result in more robust price formation by reflecting consumers' willingness to purchase in addition to suppliers' willingness to provide. Although the NYISO markets currently feature demand side participation opportunities through various wholesale demand response programs, price responsive load bids in the Day-Ahead Market, and eventually the Distributed Energy Resource (DER) participation model, the emergence of new technologies provides a strong use case for price-responsive demand in the real–time markets. The transition to the future grid requires a wholesale market structure that allows for new and existing technologies to compete on equal footing. This includes the capability for wholesale price-responsive demand to play an active role in the wholesale markets, and the integration of a wide array of emerging load-shifting and distributed-resource technologies.

The NYISO's ***DER Participation Model*** is the next step toward animating load in the wholesale markets. This participation model builds upon the NYISO's experience with demand response programs, and it will be key to enabling demand-side technological advancements that may be needed in the near future. By creating an opportunity for participation of DER in the wholesale market, the NYISO hopes to maintain rules universally applicable to small resources desiring to participate in aggregate. This initiative directly supports compliance with FERC Order No. 2222, improving access to wholesale electricity markets for small, distribution-connected assets.

When evaluating new and enhanced market models enable new technologies, it is important to consider the state initiatives that may inform future market needs. One example is the development of rules for ***Internal Controllable Lines***. Currently, there are no internal controllable lines in operation within the NYCA. However, state and local initiatives, such as New York City Local Law 97[16] and Tier 4 REC procurements, provide incentives for developers to deliver renewable generation to constrained areas using high voltage direct current (HVDC) lines. The *Internal Controllable Lines* effort is intended to facilitate the efficient scheduling and pricing of these facilities within the Energy markets. Additionally, this effort is evaluating and revising, if necessary, the ICAP Market rules for Internal Unforced Capacity Deliverability Rights (UDRs).

Unique characteristics allow energy storage assets to potentially provide many services to grid operators. In some instances, storage used exclusively as a transmission asset could provide a faster and cheaper option for providing the same or similar services as traditional alternatives. In *Western Grid*,[17] the Federal Energy Regulatory Commission (FERC) accepted the provision of cost-based rate recovery for electric storage resources through transmission rates based upon the proposed uses exclusively for transmission services in that case. The eligibility of an electric storage resource to provide transmission service for which it is technically capable has been reiterated in a FERC Policy Statement in PL17-2-000.[18]

In the NYISO there is currently no pathway by which a storage project could be evaluated through the interconnection process as a transmission asset, and no methods by which to operate a storage asset as transmission. Furthermore, market rules for such projects would need to consider what impact market participation may have to avoid double payment while allowing for flexibility and reduced revenue requirements through traditional rate-basing mechanisms. The ***Storage as Transmission*** project has two primary components. The first component would have the NYISO consider a process by which a storage project could progress through the interconnection queue while being considered and evaluated as a transmission asset, including options for cost recovery. The second component would have the NYISO explore rules and methods for operating storage as a transmission asset, taking multi-use and double payment issues into consideration, as well as the various use cases.

Improving Market Models

In addition to introducing new market models for new technology types entering the markets, it is important to consider enhancements to the current market models. This could further continued efficient

[16] https://www1.nyc.gov/assets/buildings/local_laws/ll97of2019.pdf
[17] 130 FERC ¶ 61,056 at PP 18-24, 45-46.
[18] 158 FERC ¶ 61,051

scheduling of current resources and assist in providing additional flexibility to the current market software by balancing intermittent resource output. These enhancements typically are informed by operational experience and look to improve market models to align with reliable operations.

Duration limited resources, such as energy storage resources and energy limited resources, can enable the balancing of intermittent resource generation output. However, these resources can only provide uninterrupted energy for a limited time. ***Enhance Run Limited Resource Modeling*** will review the operation of existing limited energy resources and look to improve the modeling of such resources in the market software, which, in turn, could improve the efficiency of market outcomes to support grid reliability and effectively use these resources when they are most needed.

