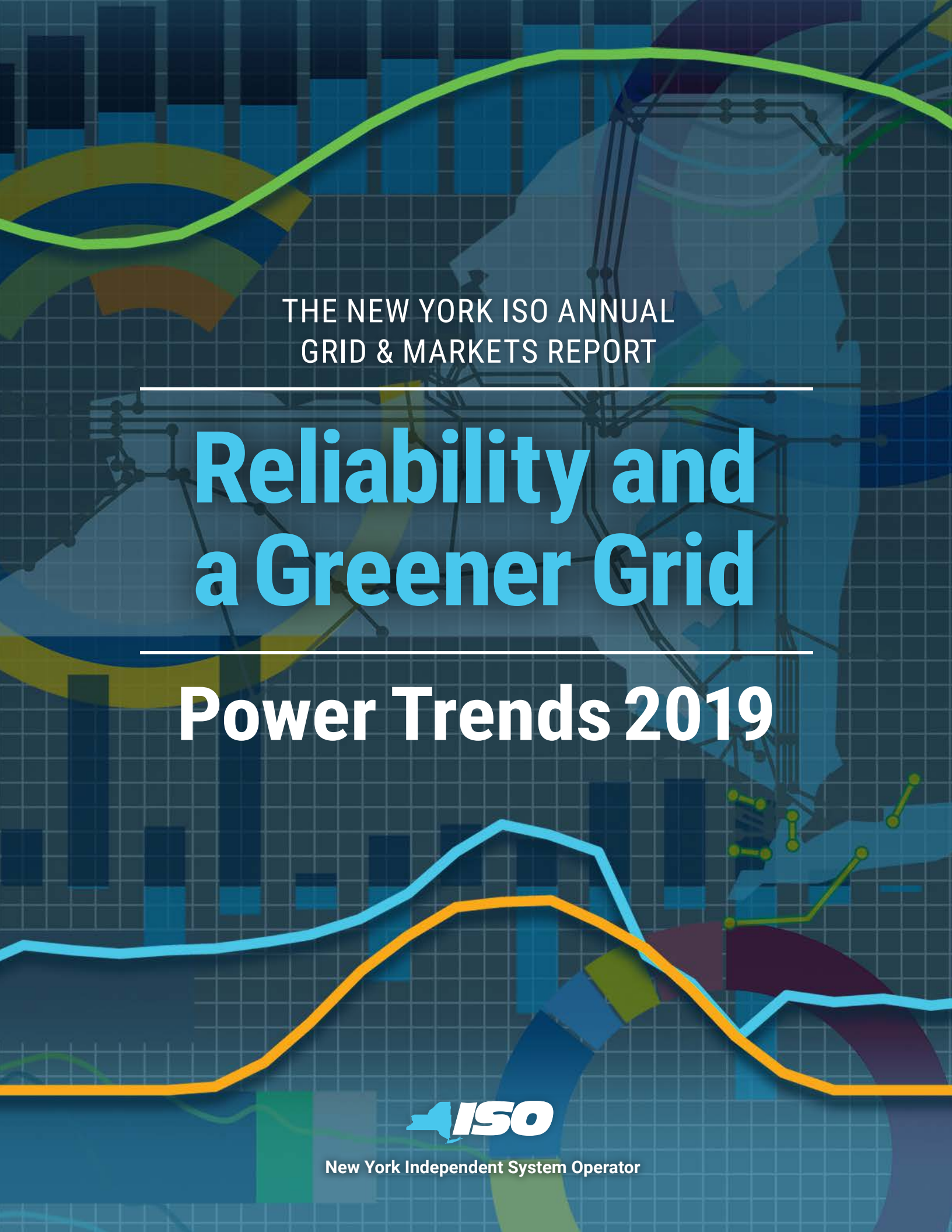
THE NEW YORK ISO ANNUAL
GRID & MARKETS REPORT

Reliability and a Greener Grid

Power Trends 2019



New York Independent System Operator

THE NEW YORK INDEPENDENT SYSTEM OPERATOR (NYISO)
is a 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.

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From the CEO

Welcome to the 2019 edition of *Power Trends*, the New York Independent System Operator's (NYISO) annual state of the grid and markets report. This report provides the facts and analysis necessary to understand the many factors shaping New York's complex electric system.

ROBERT FERNANDEZ

Power Trends is a critical element in fulfilling the NYISO's mission as the authoritative source of information on New York's wholesale electric markets and bulk power system. This report provides relevant data and unbiased analysis that is key to understanding the current electric system and essential when contemplating its future. *Power Trends 2019* will provide policymakers, stakeholders and market participants with the NYISO's perspective on the electric system as public policy initiatives accelerate change.

While competitive markets have historically brought many benefits to the state and consumers, including lower prices and lower emissions, the markets have reached an inflection point. New technologies and ambitious public policy goals are dramatically transforming how energy is produced and consumed. In this context, the NYISO is actively working with market participants and stakeholders to develop forward-thinking solutions to satisfy customers' needs.

Power Trends 2019 focuses on the NYISO's diligent work to develop measures needed to accommodate a grid in transition and effectively manage the electric system's next evolution. *Power Trends* also highlights how New York can integrate new technologies into the grid without compromising reliability.

More specifically, *Power Trends 2019* discusses the challenges and benefits associated with integrating intermittent resources, the important role energy storage can play, and how evolving public policies are changing the diversity of resources available to meet the state's energy needs. This report highlights the innovative operations, planning, and market design initiatives underway at the NYISO to meet the needs of the grid of the future.

Since 1999, the NYISO's competitive wholesale electric markets have provided significant benefits to consumers and the environment. Our commitment to reliability and efficiency shapes our success and informs our work on the changing electric system.

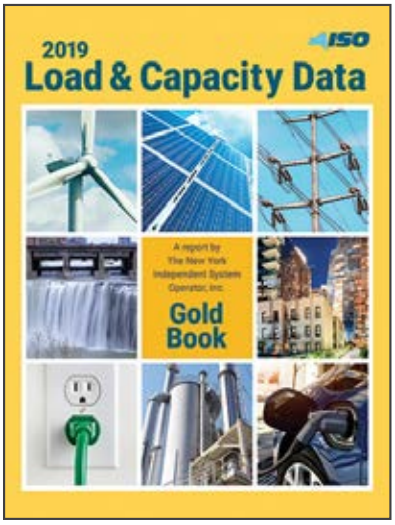
As we enter our 20th year of operation, the NYISO will continue to work with stakeholders, market participants, and policymakers, to support an electric system that is efficient, affordable, clean, and reliable.

Sincerely,

Robert Fernandez

Robert Fernandez

Interim President and CEO



DATA USED IN POWER TRENDS 2019 is from the 2019 Load and Capacity Data Report (also known as the Gold Book), unless otherwise noted.

Published annually by the NYISO, the Gold Book presents New York Control Area system, transmission and generation data and NYISO load forecasts of peak demand, energy requirements, energy efficiency, and emergency demand response; existing and proposed resource capability; and existing and proposed transmission facilities.

The Gold Book and other NYISO publications are available on the NYISO website, visit:

www.nyiso.com

NYISO by the numbers

An Authoritative Source Informing New York's Energy Future

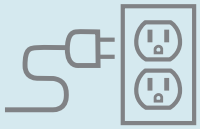
Since 1999, the New York Independent System Operator (NYISO) has provided factual information to policymakers, stakeholders and investors in the power system in support of reliable grid operations and efficient, competitive markets.

19.8M
New Yorkers served

NYISO Footprint

435
Market Participants

11,173
circuit miles of transmission managed and monitored



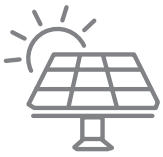
161,114
total electric energy usage, in GWh, for 2018

Supply & Demand

33,956
record peak demand, in MW, July 2013

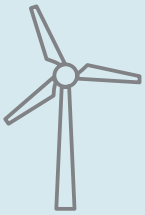
700+
power generating units

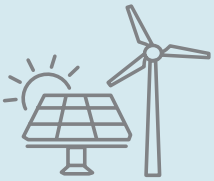
26%
of electric energy from renewables in 2018



Clean Energy

1,985
nameplate capacity for wind energy in 2019





16.9%
power grid's contribution to CO_2 emissions in NYS

56%
energy produced from zero-emitting generation, statewide

Reduced Emissions Rates

Source: U.S. EPA Air Markets Program data since NYISO launched competitive markets

51%
Carbon Dioxide CO_2

89%
Nitrogen Oxide NO_X

98%
Sulfur Dioxide SO_2

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Executive Summary

> **History shows that we achieve better results when flexible innovation pathways are favored over planned, prescriptive outcomes.**
>
> **— Former U.S. Energy Secretary Ernest Moniz** [1]

Overview

The NYISO is the independent organization responsible for operating the power grid in New York, administering wholesale energy markets, and conducting system planning. The creation of the NYISO 20 years ago has resulted in reliability and economic benefits for New Yorkers while contributing to unprecedented environmental gains. As the authoritative source of independent information on bulk power system reliability and markets, the NYISO is well positioned to help policymakers understand the implications of their policies.

Since 1999, the NYISO's markets have worked to improve system efficiency, supporting a gradual shift toward cleaner sources of generation while upholding the nation's most stringent reliability rules.

There is no historical precedent for the ambitious changes on the bulk power system envisioned by policymakers.

Now, 20 years later, the NYISO stands at the cusp of the next evolution of the electric power system. New technologies, such as storage and solar, are beginning to enter the wholesale markets. New wind projects, including off-shore projects, are being proposed. Distributed sources of electric power are being located close to consumers. New environmental standards are causing resources to retire that have been part of the generation fleet for decades.

Accelerating these changes are multiple public policy initiatives that are largely intended to address climate change issues. *Power Trends 2018* discussed the implications of ambitious public policies calling for 50% of the electricity consumed by New Yorkers to come from renewable sources by the year 2030. A year later, however, policymakers seek even more aggressive goals of 70% renewable energy by 2030 and 100% "clean energy sources" by 2040.

Additional policy initiatives have been proposed to expand the integration of new technologies, such as energy storage, while other policies have implications for the continued operation of "peaking" generators that have traditionally served to maintain system reliability in downstate regions at times of high electricity demand.

There is no historical precedent for the ambitious changes on the bulk power system envisioned by policymakers. Complicating achievement of these goals is the fact that these changes must be pursued in the context of a bulk power system that operates to the strictest reliability rules in the nation. The NYISO believes that competitive wholesale electricity markets remain central to facilitating the accelerated changes policymakers have proposed in a way that will support system reliability and economic efficiency.

State of the Grid

Twenty years of operating the bulk power system to the nation's most stringent set of reliability standards have demonstrated that competitive markets are well equipped to maintain electric system reliability while adapting to the uncertainty that emerging technologies can introduce.

Tremendous change is taking place in consumers' adoption of Distributed Energy Resources (DER) to supply a portion of their energy needs. DERs displace energy that was traditionally supplied by the bulk power system, contributing to declining load on the grid, but adding complexity to operations, market design efforts, and system planning needs. This complexity arises because shifting load from the bulk power system to local DERs is not the same as eliminating load. When those resources are not producing energy, the bulk power system must still provide energy to those homes and businesses. As a result, planning for the reliable operation of the power system as a whole must consider total expected consumption of energy, including energy provided by the DERs.

Achieving Public Policy Goals Requires a Reliable Foundation

Where once skeptics of wholesale energy markets expressed concerns that competition might lead to higher prices and dirtier sources of energy, 20 years of experience has proven the opposite to be true. Wholesale energy markets can achieve reasoned public policy objectives responsibly and efficiently. The NYISO intends to adapt to the state's increasingly ambitious environmental goals by leveraging its experience in delivering reliability through markets.

Among other initiatives, the NYISO is developing a proposal with stakeholders and policymakers to incorporate the societal costs associated with carbon dioxide emissions into its energy markets to better reflect the state's policy of reducing emissions. Similar to how competitive markets created incentives for generators to improve efficiency, a social cost of carbon priced in the energy market would create stronger incentives for those types of efficiency improvements, as well as stronger incentives for developing zero-emitting resources like wind and solar in locations where they will have the greatest effect on emissions. This carbon pricing proposal would further promote economic competition among suppliers in the NYISO's markets by directly pricing a key environmental attribute in the markets. The NYISO believes carbon pricing can help the state more efficiently attain its clean energy goals.

Other tools and market products may be necessary to continue sending proper price and investment signals to support bulk power system reliability. In addition to considering carbon pricing, the NYISO plans further enhancements to its markets to establish stronger price signals for resources, such as energy storage, that are capable of ramping up and down quickly in response to variable output from the growing level of wind and solar resources. The NYISO has developed a comprehensive proposal that would allow DERs to participate in NYISO markets and act as supply based on wholesale prices. Further, the NYISO is evaluating how to adapt its planning processes to identify opportunities to more flexibly respond to the increased volume of proposals from smaller resources seeking to interconnect.

