New York ISO
Independent System Operator

2023 Market Vision

A Report by the
New York Independent System Operator

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Introduction

The NYISO administers the nation's leading wholesale electricity markets. These wholesale electricity markets consist of:

- a **Capacity Market** with strip, monthly, and spot auctions that establish regional prices to meet New York's resource adequacy needs;
- an **Energy Market** with a day-ahead auction to prepare for the next day's power system operation and a series of real-time auctions that clears every five-minutes and establishes locational prices to meet New Yorkers electricity needs every minute of every day;
- **Ancillary Services**, such as operating reserves and regulation service, that establish regional prices and provide needed flexibility and backup to help meet New Yorkers needs when the unexpected happens, and cost-based services, such as voltage support and black start, that support robust transmission operations or help restore the power system after a complete or partial failure through cost-of-service payments; and
- a **Transmission Congestion Contracts Market** to help buyers and sellers manage or hedge locational price risk.

These elements of the NYISO wholesale electricity markets work together to support the efficient delivery of reliable electricity to every New Yorker, which also helps to keep the cost of electricity commodities as low as possible.

The wholesale electricity market rules benefit from a highly collaborative governance process where potential market rule changes are vetted with stakeholders. The shared governance process is made up of representatives of a broad swath of interests, including utilities, suppliers, public power interests, consumers, and environmental interests, including entities focused on environmental justice concerns. The shared governance process is designed to balance these interests while supporting strong collaboration among stakeholder interests and with the NYISO. This is important as these wholesale market rules are extremely complex, and modification requires thorough review and vetting. Once changes are supported by our stakeholders, the NYISO's Board of Directors also reviews them. After the NYISO Board of Directors approves potential market rule changes, the NYISO submits proposals for consideration by its regulator, the Federal Energy Regulatory Commission (FERC), which must accept the proposed rules changes for them to become effective.

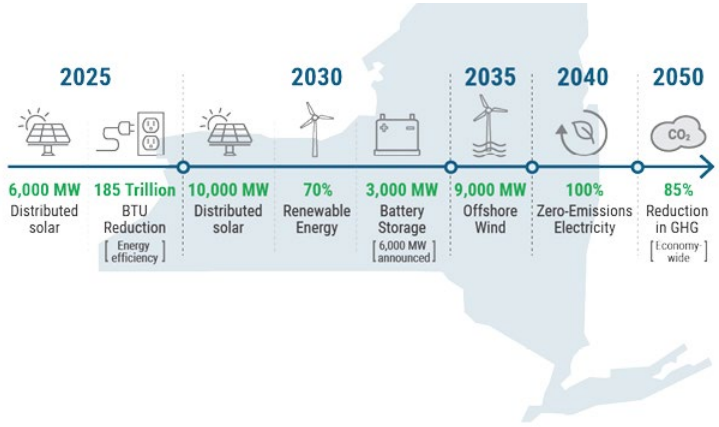
This Market Vision report, formerly Master Plan, discusses the wholesale electricity market initiatives planned for the next five years. These initiatives will require the commitment and collaboration of NYISO's stakeholders, policymakers, and regulators to be successful.

A Changing Power System

New York State lawmakers passed the Climate Leadership and Community Protection Act (CLCPA) in 2019. This law bolstered the clean energy commitment of New York already envisioned in the Clean Energy Standard (CES).

State polices are driving the state's supply mix to an electric power system supplied by zero-emitting resources, with an abundance of renewable energy and storage resources. At the same time, public policies are also encouraging many more circuit miles of transmission and distribution, and many portions of the economy electrified. Through its reliability and economic studies, the NYISO has identified a need for non-emitting resources that possess similar attributes to today's conventional fossil-fueled resources. NYISO refers to these resources as Dispatchable Emissions Free Resources (DEFRs).

Figure 1. State Energy Policy Mandates



All this is leading to a tremendous amount of change to an infrastructure system critical to the health, safety, and welfare of New Yorkers.