Proposed Project Timelines

Master Plan	2022	2023	2024	2025	2026	2027
Energy Market						
Markets for the Future						
Balancing Intermittency	SC	CP	FR	DEP		
Dynamic Reserves	CP	MDC	FR	DC	DEP	
Review of RT Market Structure				ID	SD	CP
Emissions Transparency		FR	DEP			
Enhancing Fuel and Energy Security		SC				
Long Mountain PAR Operating Protocol with ISO-NE		MDC	DEP			
More Granular Operating Reserves			MDC	FR	DEP	
5-minute Transaction Scheduling			MDC	FR	DC	DEP
Separating Up and Down Regulation Service				CP	MDC	DC
Improve Price Formation						
Constraint Specific Transmission Shortage Pricing	FR	DEP				
Improve Duct Firing Modeling	CP		MDC	DEP		
Eliminate Offline GT Pricing			DEP			
Long Island Reserve Pricing			MDC	FR	DEP	
Financial Instruments						
Evolving Financial Transaction Capabilities - Bilateral Transactions		SDS	DEP			
Unbalanced Trading Hubs				MDC	FR	DEP
Capacity Market						
Comprehensive Mitigation Review						
Comprehensive Mitigation Review	DEP					
Capacity Accrediation Measures						
Improving Capacity Accreditation	MDC	DEP				
Modeling Improvements for Capacity Accreditation		FR	DEP			
Capacity Improvements to Support Reliability						
Demand Curve Reset		SD	SC	DEP		SD
LCR Optimizer Enhancements		MDC	DEP			
Evolving Resource Adequacy Models			Coordinate Improvements with NYSRC			
Winter Reliability Capacity Enhancements				ID	CP	MDC
Improving Market Processes						
CRIS Expiration Evaluation	MDC		DC	DEP		
New Resources and Technologies						
Enabling New Resources and Capabilities						
DER Participation Model	DC	DEP				
FERC Order 2222 Compliance		MDC				
Engaging the Demand-Side		ID	CP	MDC	FR	SDS
Hybrid Aggregation Model	FR	SDS	DC	DEP		
Internal Controllable Lines	CP	MDC	FR	DEP		
Storage as Transmission		ID	Continue Based on Project Findings			
Improving Market Models						
Enhance Run-Limited Resource Modeling				CP	MDC	FR

Key			
CD	Continued Discussions	MDC	Market Design Complete
ID	Issue Discovery	FR	Functional Requirements
SD	Study Defined	SD	Software Design Specification
SC	Study Complete	DC	Development Complete
CP	Market Design Concept Proposed	DEP	Deployment

While all of the initiatives described herein may offer value to the wholesale markets, the NYISO does not have the resources to address all of them simultaneously. Unanticipated initiatives may also result from future FERC orders, stakeholder input, and/or evolving public policies, causing the proposed timelines to require revision. In light of these and other unknowns, this plan lays out what the NYISO believes to be an efficient path toward effective wholesale market reform.

Conclusion

This Master Plan discusses various wholesale market initiatives that are important to respond to a transitioning grid while maintaining reliable electricity for all New Yorkers. While there are various challenges the future grid poses, the initiatives described in this plan will ready the NYISO's wholesale markets for the anticipated transition.

Appendix I – Project Milestone Definitions

Ongoing:

- Unique to the Master Plan, this milestone acknowledges that additional development of potential projects is required before laying out a detailed project plan.

Issue Discovery:

- NYISO has facilitated education sessions for stakeholder knowledge development of problem/issue, conducted stakeholder solicitation of potential solutions to address problem/issue, and summarized findings at a working group meeting for potential ranking and future project identification.

Study Defined:

- The scope of work for the study has been presented to stakeholders, including a discussion on the necessary input(s), assumption(s) and objective(s) of the study.

Study Complete:

- Scope of work to be performed has been completed; results and recommendations have been presented to the appropriate Business Owners and stakeholders.

Market Design Concept Proposed:

- NYISO has initiated or furthered discussions with stakeholders that explore potential concepts to address opportunities for market efficiency or administration improvements.

Market Design Complete:

- NYISO has developed with stakeholders a market design concept such that the proposal can be presented for a vote at the Business Issues Committee (BIC) and/or Management Committee (MC) to define further action on the proposal.

Functional Requirements:

- NYISO has completed documentation of the functional requirements (FRS) and the Business Owner has approved.

Software Design:

- The software design document is complete and software development is ready to begin.

Development Complete:

- Software development has been completed, packaged and approved by the Supervisor.

Deployment:

- Required software changes to support commitment have been integrated into the production environment.