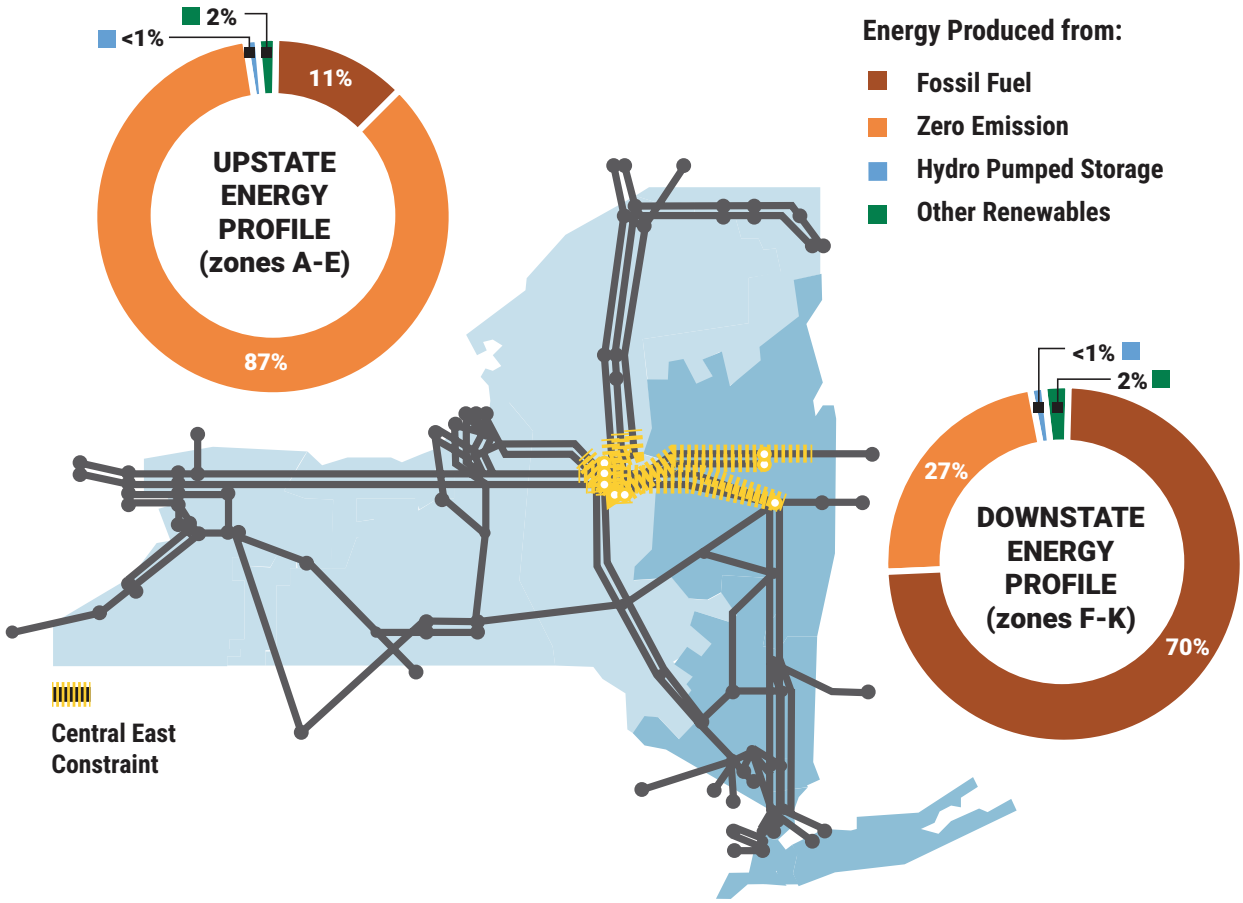
▸ **The New York Independent System Operator (NYISO)** is at the center of this changing landscape. Working with New York State and federal policymakers and over 400 Market Participants, the NYISO serves as an independent organization responsible for operating New York's bulk power system and wholesale energy markets, 24 hours a day, every day of the year.

Making Policy Work

Absent investment to expand the transfer capability of the bulk power system, investment in renewables in upstate load zones runs the risk of bringing diminishing returns in terms of progress toward both renewable energy production and carbon dioxide emissions reduction goals. This is because nearly 90% of the energy produced upstate already is derived from carbon-free resources. Because load in the upstate region is not projected to grow, the addition of new renewable resources increasingly displaces other sources of clean generation instead of allowing more renewable resources to reach customers.

Without market-based incentives for investment in renewable resources and absent a more robust transmission system to move power to load, state policies could promote a resource mix where new renewable resources increasingly displace the output from existing renewable or other zero-emitting resources.

▸ Tale of Two Grids



Furthermore, additional upstate renewable resources will place downward pressure on wholesale energy prices, placing upward pressure on the cost of the state's out-of-market incentive payments. This dynamic not only reduces the effectiveness of competitive markets as a mechanism to provide reliable service, it also jeopardizes the economic viability of resources lacking access to out-of-market revenues. Such resources may include generating capacity necessary for reliability as well as existing renewable resources whose incentive contracts with the New York State Energy Research and Development Authority (NYSERDA) have expired. Such out-of-market incentives drive increasing amounts of revenue away from New York's efficient competitive wholesale markets, shifting economic risks and costs from investors to ratepayers.

Building the Grid of the Future

Future changes to New York's fuel supply mix may challenge the ability of the bulk power system to meet demand under certain stressed system conditions, such as a prolonged cold weather or natural gas supply disruptions. The NYISO expects evolving environmental regulations and renewable energy goals to accelerate the transition from higher-emitting generation to lower-emitting resources, potentially placing the downstate region at increased risk of fuel and energy supply disruptions. The NYISO is performing a study in 2019 to examine fuel and energy security for the New York State bulk power system over the next five years. Depending on the results, the NYISO will develop recommendations for potential operational, capacity market, and/or energy market mechanisms to drive improvements in grid resilience.

In February 2019, the New York State Department of Environmental Conservation (DEC) proposed requirements to reduce emissions of smog-forming pollutants from peaking units. The proposed new rule, which calls for phasing in compliance obligations between 2023 and 2025, could impact approximately 3,300 MW of simple-cycle turbines in New York City and Long Island. The NYISO is actively engaged in the rule-development process and will work to inform policymakers, market participants, and investors of the implications of the rule to bulk and local system reliability. The NYISO has initiated the second phase of its 2018-2019 Reliability Planning Process, the *Comprehensive Reliability Plan* (CRP), which includes a study scenario evaluating the reliability impacts of a potential retirement of all 3,300 MW of peaking units impacted by the DEC's proposal.

▸ DEC Smog Emissions Reduction Proposal:

Requirements to reduce pollutants from peaking units

Expected impact to

3,300 MW

of generating capacity

Conclusion

The transformative mission before the NYISO is to align the critical objectives of reliability and economic efficiency with public policy initiatives. New York State is a national leader in accelerating change and promoting a cleaner grid. As policymakers seek a more rapid and widespread change in how energy is produced and consumed, the NYISO believes its markets and planning processes must continue to serve as a platform to facilitate this transformation. Through engagement with policymakers, regulators, and stakeholders, the NYISO intends to develop innovative market products and planning tools designed to address the needs of the grid of the future.

State of the Grid

Demand Trends & Forecasts

Twenty years of operating the bulk power system to the nation's most stringent set of reliability standards has demonstrated that competitive markets are well equipped to meet the energy needs of New Yorkers. Open access to transmission, competitive wholesale energy markets and investment signals aligned with the reliability needs of the bulk power system have enabled new technologies to compete to serve our energy needs. Emerging trends, however, are reshaping the way the power system as a whole is used.

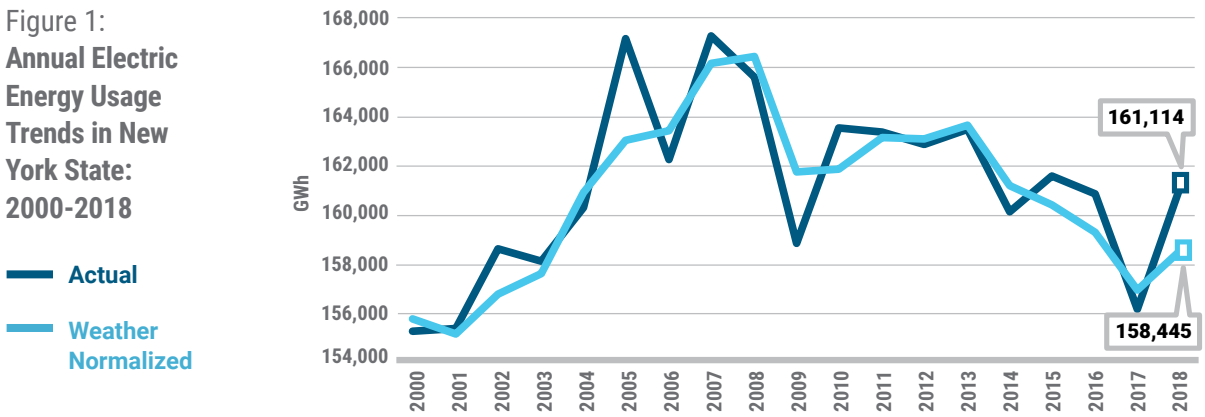
One trend impacting supply and demand is the expansion of distributed sources of energy, such as solar, that are not participating in the wholesale markets. These resources blur traditional lines for how energy is produced and consumed. Another trend shaping supply is the expansion of large-scale renewable energy resources. These emerging trends present challenges and opportunities to the operations and planning of the bulk power system, as well as the market designs needed for the rapidly evolving grid of the future.

Energy Usage Trends & Forecasts

Behind-the-meter Distributed Energy Resources (DERs) displace energy traditionally supplied by the bulk power system, reducing load served by the grid, but adding complexity to system operations, market design efforts, and planning for future needs. This complexity is due to the fact that shifting load from the bulk power system to local DERs is not the same as eliminating load. When DERs are unavailable to produce energy, the bulk power system must still provide energy to the homes and businesses that were relying on them. As a result, planning for the reliable operation of the bulk power system requires consideration of energy provided by the DERs.

As demonstrated in Figure 3, the NYISO forecasts a continued decline in energy use over the next decade. This is largely attributable to the expansion of DERs throughout the state and continued success of state initiatives to promote energy efficiency. The NYISO's forecast for energy use in New York State is consistent with national trends. According to the U.S. Energy Information Administration (EIA), electricity demand growth was nominal in 2018. Through its *Annual Energy Outlook,* the EIA suggests that national demand will slowly increase through 2050, but that this modest growth "would be higher but for significant direct-use generation from rooftop photovoltaic systems primarily on residential and commercial buildings and combined heat and power systems in industrial and some commercial applications."[2]

Figure 1:
Annual Electric Energy Usage Trends in New York State: 2000-2018



Peak Demand Trends & Forecasts

Peak demand is the maximum amount of electrical energy use for a one-hour period during the year. It represents a small fraction of annual overall electrical energy use.[3] However, peak demand is an important metric because it defines the amount of resources, measured by their capacity, that must be available to serve customers' maximum demand for energy to avoid disruptions to service. In New York, system peak load occurs during summer months when air conditioner use adds to demand.

Figure 2: **Annual Electric Energy Usage by Region: 2017-2018**

REGION	2017 GWh	2018 GWh	% CHANGE
New York State (NYCA)	156,370	**161,114**	3.03% ↑
Upstate (zones A-E)	52,938	**55,211**	4.29% ↑
Downstate (zones F-I)	30,351	**31,218**	2.86% ↑
New York City (zone J)	52,266	**53,360**	2.09% ↑
Long Island (zone K)	20,815	**21,326**	2.46% ↑

Reliability standards, such as installed capacity requirements, are based on projected system peak demand. These reserve requirements determine the total amount of power capacity that must be available to reliably meet the maximum hourly energy needs.

New York's all-time record peak demand of 33,956 MW was reached in July 2013 at the end of a week-long heat wave.

Figure 3:
Electric Energy Usage Trends and Forecast in New York State: 2018-2029

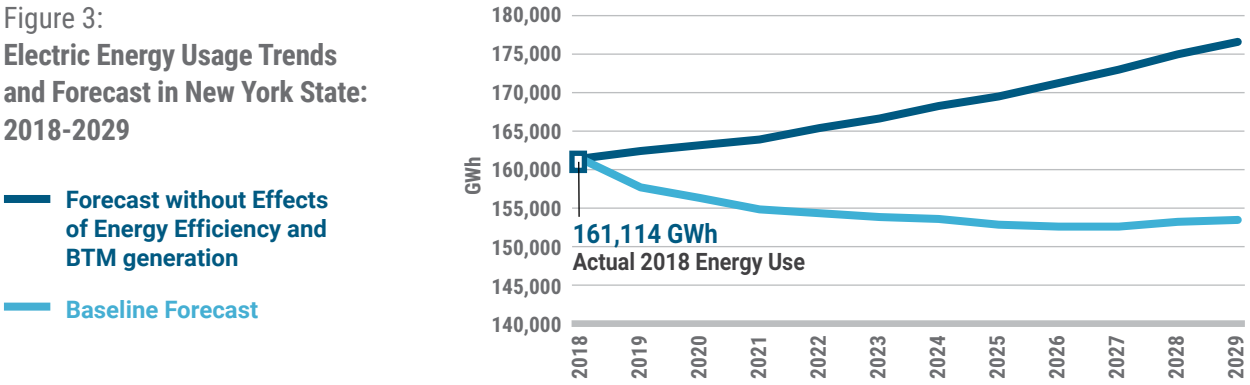
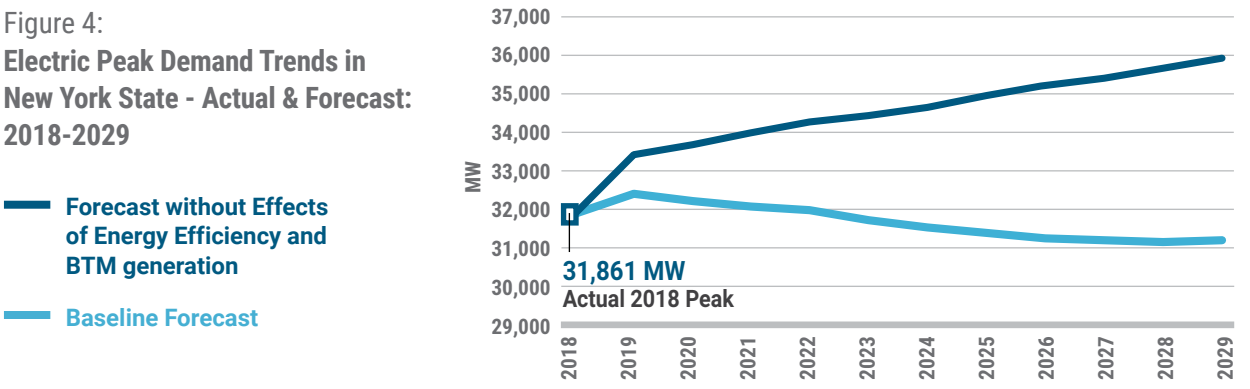