This transition needs to be carefully planned and executed, especially since the electrification of other parts of the economy amplifies the need for a reliable and resilient electricity system. It will also be very important that the wholesale electricity markets continue to deliver the least cost electricity available to consumers.

The wholesale electricity market is the platform for such a transition. It is designed to incentivize an orderly transition for economic entry and exit, where new technologies and resources are added before existing resources that we rely on for system reliability retire. The transparent market signals provided by wholesale electricity markets, reflecting the balance between new supply, and retiring resources, can serve to inform market participants, developers, stakeholders, and policymakers as we progress through this transition.

New Challenges

The wholesale electricity market in New York is fundamentally sound and built on a strong foundation of reliability and market principles. However, the operation of the power system will change with the expected addition of over 45 GW of intermittent renewable resources to meet the CLCPA, fueled by wind and solar energy. For context, the current fleet in NY is roughly 41 GW.

Figure 2. Anticipated NYCA Capacity and Generation Changes

Source 2021-2040 System & Resource Outlook

Since renewable resources generally act as low-cost supply, they displace more flexible resources that can come on and off quickly. Unlike conventional baseload resources, such as nuclear and combined cycle generators, output from renewable resources is highly variable since these resources rely on the weather to produce electricity.

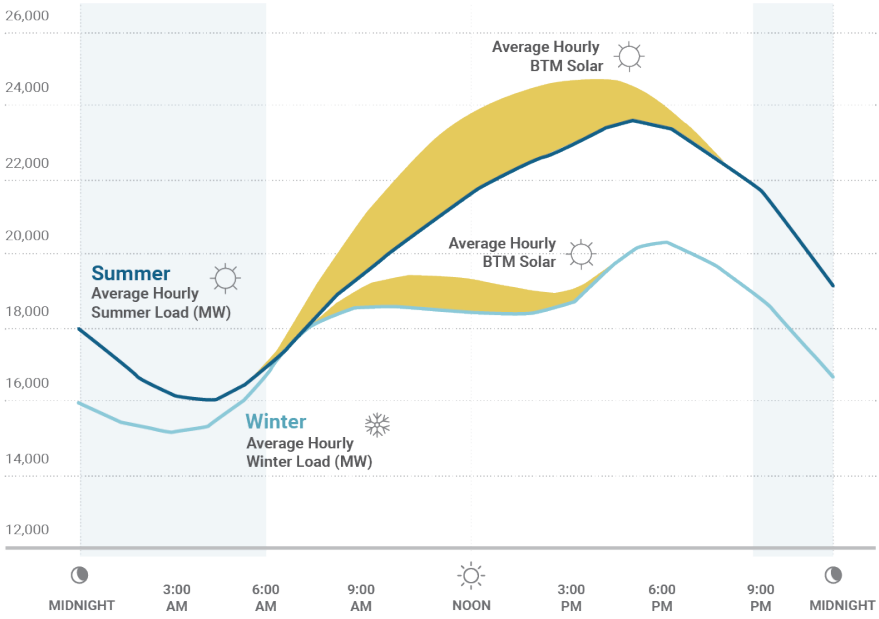
About half of the 45 GW of new supply is expected to be solar resources. The output from these resources varies greatly, both daily and across the seasons, with spring being most advantageous for high solar output and winter most limiting with almost zero solar output.

The CLCPA envisions adding storage resources that can capture the excess output from renewable resources when the power system does not need it and deliver that energy when the output from renewable resources is diminished, and the power system does need it.

The attributes of current storage technologies vary greatly. Some storage resources, such as batteries, have limited duration capabilities (less than 4 hours of stored energy) but can ramp very quickly. Some storage resources may have a few days or a week of stored energy but must be configured ahead of time to

either consume or produce energy and are not highly flexible. Other storage resources, such as pumped-hydro storage, have many hours of storage capability (8 to 12 hours) and are flexible in that they can be called on quickly (in less than 10 minutes), ramp quickly, and, in some cases, seamlessly ramp from consuming to producing or vice-versa.