Figure 4:
Electric Peak Demand Trends in New York State - Actual & Forecast: 2018-2029

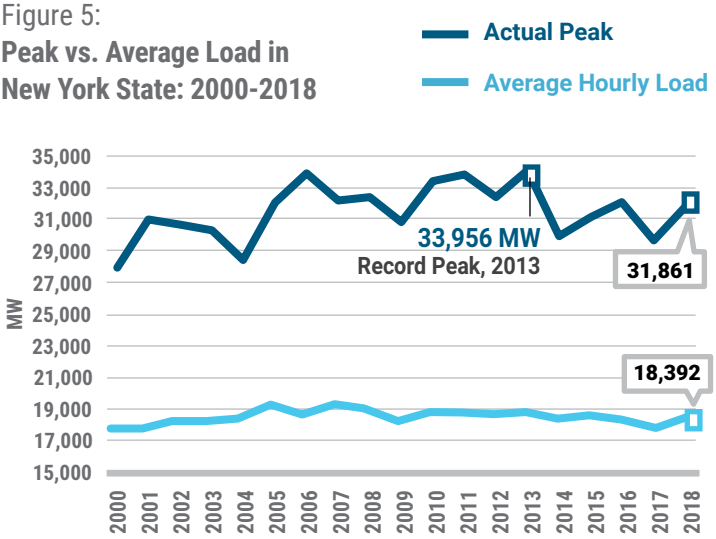


Energy Efficiency & Distributed Energy Resources

Energy efficiency programs, distributed solar, and other behind-the-meter DERs — such as small generators — are reducing peak demand and moderating the growth of energy supplied by the bulk power system by displacing energy production from existing large-scale generation resources.

Energy efficiency is improving with new building codes and appliance standards, along with the proliferation of government, utility, and community programs and policies that encourage usage of energy efficient products. These efficiency gains are expected to reduce peak demand on New York's bulk power system by 4,858 MW in 2029. The NYISO projects an accompanying decrease in energy usage served by the bulk power systems over the same timeframe; culminating in 22,868 fewer GWh by 2029.

Figure 5:
Peak vs. Average Load in New York State: 2000-2018

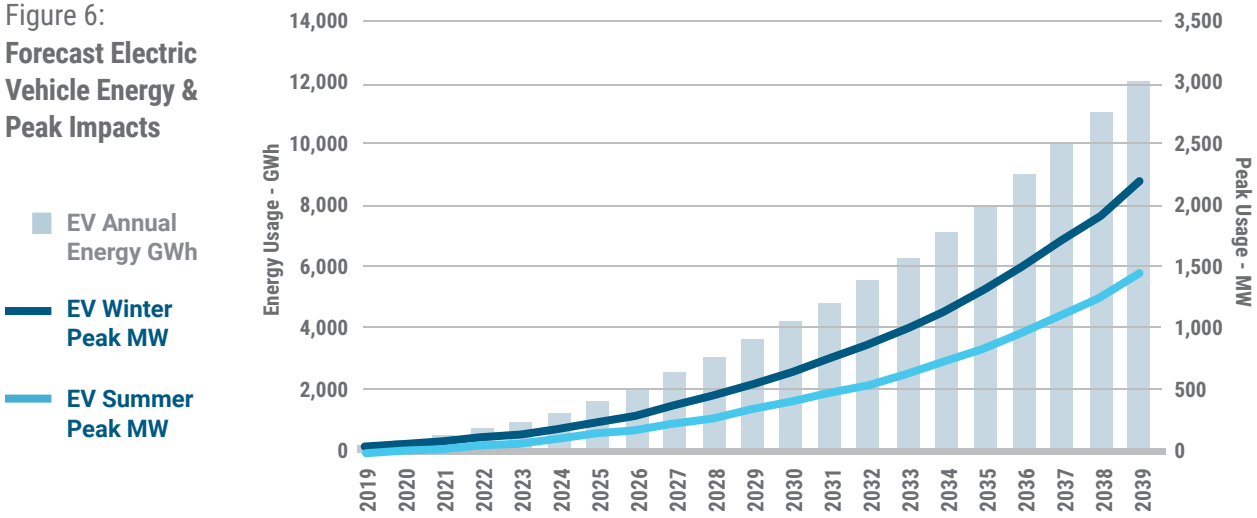


Similarly, the NYISO projects that the addition of behind-the-meter solar resources will reduce peak demand on the bulk power system. Those new resources will also contribute to the lowering of annual energy usage served by the bulk power system. The NYISO anticipates that the contribution of solar toward system peak will be less than the total capability of the resource, due to the reduction in available sunlight late in the afternoon when system peak typically occurs.

Other behind-the-meter resources, such as fuel cells and combined heat and power systems, will also reduce both peak demand and energy usage by the bulk power system.

It is important to note that these forecasts include the additional usage and demand impacts of increased adoption of electric vehicles (EVs). Based on the NYISO's analysis of expected EV adoption

Figure 6:
Forecast Electric Vehicle Energy & Peak Impacts

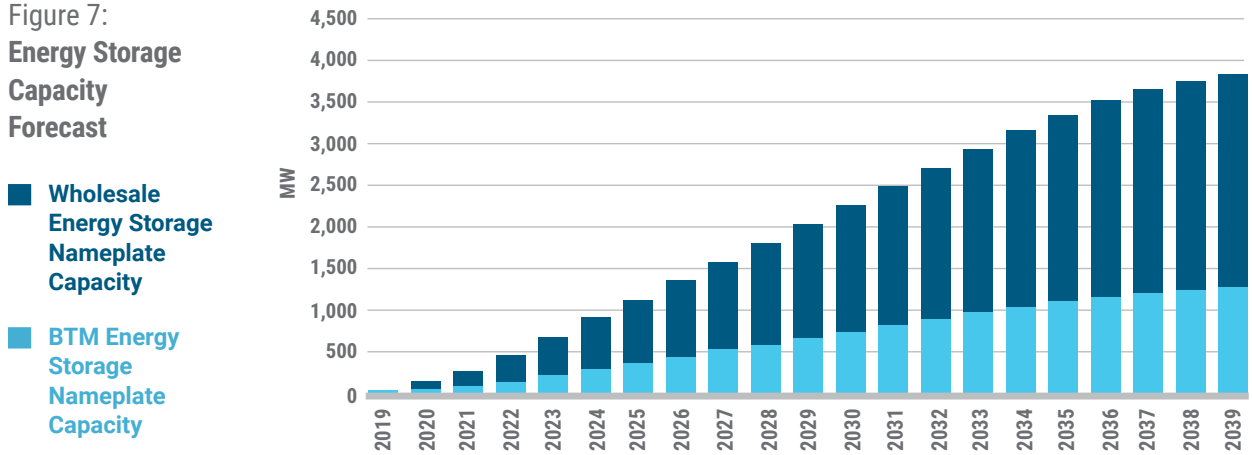


rates, the emerging transportation technology is expected to increase annual energy use on the grid by 4.2 million MWh by 2030, or the equivalent energy consumption of approximately 587,000 homes. Demand associated with EVs is forecast to contribute 410 MW to the bulk power system's summer peak in that year.

EVs' contribution to winter peak is expected to be greater as the winter system peak typically occurs later in the day when drivers are expected to return home and begin recharging vehicles. An added element impacting winter demand forecasts is that battery performance in colder conditions is inherently less efficient than in warmer weather. Absent incentives to charge electric vehicles off peak, the NYISO forecasts that EVs will add 650 MW to winter peak by 2030.

With respect to battery storage, which will slightly increase load due to inefficiencies associated with converting and storing electricity. The NYISO projects growth in grid-connected storage resources that will participate in wholesale markets as competitive suppliers. The NYISO also projects growth in behind-the-meter storage deployments that will serve to reduce peak demand as customers use the technology to better manage their energy use in response to market signals and system conditions.

Figure 7:
Energy Storage Capacity Forecast

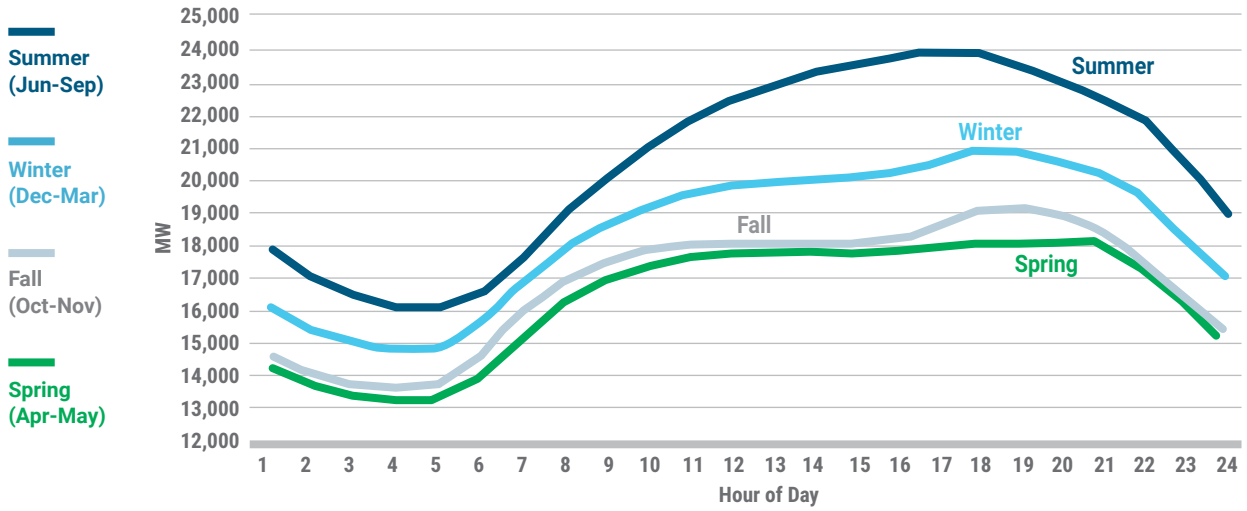


Daily & Seasonal Demand Patterns

The demand for electricity fluctuates throughout the day and varies by season. Hourly demand for electricity is influenced by the time of day and weather. Seasonal variations in demand patterns are also largely weather-related. **It is worth noting that, as the level of renewable energy generation grows, more and more of the electricity supply will be influenced by weather conditions.** Wind and solar generation vary with the level of wind and sunshine across New York. Ultimately, enhanced transmission capabilities and expanded energy storage are expected to offer bulk power system operators added tools to balance simultaneous variations in supply and demand. However, the increased influence of weather on both supply and demand will add complexity to bulk power system operations.

In New York, peak demand occurs during the summer when heat waves prompt greater use of air conditioning (see Figure 8). For example, the highest recorded peak demand in New York, 33,956 MW, occurred in July 2013. In comparison, New York's record winter peak demand, recorded in January 2014, totaled 25,738 MW.

Figure 8: **Seasonal Hourly Demand Patterns: 2018**



Resource Trends

Power Generation Trends

Since 2000, private power producers and public power authorities have added 12,949 MW of new generating capacity in New York State, including new power plants, upgrades to existing power plants, and power plants returning to service following a deactivation. This additional generation represents more than 30% of New York's current generation.

80%

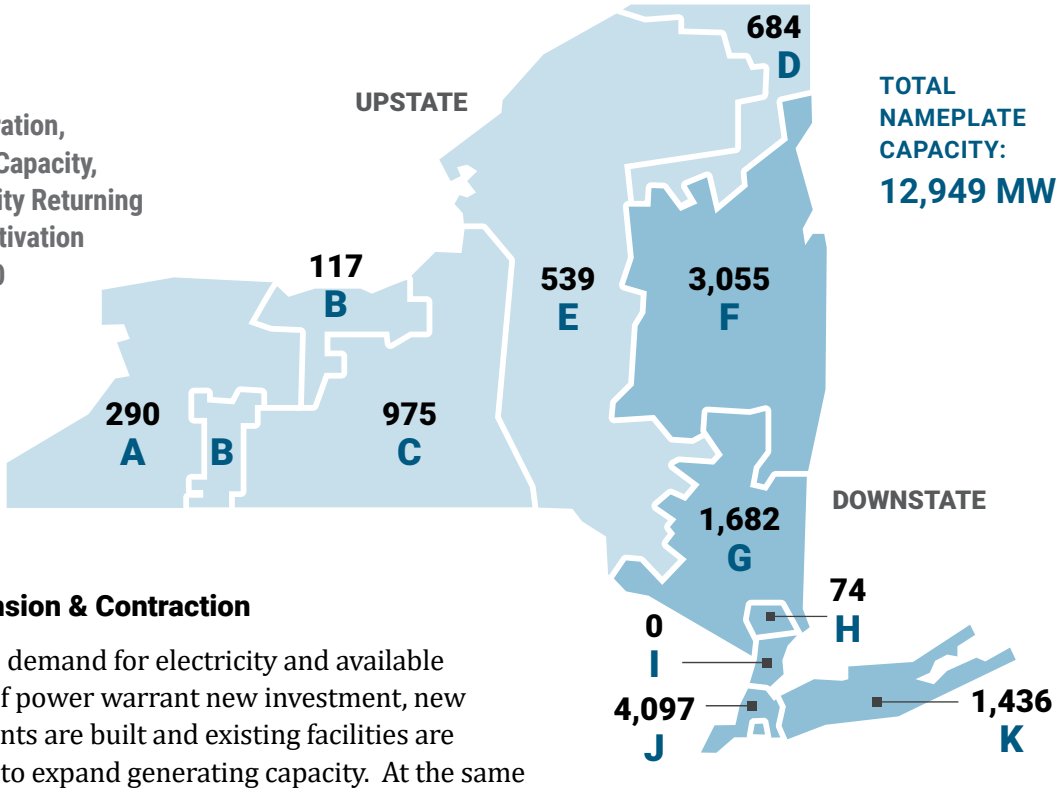
of new generation has been developed in southern and eastern New York (NYISO zones F-K), where demand is greatest.