Figure 3. Summer and Winter Behind-the-Meter Solar Performance



The power system is getting more complex, with an abundance of new technologies and resources added to the power system that do not have a long track record of reliable configuration or operation. These resources, known as inverter-based resources, rely on software based electronics to perform, leading to a higher probability of misconfiguration, mis-operation, or failure of the resource to react to system conditions correctly. The industry is currently grappling with best practices, standards, and operating procedures that would minimize the risk to reliability based on poorly designed or configured technologies. However, there is still much learning to do before these risks can be meaningfully mitigated.

Lower operating margins are leading to higher power system stress, and aging equipment is more susceptible to failure when operating under stressed conditions. There are also increased challenges with the integration and coordination of smaller resources, many of which are not able to respond to dispatch signals scattered across many different voltage levels (*i.e.*, transmission, sub-transmission, networked distribution, and radial distribution) of the power system.

These changes in resource mix lead to a need for:

- A diverse mix of dispatchable resources to address renewable balancing and uncertainty:
  - Dispatchable: Resources that can follow instructions to increase or decrease output on a minute-to-minute basis;
  - Short Notification: Resources that can start quickly (<10 minutes);

  - Zero/Minimal Downtime: Resources that can cycle often with minimal to zero downtime;
  - Fast ramping: Resources that can quickly follow net load to manage ACE on a second-to-second basis; and
  - Energy Secure: Resources that can provide energy for multiple hours and days regardless of weather, storage, or fuel constraints.
- Resources that support power system strength and stability and minimize operational risk:
  - Resources that can hold their bus voltage regardless of topology or resource commitment;
  - Resources sized to avoid extreme contingency scenarios, where contingency reserves may be expensive or unavailable, and loss of generation does not contribute to Loss of Load Events (LOLE) or Expected Unserved Energy (EUE); and
  - Resources that can support frequency response.

Well-functioning wholesale electricity markets provide signals that incentivize the resource attributes needed to support a reliable and resilient power system. The changes to the power system resource mix are creating new challenges to the reliability and resilience of the power system. New York's wholesale electricity market must adapt to address these challenges and provide signals that support the resources needed to continue to support the reliable delivery of electricity.

Capacity Market

The Capacity Market provides fixed cost recovery, net of energy and ancillary service revenues, for resources eligible to sell capacity. This supports resources needed to ensure a diverse resource mix that can reliably serve all New Yorkers.

Capacity is measured in two ways:

- As installed capacity (ICAP), which measures the nameplate or demonstrated maximum capability of resources; and
- As unforced capacity (UCAP), which measures the reliable capacity available from a resource to serve load. UCAP allows for a MW of capability to be compared to any other MW of capability, known as fungibility, regardless of resource, technology, or location.

The NYISO supports the work of the New York State Reliability Council (NYSRC), which annually establishes the amount of capacity that must be procured to maintain reliability. These requirements are converted into UCAP terms for use in the Capacity Market clearing process. These requirements are designed to establish the amount of ICAP needed to meet the standard of avoiding voluntary transmission level load shedding from happening more than once every ten years.

Assessing Reliability Risk and Assigning Reliability Value

As the resource mix transitions and extreme weather events occur more frequently, the risks to the power system and supporting infrastructure, such as natural gas pipelines, shifts. Understanding how these changes impact the generation fleet's ability to reliably serve load becomes critical for all involved in the safe and reliable delivery of electricity to customers you.

The resource adequacy analysis performed to support the NYISO's capacity market is a critical tool for understanding how these risks are evolving. However, this analysis is based on mathematical models and these models are only as good as their inputs and assumptions. There is a constant need to evolve the robustness of these models, and the NYISO works closely with the NYSRC to evaluate modeling improvements. Many improvements have been made over the years, and more are planned.

The NYISO's efforts with ***Modeling Improvements for Capacity Accreditation*** *and a new effort* ***Evolving Resource Adequacy Models*** are considering how to account for new operational, weather-related, and correlated risks. These improvements will focus on helping all involved understand the new and changing risks with delivering reliable electricity to all New Yorkers.

Transmission Security and the Need for Resource Diversity

A reliable power system requires diversity in the resource mix. Combining a set of resources whose operational characteristics, are not all the same, creates opportunities for managing correlated issues and provides natural redundancy. For example, the NYISO recently alerted the industry to an issue where not enough resources are projected to be available in New York City when certain simple-cycle fossil generators ("peakers") retire in 2025 due to new environmental regulations.

The main risk from these retirements is the ability to control flows on the transmission system, known as transmission security. Generally, resources do not contribute similarly to transmission security, and this power system service is not specifically compensated for in the wholesale market. The NYISO will be investigating how best to include transmission security needs in the wholesale market with the ***Valuing Transmission Security*** project.

Growing Concerns About Winter Reliability

The retirement of nuclear and coal facilities has created a much larger reliance on natural gas-fueled generators, especially in southeast New York. Natural gas continues to be relied upon to provide heat for commercial and residential buildings as previous codes and policies encouraged the shift to using cleaner natural gas. At the same time, the existing infrastructure and supply of natural gas in New York is not expanding to support the growing reliance on natural gas.

These changes place an additional burden on the existing and aging natural gas infrastructure, and it is of growing importance to understand how these shifts are creating risks for natural gas-fueled generators to be available on the coldest days of winter. These impacts are not unique to New York, and neighboring regions, including New England, Quebec, Ontario, and the Mid-Atlantic, are facing similar risks of insufficient capabilities during the winter season.

Winter Reliability Capacity Enhancements is a project that is focused on understanding these emerging winter risks. The effort will also focus on determining how best to incorporate these changes into the capacity market structure so that the market properly signals the times of year (seasons) that resources are needed most and properly values resources that can contribute the most to winter reliability.

Markets that Support the Transition

New York's power system is changing. New transmission investments are being made across the state to improve the ability of renewable energy to supply energy to customers. Conventional resources face more stringent emissions requirements, and in some cases, these policies are leading to retirement of highly flexible generators. Economic development opportunities are also leading to large investments in new facilities that will support new industries across New York. These new facilities are expected to be large electricity consumers.

The capacity market currently establishes market signals through market prices for four regions of New York. These areas have historically been defined by limitations to deliver electricity from one area to another. As the power system changes, it is expected that these historical limitations of power delivery will also change. It will not be cost-effective to upgrade transmission to eliminate all the delivery limitations.

Therefore, it is important that the capacity market be able to adapt to account for any changes to these limitations of electricity delivery. The NYISO will be working through the question of how granular the capacity market regions need to be as part of the ***Granular Capacity Market Pricing*** project.

Changes to capacity market regions have large consequences and should not be something that is rushed into; however, it is just as important to make sure that capacity market price signals remain consistent with locational reliability needs. Additionally, the design of the capacity market regions (or Localities) also impacts how resource deliverability analysis should be performed.

The NYISO believes it needs to have a clearer view of how granular capacity market pricing areas might be before it can turn its attention to the ***Deliverability Improvements*** project. This effort will work through the role of the New Capacity Zone (NCZ) study and resource deliverability studies performed in the Class Year or Expedited Deliverability Study processes. It is expected that any changes to how capacity market pricing regions are defined will require reconsideration of the NCZ and resource deliverability studies.

Other Capacity Efforts

The NYISO expects to be completing projects it started over the next few years, including implementing the ***LCR Optimizer*** changes and software to help manage ***CRIS Expiration*** tracking. Additionally, the ***Demand Curve Reset*** has kicked off as defined by the NYISO tariff.