Nearly 80% of that new generation has been developed in southern and eastern New York (NYISO zones F-K), where power demand is greatest. New York's wholesale electricity market design, which includes locational based pricing and regional capacity requirements, encourages investment in areas where it is most needed.

Additions to New York's power-producing resources in upstate regions resulted from either upgrades to existing power plants or the interconnection of new renewable resources sited in upstate regions based on physical factors such as the suitability of wind conditions for energy production.

A growing amount of New York's gas-turbine and fossil fuel-fired steam-turbine generation capacity is reaching an age at which, nationally, a majority of similar capacity has been deactivated. In 2019, 1,166 MW of steam-turbine generating capacity in New York State is 62 years old or older — an age at which, nationally, 95% of such capacity has ceased operations. For gas turbines, 2,331 MW of generating capacity in New York State is 47 years old or older. Nationally, 95% of generating capacity using this technology has deactivated by this age. By 2029, more than 8,370 MW of gas-turbine and steam-turbine generating capacity in New York could reach an age at which nationally 95% of these types of generation capacity have deactivated. **While there have been significant additions to New York's generating capacity since 2000, power plants age like all physical infrastructure. The need to maintain, upgrade, or replace aging generation infrastructure requires renewed attention.**

Figure 9:
New Generation, Upgraded Capacity, and Capacity Returning From Deactivation Since 2000



Expansion & Contraction

As the demand for electricity and available supplies of power warrant new investment, new power plants are built and existing facilities are upgraded to expand generating capacity. At the same time, existing power plants may elect to deactivate in response to economic circumstances, physical plant conditions, or regulatory requirements.

According to the EIA, more than 31,000 MW of generating capacity was added nationwide in 2018, more than 60% of which was fueled by natural gas.[4] The additions offset the retirement of nearly 19,000 MW of generating capacity, 94% of which was powered by fossil fuels, primarily coal. In fact, the EIA notes that between 2007 and 2018, 55,000 MW of coal-fired generating capacity in the United States was retired. The EIA expected another 4,000 MW of coal-fired generating capacity to retire in 2019. For perspective, 313,000 MW of coal-fired generating capacity existed nationally in 2007.[5]

Since 2000, 11,335 MW of capacity from new generating units and unit upgrades have been added to New York's electric system while 7,343 MW have retired or suspended operation. The pattern of expansion and contraction has ranged from the net addition of more than 2,000 MW between 2005-2006 to a net reduction of more than 1,100 MW between 2012-2013.[6]

Figure 10:
Gas- and Steam-Turbine Capacity Nearing Retirement

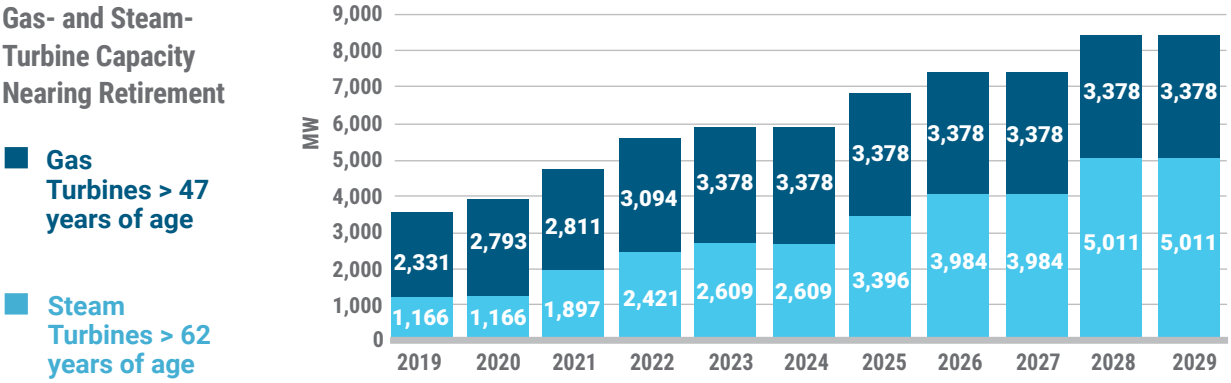
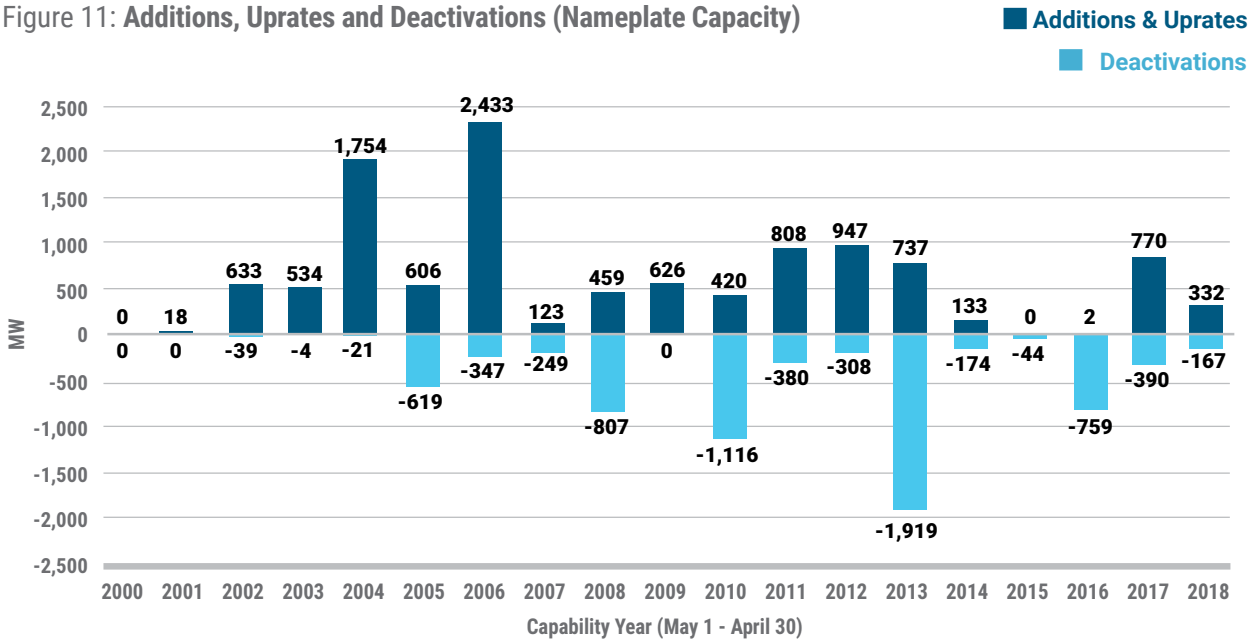


Figure 11: **Additions, Uprates and Deactivations (Nameplate Capacity)**



Generation additions were primarily natural gas-fueled or wind-powered. Since 2000, nearly 3,000 MW of generation fueled by coal have retired or suspended operation.

The pattern of expansion and contraction has continued in recent years. **Price signals from the NYISO's markets have encouraged more efficient resources to enter the market, while at the same time signaling less efficient generation to exit the market.** These locational signals inform investors when to add generation, and where to invest in new resources on the bulk power system to most efficiently serve consumer needs. In parallel, state and federal policies are promoting investment in new clean energy generation.

New York's Regional Transmission

New York's bulk power system moves electricity over 11,173 circuit-miles of high-voltage transmission lines to meet the needs of energy consumers, from the remote and sparsely populated regions of the Adirondacks to the densely packed heart of Manhattan.[7] Over 80% of the transmission system entered into service before 1980.

80%

of NYS transmission entered into service before 1980.

The power demands of the downstate region have attracted the development of various transmission projects, primarily to serve southeastern New York, including New York City and Long Island. More than 2,700 MW of transmission capability have been added to serve New York's electric system since 2000.

Further upgrades and enhancements of New York's transmission infrastructure are being planned in response to New York State public policy-related transmission expansion needs. In 2017, the NYISO evaluated

competing projects and selected NextEra's proposal, which is currently going through the permitting process for siting administered by the New York State Public Service Commission (PSC). Known as the Empire State Line, this project is consistent with New York State's Western New York public policy objectives, which include:

- Adding new transmission capability between Buffalo and Rochester
- Addressing bulk power system constraints that limit output of the Niagara hydroelectric facility and imports from Ontario

In April 2019, the NYISO selected proposals to address the PSC's AC Transmission Public Policy initiative, which aims to expand transmission capability within existing rights of way in the Central New York and Hudson Valley transmission corridors. The NYISO selected a proposal from the New York Power Authority (NYPA) and North America Transmission to expand transmission capabilities between centeral and eastern New York. At the same time, the NYISO selected proposals from the Albany region through the Hudson Valley region. Combined, the upgrades are expected to deliver more than 1,000 MW of additional power from upstate generators to downstate consumers.

Figure 12:
New Transmission in New York State: 2000-2018

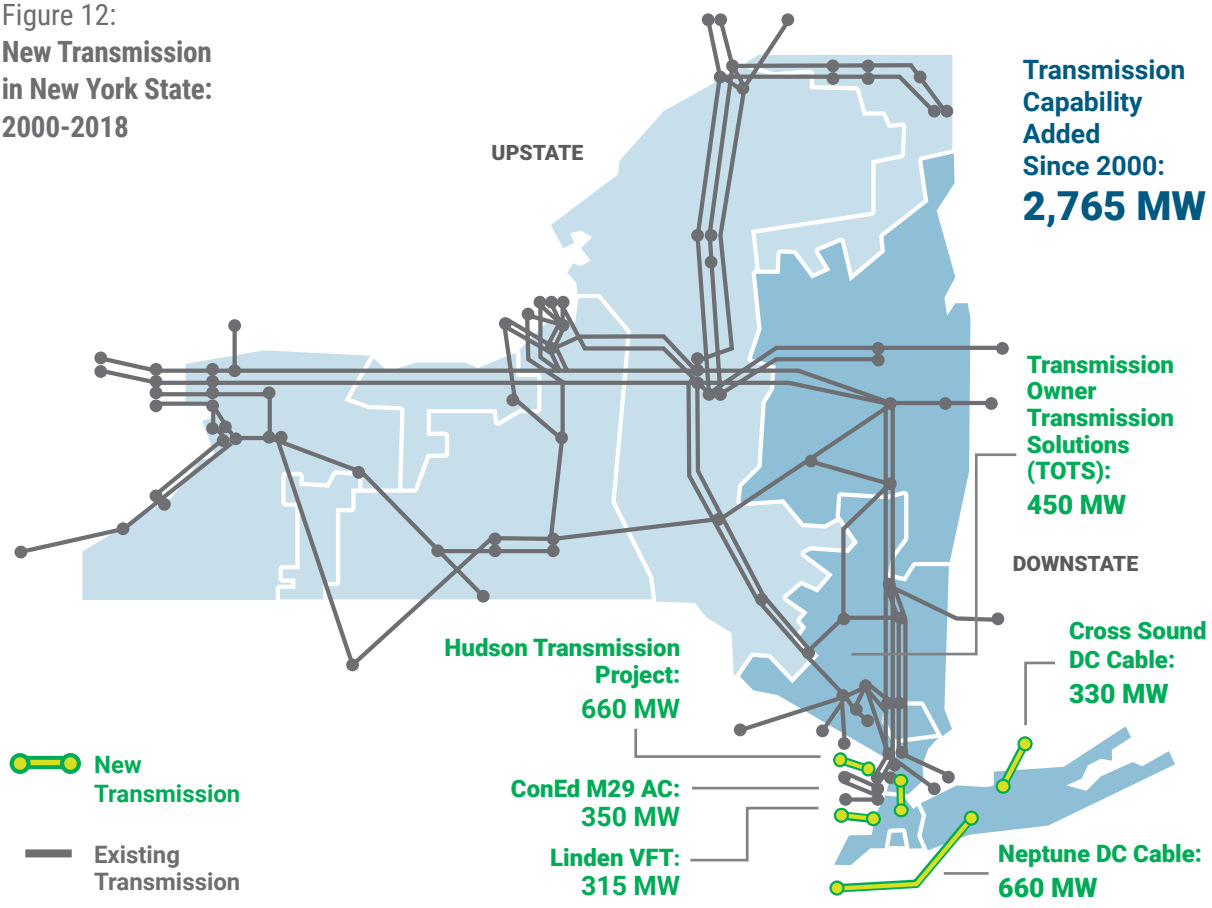
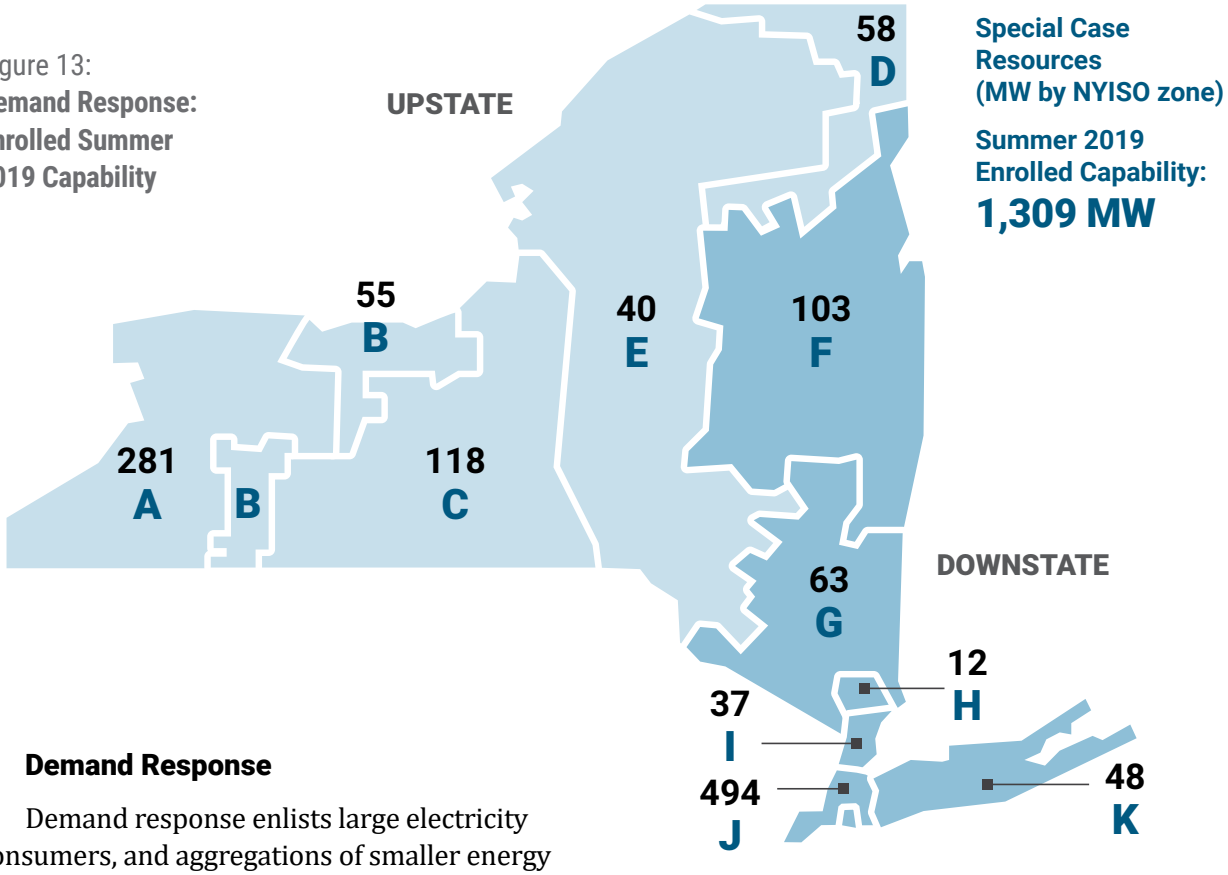