Capacity Market Plan

Figure 4. Capacity Market 5-year Plan[1]

	2022	2023	2024	2025	2026	2027	2028
			Market Vision 2023				
Capacity Market							
Capacity Accrediation Measures							
Improving Capacity Accreditation	MDC	DEP					
Modeling Improvements for Capacity Accreditation		FR	DEP				
Demand Curve Reset		SD	SC	DEP		SD	SC
Capacity Improvements to Support Reliability							
Evolving Resource Adequacy Models			Coordinate Improvements with NYSRC				
Valuing Transmission Security			ID	MDC	FR	DC	DEP
Winter Reliability Capacity Enhancements			ID	MDC	FR	DC	DEP
Granular Capacity Market Pricing			ID	Continue Based on Issue Disovery			
Deliverability Improvements				Develop Improvements Consistent with Granular Capacity Market Pricing			
Improving Market Processes							
LCR Optimizer Enhancements		MDC	DEP				
CRIS Expiration Evaluation	MDC	FR	DC	DEP			

[1] See Appendix – Legend for 5-year Plans for description of milestones.

Energy Market

The NYISO-administered wholesale energy market provides suppliers and consumers with operational signals about power system conditions. These signals also reward resources and consumers that are most flexible. These markets simultaneously procure energy, operating reserves, and regulation services, known as co-optimization. This is an extremely efficient way to procure all services at the least possible cost. The wholesale energy market also:

- Establishes resource schedules, including conventional generators, batteries, hydro, pumped-hydro, renewable generators, demand response, and distributed energy resources;
- Economically evaluates and schedules market area-to-market area interchange transactions;
- Provides nodal energy price signals, known as locational-based marginal prices (LBMPs) for resources;
- Provides zonal energy price signals for consumers (or demand);
- Provides regional price signals for operating reserves;
- Provides State-wide price signals for regulation services; and
- Provides transmission congestion price signals for transmission constraints that limit the flow of economic energy.

The Energy Market consists of a day-ahead and real-time market, known as a two-settlement market, and settles all services nominally every five minutes in real-time. This structure incentivizes resources that clear day-ahead to be available in real-time or risk selling any unfulfilled schedule at real-time prices. It also allows customers to hedge real-time price volatility by purchasing services at day-ahead prices.

The energy market is set up to simulate expected actual operating conditions and schedules resources to support the reliable delivery of energy to customers every second of every day. It also supports the coordination of energy purchases and sales between neighboring regions. As the operation of New York's power system becomes more complicated with the addition of intermittent, limited duration, and transmission-constrained resources, the market tools and market products will also need to evolve to be able to continue to simulate expected actual operating conditions and mitigate new risks to reliable electricity.

Managing Intermittency

The operating characteristics of the power system are changing with the introduction of large quantities of renewable and duration-limited resources. The sudden loss of large amounts of energy due to rapid changes in weather conditions and the uncertainty surrounding predicting how much energy to count on from these resources introduces operational challenges that must be addressed.

These challenges will require having resources on standby to provide energy when the availability of the renewable fleet diminishes. This concept of having resources on standby is not new. However, the timeframes and duration needs must be better defined to provide clearer signals on the standby resource capabilities needed. Previously, what mattered was how quickly a resource could start, but with new duration-limited resource technologies, it becomes more important to define the duration needs of standby resources.

The ***Balancing Intermittency*** project is focused on identifying and developing new ancillary service products to better define the standby resource needs. Existing ancillary service products will then be expanded to better account for resource and net load uncertainty to operate the changing power system. Uncertainty is generally exacerbated with the introduction of renewable resources, and net load uncertainty can mostly be attributed to the development of large amounts of behind-the-meter solar. The NYISO believes that New York currently has about 5 GW of behind-the-meter solar in operation today.

The addition of new products and expanded use of existing products also suggests that great care should be taken when scheduling resources to provide these products and pricing these products. The ***Balancing Intermittency*** project will also give consideration to these issues.

Today's ancillary service products and the new products being considered as part of the ***Balancing Intermittency*** project have requirements that are defined through an offline study and set to the same value, with minor exceptions, every hour of every day. This methodology has worked well as the largest risk to the power system could be defined as the loss of the largest generator, which was a nuclear reactor that generally runs every day at its designed maximum capability. The addition of large quantities of offshore wind, greater than 9 GW expected, off Long Island and New York City, and the addition of large transmission lines that terminate in New York City load centers create additional reliability risks that ancillary service product requirements must change to address.