Figure 13:
Demand Response: Enrolled Summer 2019 Capability



Demand Response

Demand response enlists large electricity consumers, and aggregations of smaller energy users, to reduce consumption from the bulk power system during periods of peak demand or in response to price signals. Demand response providers continue to adapt as technology enables increasingly sophisticated management of power consumption. [8]

Prior to the establishment of wholesale electricity markets, the electric system addressed growth in peak demand with comparable increases in generating capacity. Demand response programs have provided a conservation-orientated alternative to new generation resources by incentivizing and coordinating consumers to reduce their use of electricity from the bulk power system.

According to the Federal Energy Regulatory Commission (FERC), demand response resources in the nation's seven ISO/RTO regions totaled 27,541 MW in 2017, representing 5.6% of peak demand — up from 5.3% of peak demand in 2016. [9]

▸ Special Case Resources:
A demand response program that helps to maintain reliability by calling on electricty users to reduce consumption during times of shortage conditions.

Large power customers and aggregated groups of smaller consumers participate in several demand response programs developed in the NYISO markets. [10] In summer 2018, the programs provided a total of 1,315 MW of load reduction capacity — representing 4.1% of the 2018 summer peak demand.

For the summer of 2019, the NYISO's largest demand response program, Special Case Resources, is projected to be capable of providing up to 1,309 MW of demand reduction. Additionally, the Emergency Demand Response Program is expected to be able to provide 5 MW of demand reduction.

Resource Outlook

Reliability Assessment

The NYISO conducts comprehensive system planning to maintain the long-term reliability of New York's bulk power system. Every two years, the NYISO's Reliability Planning Process (RPP) examines the reliability of the state's bulk power system over a 10-year planning horizon. The NYISO identifies reliability needs by applying mandatory and enforceable rules established by international, national, regional and New York State-specific reliability standards organizations. The standards examine two key aspects of reliability:

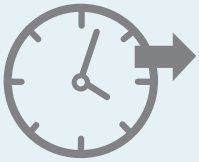
- Analysis of whether the system has enough resources to reliably serve the forecasted demand if some resources or facilities are unavailable
- Evaluation of the electric grid's ability to operate reliably over a broad spectrum of system conditions and following a wide range of probable system events

The NYISO's planning processes strive to achieve market-based solutions to identified needs whenever possible. This allows developers and investors to respond to the needs and price signals in the NYISO's markets and to assume the risks of such investments.

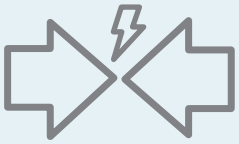
Reliability planning is the key to maintaining the integrity of the electric grid. The NYISO regularly performs an evaluation through its *Reliability Needs Assessment* (RNA). If the assessment finds emerging needs, the NYISO solicits market solutions. Regulated solutions are also solicited as a backstop, in the event they are needed to maintain bulk power system reliability. Then, a *Comprehensive Reliability Plan* (CRP) details the solutions proposed for meeting any needs identified through the process. If a regulated backstop solution is required to meet reliability needs, the NYISO selects the more efficient or cost-effective solution. The NYISO's tariffs provide that, following regulatory approval, the costs of a transmission project can be allocated to, and recovered from, those customers benefitting from the upgrade.

Every 5 minutes 24/7, 365

electricity in NY is bought and sold through wholesale energy markets.



Energy Markets: Provide day-ahead and real-time commitments to meet load.



Ancillary Services: Every six seconds resources compete to respond to changing system needs.

Capacity Markets: Ensure enough generation to meet peak demand and encourage generators to invest in new technology and deactivate outdated resources.

▸ New York's Installed Reserve Margin (IRM):
The not-for-profit New York State Reliability Council develops and monitors compliance with reliability rules specifically established for New York State's electric system. Those rules include an Installed Reserve Margin, established annually with approval from the Federal Energy Regulatory Commission (FERC) and the New York State Public Service Commission (PSC).

17%

the approved Installed Reserve Margin for the 2019-2020 Capability Year that began on May 1.

5,505 MW

of reserve capacity resources is needed to meet the projected demand of 32,382 MW.

42,056 MW

the total resource capability available to serve New York state for summer 2019.

The NYISO recently finalized the *2018 RNA*, which identified no reliability needs over the 2019-2028 planning horizon. Consistent with past practice, the *2018 RNA* also assessed the impacts of possible scenarios (i.e., higher load forecast and additional generation removal) that identified possible reliability risks. While the NYISO does not solicit solutions to needs identified in these types of scenario analyses, the goal of these analyses is to inform policymakers and investors about potential longer-range uncertainties that could impact the bulk power system. Numerous risk factors exist that might introduce reliability concerns, including:

- Changes in the availability of generating capacity
- Deactivations of existing generating capacity
- Delays in expected generator or transmission additions
- Higher than expected load levels

The NYISO continuously monitors the bulk power system to determine whether these risk factors could give rise to a reliability need between planning cycles. One specific risk factor the NYISO is examining with its stakeholders in the development of the next CRP is to evaluate potential conditions related to the New York State Department of Environmental Conservation's "peaker rule," which is discussed in detail later in this report.

Extending Plant Operations for Reliability

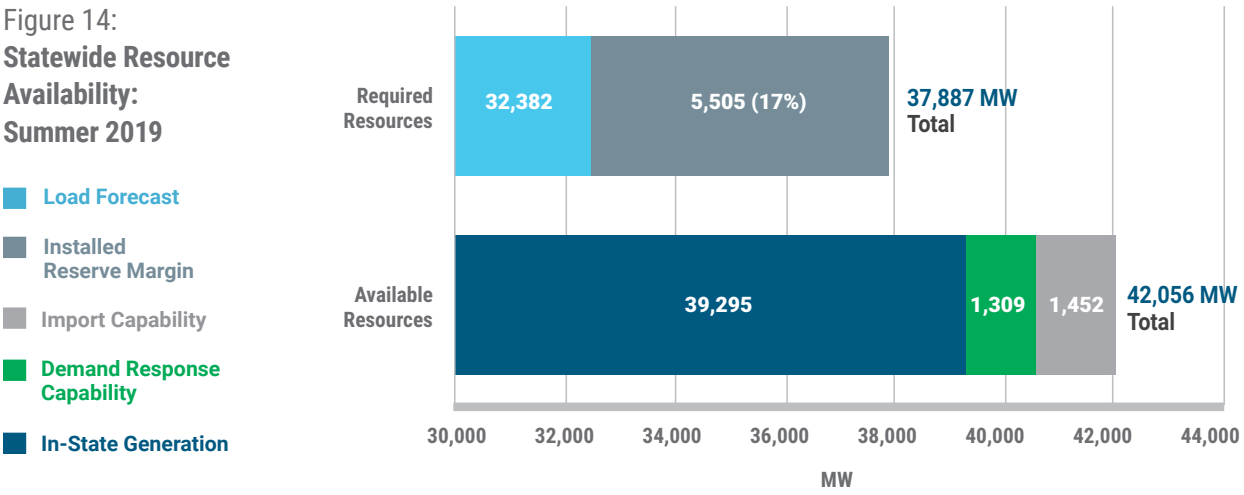
In addition to its regular reliability planning processes, the NYISO conducts a facility-specific generator deactivation assessment to address any reliability needs that could result from a generator deactivation, which includes the retirement or mothballing of a generator.

Pursuant to this process, upon receipt of a completed deactivation notice, the NYISO assesses whether the proposed deactivation could result in a reliability need (transmission security or resource adequacy) over a five-year planning horizon. If a reliability need is identified, the NYISO solicits for solutions, which could include replacement supply, transmission facility upgrades, or transmission additions. As a last resort, NYISO may enter into an agreement with the deactivating generator to retain its services temporarily until a longer-term solution to the reliability need can be implemented.

2019 Reliability Outlook

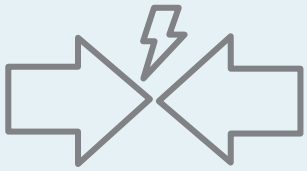
Each year, the New York State Reliability Council (NYSRC) establishes an Installed Reserve Margin (IRM) identifying the capacity that must be available, above the amount necessary to supply forecasted peak demand. This reserve requirement is necessary to address risks to operating the bulk power system reliably when supply resources or transmission lines could suddenly become unavailable. Resources eligible to satisfy this requirement may include generation, demand response, or imported resources from other regions. For the 2018-19 Capability Year (May 1, 2018 – April 30, 2019) the IRM was set at 18.2%, meaning the system needed 5,989 MW of reserve capacity resources above the projected peak demand of 32,904 MW.

Figure 14:
Statewide Resource Availability: Summer 2019



For the current Capability Year (May 1, 2019 – April 30, 2020), the NYSRC decreased the IRM to 17%, necessitating that 5,505 MW of reserve resources be available in addition to the capacity needed to meet a projected peak demand of 32,382 MW. While the NYSRC considered a number of factors that drove the decision to decrease the IRM, including reduced load forecasts and an improvement in generation fleet availability, it also pointed out factors that are placing upward pressure on the IRM. Chief among these factors is the increased wind energy capacity on the system. According to the NYSRC, the "relatively high IRM impact (associated with wind capacity) is a direct result of the relatively low capacity factor of wind facilities during the summer peak period." **As intermittent resources like wind and solar expand across the bulk power system, the IRM percentage will need to increase because intermittent resources do not contribute an equivalent amount of capacity to reliably meet peak demand as dispatchable resources.** Policymakers will need to be cognizant that the intermittency of renewable resources requires that flexible and controllable capacity be available to meet load in the absence of sufficient renewable energy production.

For the summer of 2019, the total resource capability available to serve New York State is 42,056 MW. These resources include the installed generating capacity of in-state power projects, imports available to the system, and projected levels of demand response participation.



▸ Capacity and Energy

There are differences between a generator's ability to produce power (capacity) and the amount of electricity it actually produces (energy).

Capacity: is the maximum electric output that a generator can produce. It is measured in MW.

Energy: is the amount of electricity a generator produces over a specific period of time. It is measured in megawatt-hours (MWh). (A generating unit with a 1 MW capacity operating at full capacity for one hour will produce 1 MWh of electricity.)

Capacity Factor: measures actual generation as a percentage of potential maximum generation. (A generator with a 1 MW capacity operating at full capacity for full year, or 8,760 hours, would produce 8,760 MWh of electricity and have an annual capacity factor of 100%.)

Generators: do not operate at their full capacity all the time. A unit's output may vary according to weather, operating conditions, fuel costs, market prices, and/or scheduling instructions from the grid operator. The ability of generators to operate at full capacity also varies by the type of facility, the fuel used to produce power, and the unit's technology.

The total resource capability in 2019 is about 783 MW less than last year's level. Available resources remain well above the projected peak demand of 32,382 MW, plus the reserve requirement — a combined total of 37,887 MW.

This estimate of total resources measures the maximum capability of available resources. However, outages of generating and transmission facilities, or lower-than-expected participation in demand response can reduce the availability of resources. Similarly, the forecasted peak represents a baseline estimate. Extreme weather could drive the peak demand to more than 34,000 MW in 2019.

In meeting the IRM's statewide resource adequacy obligation, the capacity market also must procure sufficient local capacity resources for three separate downstate regions (zones G-J in the lower Hudson Valley, New York City, and Long Island) where transmission constraints limit power flows into these regions. To address these constraints, Locational Capacity Requirements (LCRs) are analyzed and established annually for each region. These LCRs set the minimum amount of capacity that must be procured within the region to reliably serve load. The LCRs also serve to bolster system resiliency by seeking to provide an appropriate distribution of available resources to meet forecasted demand and expected system conditions.

In June 2018, after significant collaboration with stakeholders and approval by the NYISO's shared governance process, the NYISO submitted proposed tariff changes to FERC to implement a new method for determining LCRs. This alternative methodology determines LCRs for each of the regions in a way that minimizes the total statewide cost of capacity while continuing to meet reliability requirements. In October 2018, FERC accepted the NYISO's tariff filing and new methodology, which was implemented for the 2019-20 capability year. Beginning May 1, 2019, the LCR for New York City (zone J) is 82.8%; for Long Island (zone K), 104.1%; and, for the lower Hudson Valley region (zones G-J), 92.3%.

Resource Diversity & Fuel Mix

Fuel mix affects both the reliability of the electric system and the price of power. A balanced array of resources enables the electric system to better address issues such as price volatility, fuel availability, and requirements of public policy.

Market factors, including fuel costs, operation and maintenance; as well as capital investment considerations such as the costs of siting, permitting, and construction, have significant influence on the mix of generation technologies and fuels used to produce power. For example, the current price advantage of natural gas is driving significant development of gas-fired generation throughout the nation, and placing economic pressure on resource types that use less economic fuels or have higher production costs.

From a statewide perspective, New York has a relatively diverse mix of generation resources. However, New York's bulk power system is characterized by stark regional differences whereby the downstate supply mix is less diverse than the upstate supply mix. Several factors have resulted in the power demands of New York City and Long Island being served with local generation primarily fueled by natural gas. These include more stringent air quality regulations, transmission constraints into and within these areas, and reliability standards that establish local generation requirements in the downstate region. However, many of these are dual-fuel power plants capable of using oil when necessary — which provides fuel diversity, economic, and reliability benefits to the system.

In addition to looking at capacity it is important to consider the actual amount of energy generated by those power plants.

For example, power plants that run on:

▸ Fossil Fuels

67%

of New York's generating capacity, 41% of its production.

▸ Nuclear

14%

of New York's generating capacity, 32% of its production.

▸ Hydropower

11%

of New York's generating capacity, 21% of its production.

New York's fleet of fossil fuel-fired power plants includes older facilities with higher operating expenses or fuel costs, which are typically selected to run only during periods of higher demand or when market clearing prices are higher. While these facilities add to overall capacity totals, they contribute proportionally less to the annual amounts of electric energy produced in New York.

Renewable resources, such as hydro, wind, and solar energy have no fuel costs, making them more competitive in the NYISO energy market's scheduling process than older and potentially less efficient fossil generators. However, the fuel supplies of these renewable resources are variable due to changing weather conditions. The intermittency of renewable resource operation influences the availability of their output, measured by a metric called "capacity factor." A capacity factor is a comparison of how much electricity a generator produces, on average, relative to the maximum output it could produce at continuous, full-power operation.

Generators with comparatively low fuel and operating costs are usually selected in wholesale electricity markets to consistently supply power. Lower capacity factors indicate that a generator operates less frequently, such as during peak demand periods, or that its operation depends on the intermittent availability of its fuel supply, such as hydro, solar, and wind energy.

Figure 15: Generating Capacity in New York State by Fuel Source — Statewide, Upstate New York and Downstate New York: 2019

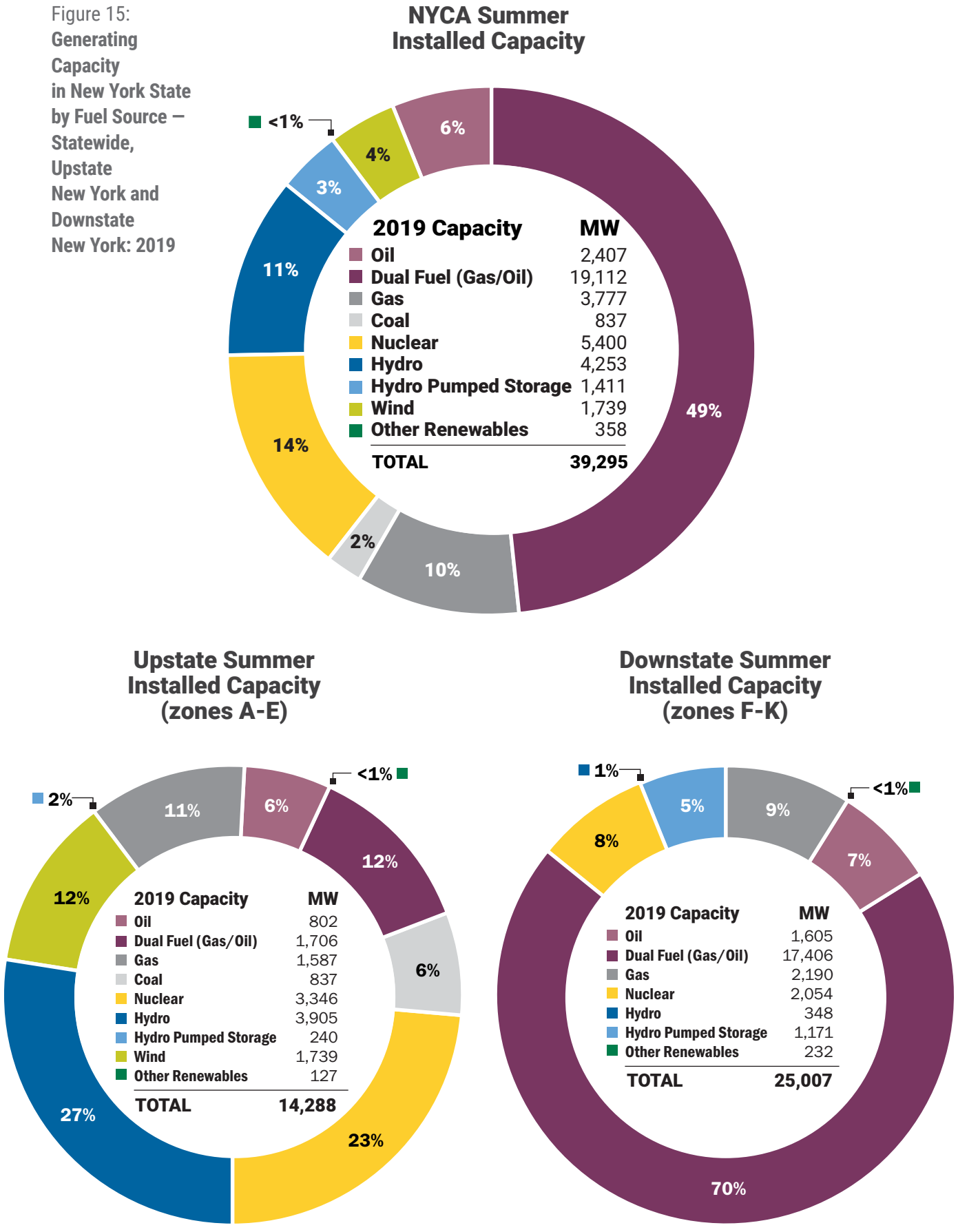
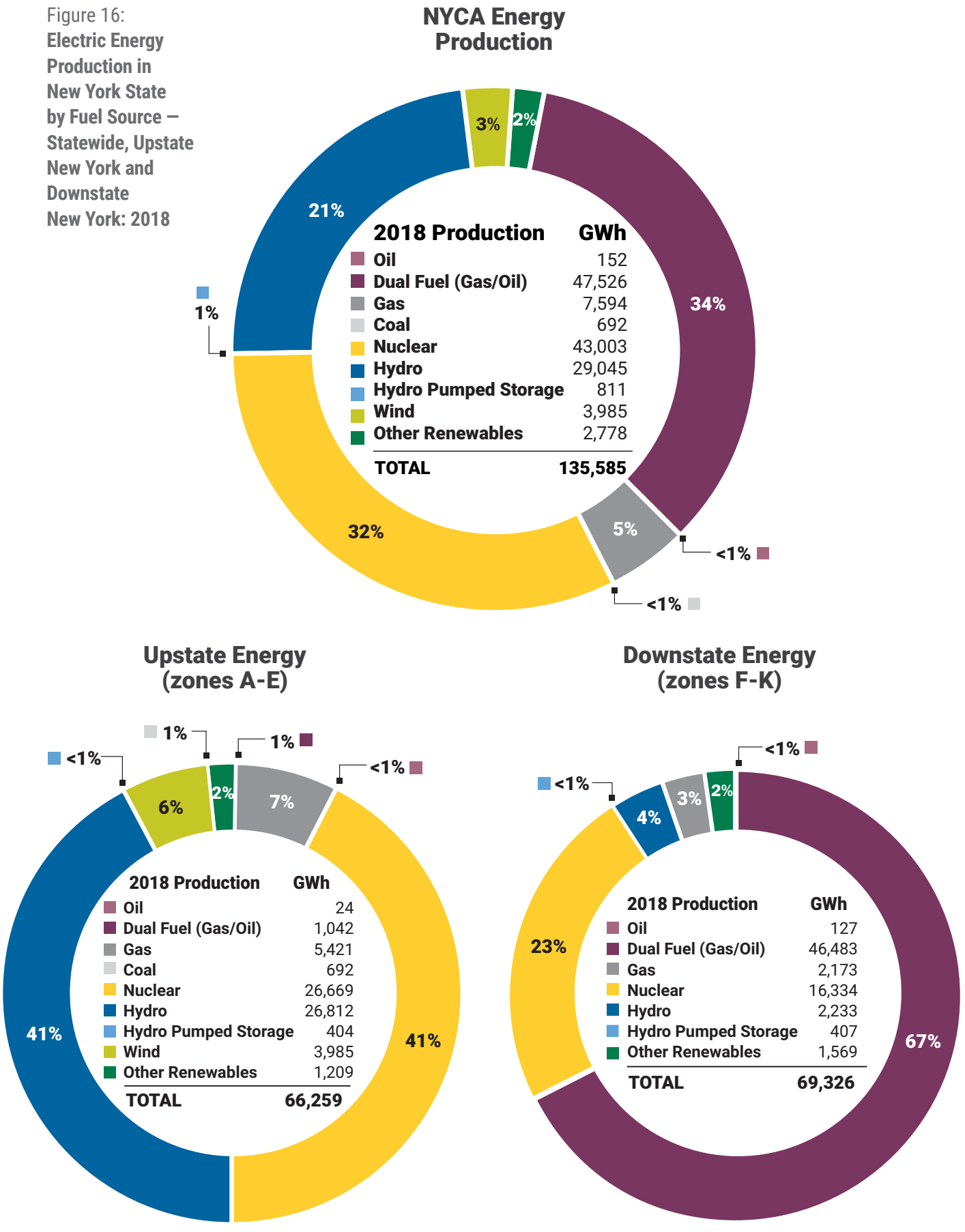


Figure 16:
Electric Energy Production in New York State by Fuel Source — Statewide, Upstate New York and Downstate New York: 2018



The relative capacity factors of different types of generation are important considerations in planning the future fuel mix. For example, based on 2018 operating performance, **it would require 3 MW of wind capacity to produce the same amount of energy as 1 MW of hydro capacity over the course of a year.** The intermittent nature of these resources is challenging as they cannot respond to calls for additional energy in the same manner that more conventional supply resources can. As a result, even if sufficient intermittent renewable capacity is developed to produce the equivalent amount of energy as high-capacity resources such as hydro or nuclear units, that energy may not be available when it is needed by consumers.