Although continuing the practice of statically defining these product requirements as the renewable resource fleet grew and risks increased would, in theory work, it is expected that this would be an inefficient design. The NYISO instead considered the idea of dynamically determining the product requirements based on the expected or actual operation resources and is working on this concept as part of the ***Dynamic Reserves*** project.

Dynamically determining where and how many reserves to procure will improve the efficiency of any new products developed under the ***Balancing Intermittency*** project. These two projects are sequenced to avoid duplication of efforts and allow for the introduction of this mathematically challenging concept in a measured way before expanding its use to consider resource and load forecast uncertainty and potentially

other use cases.

The ***Balancing Intermittency*** and ***Dynamic Reserves*** projects are expected to improve the effectiveness and efficiency of the energy market, thereby improving how the energy market supports power system operations. These projects will also be helped by allowing Long Island resources to settle using Long Island ancillary service prices, which is the focus of the ***Long Island Reserve Constraint Pricing*** project. The availability of reserve providers is also important, and the ***Operating Reserve Performance*** project will aim to create more incentives for resources to be available. Finally, the ***Improving Duct Firing Modeling*** project will improve the modeling of available combined-cycle generator capability and may also help with the modeling of hybrid resource aggregations that would make more functional reserves available to the market.

Other Energy Market Efforts

The ***Emissions Transparency*** project will provide information to the public about system carbon dioxide emissions. The ***Evolving Financial Transaction Capabilities – Bilateral Transactions*** project will allow energy storage resources to be the sink of a bilateral transaction, which can be helpful to demonstrate that certain clean resources were the intended source of energy for the storage resource. Developing the capability to allow single-sided transactions to or from the market to a Trading Hub will be the focus of the ***Market Purchase Hub Transaction*** project.

Energy Market Plan

Figure 5. Energy Market 5-year Plan

	2022	2023	2024	2025	2026	2027	2028
			Market Vision 2023				
Energy Market							
Markets for the Future							
Balancing Intermittency	SC	CP					
Phase 1 - Modify Existing Product(s) for Uncertainty			MDC	DEP			
Phase 2 - New Product(s)				FR	DEP		
Phase 3 - Shortage Pricing Updates/Reconsider Scheduling Costs					MDC	FR	DEP
Dynamic Reserves	CP	MDC					
Phase 1 - Transmission Headroom			FR	DC	DEP		
Phase 2 - Dynamically Adjust for Uncertainty				MDC	FR	DEP	
More Granular Operating Reserves						MDC	FR
Reserves for Congestion Management						CP	Continue
Operating Reserve Performance			MDC	DEP			
Separating Up and Down Regulation Service					CP	MDC	DC
Review of RT Market Structure				ID	Continue Based on Findings		
Emissions Transparency		FR	DEP				
Ambient Adjusted Transmission Line Ratings					FR	DC	DEP
Improve Price Formation							
Improve Duct Firing Modeling	CP		FR	DEP			
Eliminate Offline GT Pricing				DEP			
Long Island Reserve Constraint Pricing			CP	DEP			
Financial Instruments							
Evolving Financial Transaction Capabilities - Bilateral Transactions		SDS	DEP				
Reserving Capacity for TCC BoP Auctions						SDS	DC
Time Differentiated TCCs							
Market Purchase Hub Transactions			MDC	FR	SDS	DEP	

New Resources and Market Participation

Public policies are driving the research and advancement of new technologies. As these new technologies become commercially viable, there is a need to consider their operational characteristics to allow them to be incorporated into the wholesale market as efficiently and effectively as practicable.

Policy Driven Transmission

New York established a tier 4 renewable energy credit program designed to support renewable resource development in New York City or support the delivery of renewable energy to New York City. This program selected two projects, Champlain Hudson Power Express (CHPE) and Clean Path New York. Champlain Hudson Power Express is being developed to deliver energy from Quebec to New York City, while the Clean Path New York project is under development to deliver energy from central New York to New York City.