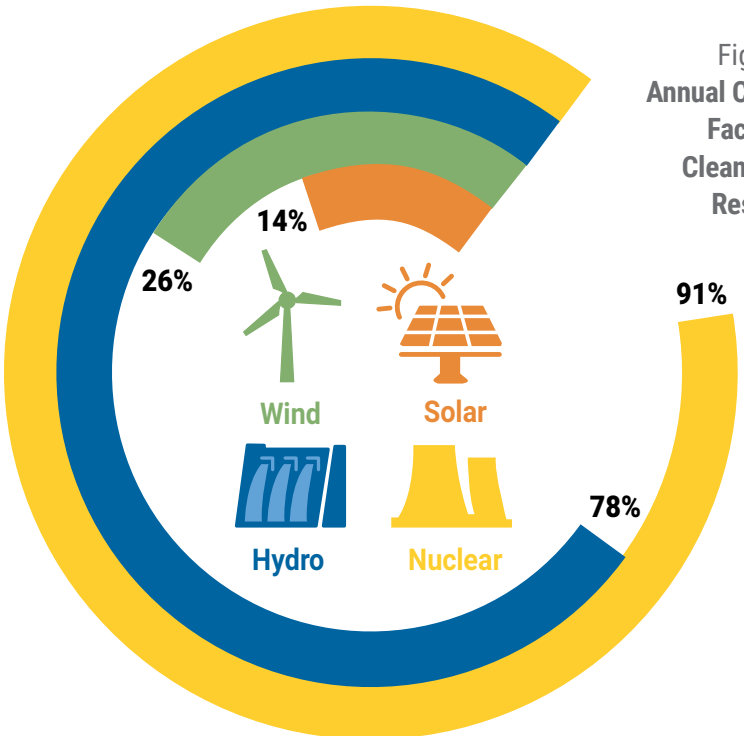
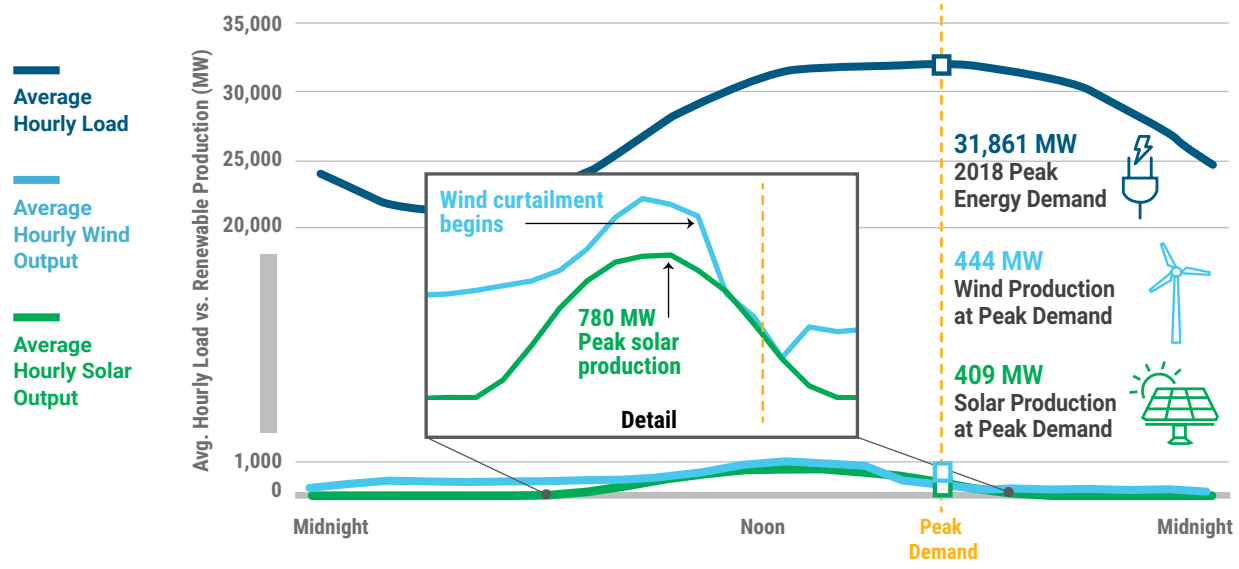


Figure 17: **Annual Capacity Factors for Clean Energy Resources**

The peak demand day of August 29, 2018 illustrates the challenge of reliably integrating intermittent resources to supply the system under high-demand conditions. Wind production was relatively robust during much of the day, increasing from about 400 MW at midnight to nearly 1,100 MW by noon. Solar resources similarly contributed, growing to 780 MW by just after noon. However, peak demand on that day was not reached until 4 p.m. By then, transmission constraints required that wind production be curtailed to about 445 MW at the peak hour while solar energy production declined by nearly 48%, contributing only 410 MW at the time demand on the bulk power system peaked at 31,861 MW.

Even during winter months when wind energy production is typically more robust, challenges with coordinating production with load still exist. The NYISO **observed a record wind production level of 1,625 MW just before midnight on February 8, 2019, at which point it was serving 9% of the state's electrical demand in that hour.** For all but 30 minutes of this day, wind contributed more than 1,000 MW to meet system needs. **However, wind production began to decline throughout the day on February 9th to a level of 629 MW at 6 p.m., meeting only 3% of system load when demand peaked at 20,275 MW.** Solar resources, which are less productive in winter months, did contribute toward meeting overall load. However, the sun had already set by the time peak demand on the system was reached, leaving solar production at 0 MW. Increased production from natural gas and dual-fuel resources was necessary to meet demand as production from intermittent resources declined.

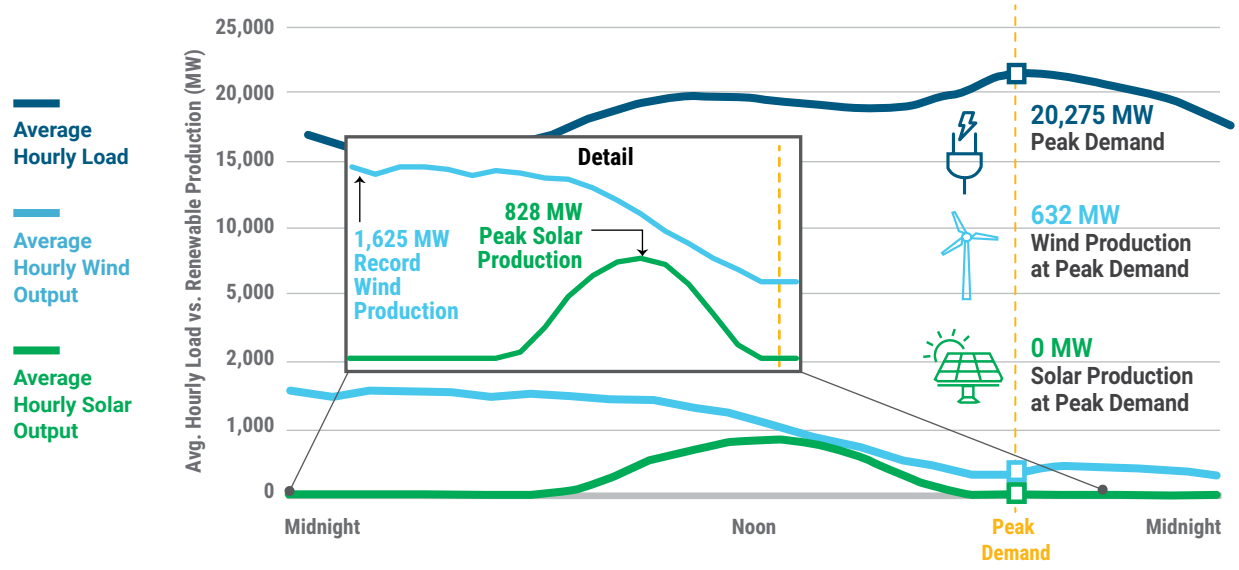
Figure 18: **Intermittent Resource Contribution to Load on 2018 Peak Demand Day (August 29)**



Battery storage can contribute to meeting operational needs and is often discussed as a necessary tool to balance the intermittent nature of renewable resources. However, battery storage is insufficient to fully meet peak demand, even at penetration levels envisioned by policymakers over the next decade, due to technological constraints limiting their contribution to meeting the full duration of peak demand periods.

To balance lower capacity factor, intermittent resources, and shorter-duration resources like energy storage, bulk power system operators will require a full portfolio of resources that can be dispatched in response to any change in real-time operating conditions to maintain bulk power system reliability. The ability to dispatch resources to reliably meet ever-changing grid conditions and serve New York's electric consumers will always be paramount.

Figure 19: **Intermittent Resource Contribution to Load after Record Wind Production Day (February 9, 2019)**

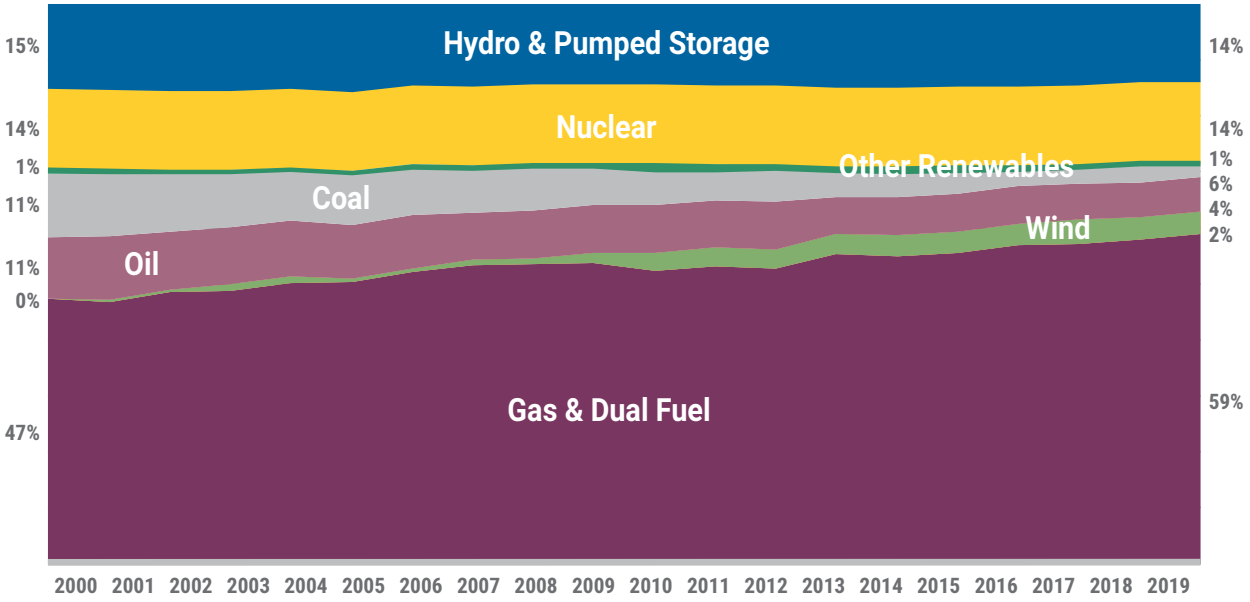


The portion of New York's generating capability from natural gas and dual-fuel facilities grew from 47% in 2000 to 59% in 2019. Wind power — virtually non-existent in 2000 — grew to nearly 4.5% of New York State's generating capability in 2019.

In contrast, New York's generating capability from power plants using coal declined from 11% in 2000 to 2% in 2019. Generating capability from power plants fueled solely by oil dropped from 11% in 2000 to 6% in 2019.

The shares of generating capability from nuclear power plants and hydroelectric facilities have remained relatively constant since 2000. Nuclear accounted for 14% of New York's generating capability in 2000-2019. Hydropower (including pumped storage) represented 15% of the state's generating capability in 2000 and 14% in 2019.

Figure 20: **New York State Fuel Mix Trends: Capacity 2000-2019**



Electricity Prices & Fuel Costs

The average wholesale electric energy price in 2018 was $44.92 per megawatt-hour (MWh), increasing from $36.56 in 2017. Wholesale electricity prices are directly influenced by the cost of the fuels used by power plants to produce electricity. In New York, the price of natural gas and the cost of electricity are closely correlated because gas-fired generation often establishes the clearing price for electricity in NYISO's wholesale energy market. Cold temperatures in early 2018 led to record high natural gas prices. As a result, the average natural gas price in 2018 was $4.35/MMBtu, compared to an average price of $3.16/MMBtu in 2017.

Energy Prices & Demand

Wholesale electricity prices also rise and fall with power demands. Lower demand for electricity allows a larger proportion of electricity to be generated by more efficient and less costly facilities,

resulting in lower prices. In 2018, the average hourly load on the New York bulk power system was 18,392 MW, representing a 3% increase from 2017 when the average hourly load on the bulk power system was 17,850 MW.

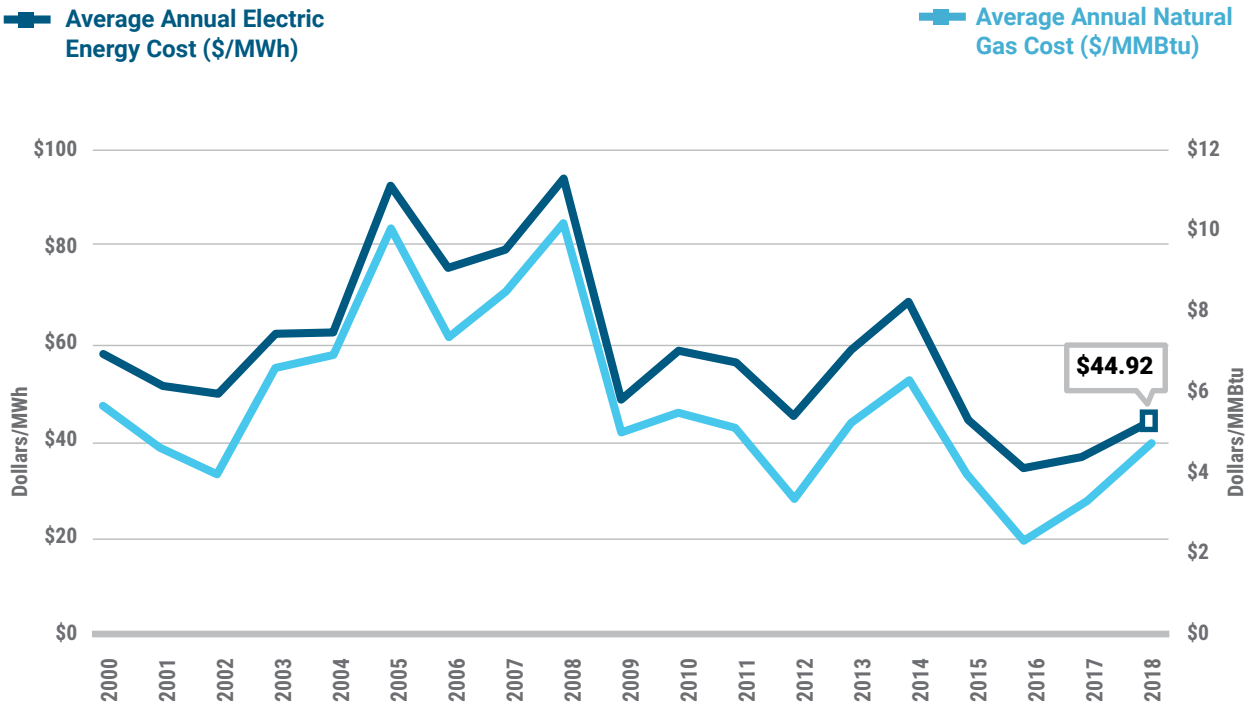
Capacity Prices

Capacity prices during the Summer 2018 Capability Period were mixed compared to those of the previous Summer Capability Period.