The ***Integrating Champlain Hudson Power Express*** project will focus on any modification to the interchange scheduling market rules to support the operation and open use of the new Champlain Hudson Power Express high voltage direct current transmission line. Clean Path New York will be New York's first internal high voltage direct current transmission line, and the ***Internal Controllable Lines*** project is focusing on how best to incorporate an internal controllable transmission line into the power system operation and the wholesale market.

The ***Long Mountain PAR Operating Protocol with ISO-NE,*** project is focusing on establishing an operating agreement on a new set of phase angle regulators that are being developed as part of the AC Transmission Public Policy project. These phase angle regulators will operate on a transmission interconnection with ISO-NE and their operation will need to be coordinated with our neighbor.

Improving Energy Storage Operation

New York is planning on adding at least 6 GW of energy storage to New York's power system. Coordinating the effective operation of such a large quantity of resources that have their own operating constraints will require advanced operational tools and improvements to the wholesale market modeling techniques. The Advanced ***Storage Modeling and Operation*** project will consider better modeling techniques for energy storage scheduling in the day-ahead and real-time markets, as well as improved tools for power system operators to better understand and manage the energy storage fleet's capabilities.

New Resources Plan

Figure 6. Advancing and Integrating New Resources 5-year Plan

	2022	2023	2024	2025	2026	2027	2028
			Market Vision 2023				
New Resources and Technologies							
Enabling New Resources and Capabilities							
FERC Order 2222 Compliance		CP	FR	DC	DEP		
Engaging the Demand-Side		ID	CP	MDC	FR	DC	DEP
Participation Opportunities for Small DER					CP	MDC	DC
Hybrid Aggregation Model	FR	SDS	DC	DEP			
Clean Hydrogen			CP	FR	DC	DEP	
Integrating Champlain Hudson Power Express (CHPE)			MDC	FR	DEP		
Internal Controllable Lines	CP	MDC	FR	DC	DEP		
Storage as Transmission		ID	CP	Continue Based on Project Findings			
Improving Market Models							
Advanced Storage Modeling and Operation			CP	MDC	DC	DEP	
5-minute Transaction Scheduling			CP	MDC	FR	DC	DEP
Enhance Run-Limited (WELR) Resource Modeling							CP

Conclusion

A tremendous amount of change is happening in New York's energy system. The plan laid out in this *2023 Market Vision* highlights the breadth of issues that need to be addressed. These issues will require the attention and commitment of market participants, policymakers, and regulators to drive successful outcomes that benefit all involved. We must look for solutions to address policy, reliability, and market needs, as New York's power system is nearing a tipping point. Every option must be on the table.

Our history has proven that the best solutions to our challenges have come from engagement and collaboration. The NYISO looks forward to working together with stakeholders, market participants, and policymakers to move these efforts forward and to support New York's vision of transforming the power system. Thank you.

Appendix – Legend for 5-year Plans

ID	**Issue Discovery**	NYISO has facilitated education session(s) 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.
SD	**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.
SC	**Study Complete**	Scope of work to be performed has been completed; results and recommendations have been presented to the appropriate Business Owners and stakeholders.
CP	**Market Concept Proposed**	NYISO has initiated or furthered discussions with stakeholders that explore potential concepts to address opportunities for market efficiency or administration improvements.
MDC	**Market Design Complete**	NYISO has developed with stakeholders a market design such that the proposal can be presented for a vote at the BIC, OC, or MC to define further action on the proposal.
FR	**Functional Requirements**	NYISO has completed documentation of the functional requirements and the Business Owner has approved.
SDS	**Software Design Specification**	The software design document is complete and software development is ready to begin.
DC	**Development Complete**	Development has been completed, packaged and approved by the Supervisor.
DEP	**Deploy**	Required software changes to support commitment have been integrated into the production environment.