- The average Spot Market Auction price in New York City was slightly lower at $10.00/kW-month compared to $10.04/kW-month in 2017.
- In Long Island, the average price was slightly higher at $6.70/kW-month compared to the 2017 average of $6.66/kW-month.
- The average Spot Market Auction price over the Summer 2018 Capability Period was also higher in the lower Hudson Valley region (zones G-J), where the 2018 average price was $10.00/kW-month compared to $9.85/kW-month in 2017.
- For the New York Control Area (NYCA), the average price in 2018 was $3.42/kW-month compared to $2.35/kW-month in the previous Summer Capability Period.

These changes were driven primarily by changes in the respective Locational Capacity Requirements, as well as by the changes in available capacity.

Figure 21: **Natural Gas Costs and Electric Energy Prices: 2000-2018**



Public Policy & The Grid

Achieving Public Policy Goals Requires a Reliable Foundation

Since 1999, the NYISO's markets have worked to improve system efficiency, supporting a gradual shift toward cleaner sources of generation while upholding the nation's most stringent reliability rules.

Now, 20 years later, the NYISO stands on the cusp of the next evolution of the electric power system. New technologies, such as storage and solar, are beginning to enter the wholesale markets. New wind projects, including off-shore projects, are being proposed. Distributed sources of electric power are being located close to consumers. New environmental standards are causing resources that have been part of the generation fleet for decades to retire.

The foundational public policy formed decades ago was focused on establishing a reliable bulk power system to meet the growing energy needs of New York residents and business. Access to reliable electric energy would, of course, spur new and innovative uses to enhance commerce and our standards of living. Edison's inventions of the light bulb and the first power grid in lower Manhattan led to unimagined innovations in public transportation, heating and cooling, medical technologies, and the digital age. All of these innovations that touch our lives are tied together by the need for reliable electric energy.

In this paradigm, where uninterrupted access to electricity became integral to our society, reliability quickly became the priority public policy. Elected officials and policymakers realized that modern society needed strong assurances that bulk power system reliability would be maintained. In New York, that recognition resulted in the formation of the New York Power Pool (NYPP), the predecessor organization to the NYISO. The NYPP was established in the wake of a widespread, disruptive power outage a half century ago to enhance reliability through greater collaboration and grid coordination across utility service territories for the benefit of all New Yorkers.

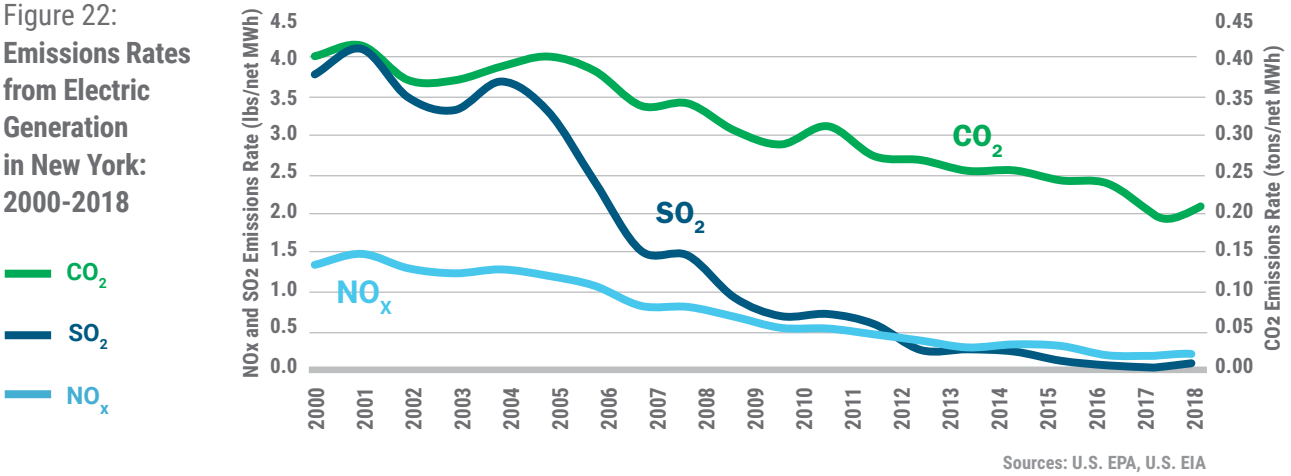
The NYPP brought a level of independence to management of the bulk power system in support of system-wide reliability. As reliability on the bulk power system improved under the NYPP's efforts, policymakers turned their attention to the economics of the grid in the 1990s. The emerging public policy challenge of that time was to deliver the same level of reliability in a more economically efficient manner.

To that end, the NYPP was re-imagined as the NYISO in 1999 and tasked with designing competitive markets to meet New York's electricity needs reliably. The NYISO expanded upon the NYPP's primary mission of maintaining bulk power system reliability by leveraging economic competition as a means of securing reliability more efficiently and at lower cost.

▸ **Competitive Markets:** Provide incentives for generators to improve operational performance and invest in new, more efficient technologies.

This transformation led to significant changes in the rules for selecting suppliers to meet demand by using competitive auction processes to select the least-cost set of resources capable of reliably meeting consumers' energy needs. The formation of these competitive market structures created strong incentives for owners of generation to improve the operational performance and availability of their power plants and invest in new, more efficient technologies where and when needed to meet the needs of energy consumers.

Figure 22:
Emissions Rates from Electric Generation in New York: 2000-2018



Sources: U.S. EPA, U.S. EIA

In the 20 years since its inception, the NYISO's markets have worked to improve system efficiency, supporting a gradual shift toward cleaner sources of generation while upholding the nation's most stringent reliability rules. The results illustrate the benefits: power costs in 2018 were 23% lower than power prices when the NYISO's markets were launched in 2000.

While the NYISO's markets drove economic efficiency, competitive wholesale markets also contributed to dramatic reductions in carbon dioxide, nitrogen oxide, and sulfur dioxide emissions rates.

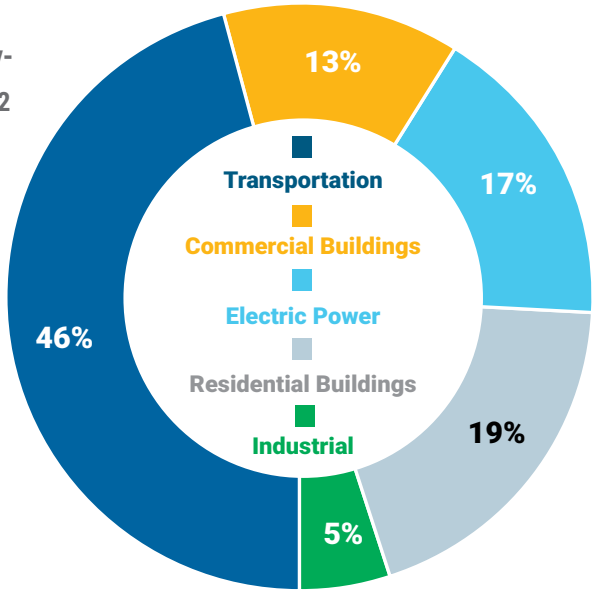
23%

lower power costs in 2018 since the NYISO markets were launched in 2000.

Where once skeptics of wholesale energy markets expressed concerns that competition might lead to higher prices and dirtier sources of energy, 20 years of experience has proven the opposite to be true. In a competitive environment, generation owners are compelled to operate efficiently in ways that preserve their availability to system operators and make them more economically competitive so that they can be dispatched to earn revenue.

In a report published in February 2019, the EIA evaluated sector-specific carbon dioxide emissions for each state. [11] The report, which provides emissions data from 2005-2016, indicates that the energy sector contributed just 16.9% of all carbon dioxide emissions in New York State during this period. By comparison, the transportation sector produced 46.1% of carbon dioxide emissions in the state, commercial and residential properties produced 31.9%, and the industrial sector contributed 5.1%. According to EIA data, the energy sector in New York State emitted 57.6 million metrics tons of carbon dioxide in 1999, the last year prior to the inception of NYISO wholesale energy markets. In 2016, carbon dioxide emissions from the energy sector in New York declined to 27.7 million metric tons, a 52% reduction from 1999. By comparison, carbon dioxide emissions from the transportation increased by 13.2% during this same timeframe, growing from 66.6 million metric tons in 1999 to 75.4 million metrics tons in 2016. Carbon dioxide emissions from the commercial and residential sector fell by 19.2% over this same period.

Figure 23:
NYS Energy-Related CO_2 Emissions by Sector



Source: U.S. EIA

Success in lowering carbon dioxide emissions from the energy sector is the result of wholesale energy markets working in conjunction with sound environmental policy to produce both economic and environmental benefits for New York. A clear area of opportunity to realize greater carbon dioxide emissions reductions is the transportation sector. New York has taken steps toward electrification of the transportation sector, including through its participation in the Multi-State ZEV (Zero-Emission Vehicle) Task Force, as well as the Charge NY initiative, which announced plans to develop a network of up to 3,000 charging stations, and put 40,000 plug-in vehicles on the road, by 2020. [12] With substantial progress in reducing carbon dioxide emissions from the energy sector already achieved, efforts aimed at the transportation sector will target a larger source of emissions that can leverage the grid's lower carbon intensity to enable environmental improvements.

Increasingly, New York State is focused on development of clean energy resources in support of reducing carbon dioxide emissions from the power sector. Wholesale energy markets have already moved the sector in this direction through competitive pressures to improve power plant efficiency and a market design that ensures the efficient dispatch of wind and solar resources. However, policymakers are seeking to accelerate these types of changes on the bulk power system, necessitating an examination of how markets can be adapted to continue to support increasingly ambitious public policies.

A decade ago, New York State developed programs such as the Renewable Portfolio Standard (RPS) and the Regional Greenhouse Gas Initiative (RGGI) to signal generators to decrease their emissions. More recently, the state's Reforming the Energy Vision (REV) and Clean Energy Standard (CES) policies established new programs for reducing the environmental impacts of energy production and integrating renewable energy resources into New York's bulk power system.

▸ **Regional Greenhouse Gas Initiative (RGGI):** The first market-based regulatory program in the United States to reduce greenhouse gas emissions.

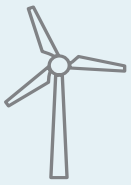
To support the development of clean energy in this competitive environment, contracts for Renewable Energy Credits (RECs) between the state and private developers replaced utility contracts for energy output at pre-set prices. By procuring RECs only, rather than entering into long-term contracts for energy at fixed prices, the state recognized value in relying on wholesale energy market revenues to inform investment decisions. The REC payments offered greater assurances to developers that they would be able to recover their investment, but developers remained at risk for properly designed and sited projects that could earn revenue in the competitive wholesale electricity markets. Rather than placing ratepayers at risk for long-term, pre-set price contracts, policymakers

leveraged the newly formed competitive market to mitigate ratepayer risk while still promoting clean energy resources.

These early efforts to incentivize development of clean energy resources were relatively modest in comparison to today's policy goals. New York's RPS program, established in 2004, sought to increase the percentage of electricity from renewable resources from 19% to 25% by 2013.

With renewable resources providing about 28% [13] of the total amount of electricity consumed as of 2017, the state has officially ramped up its goal to 50% renewable by 2030. Governor Cuomo called for an even more aggressive goal of 70% renewable energy by 2030 in his 2019 State of the State address. Further, the governor's agenda calls for the state's electricity demand to be supplied by 100% "clean energy sources" by 2040, with legislation proposed to form a "Climate Leadership Council" to work with the state's Department of Environmental Conservation (DEC) to define eligible clean energy sources on the basis of their carbon dioxide emissions profile.

28%



of electricity consumed was generated by renewables in 2017 according to NYSERDA.

On the federal level, Congress is considering its own "Green New Deal" resolution that, among other priorities, calls for meeting 100% of the power demand in the United States through clean, renewable, and zero-emission energy sources in the next ten years. At the same time, other national energy policy perspectives are focused on grid resilience and maintaining certain types of generating facilities, namely coal and nuclear units. The perspectives and priorities represented by these varying policy positions may seem to be very different, but both present challenges to grid operators who are responsible for developing and carrying out the operational, market design, and system planning needs for the grid of today and the grid of the future.

As legislation related to climate change and the power grid is considered, policymakers should consider that wholesale energy markets are best equipped to guide necessary investments to where they can provide the greatest benefit for consumers and the environment. Potential legislation intended to reshape the grid should not prescribe or limit solutions, but instead enable market forces to drive towards solutions that build upon the success of energy markets in New York.

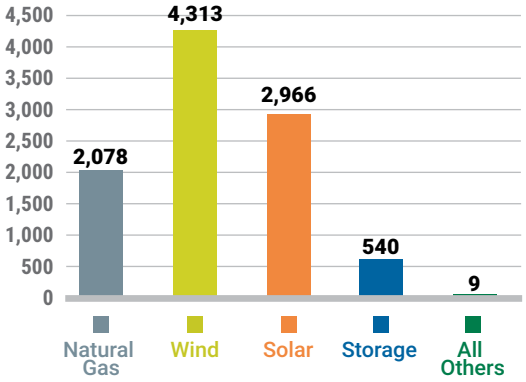
While the implications of climate change are being debated in our nation's capital and in state capitals like Albany, the physical needs associated with maintaining bulk power system reliability must be fully understood and at the core of effective policymaking decisions. Climate change and the physics of meeting bulk power system reliability need not be competing influences shaping the grid of the future. The pursuit of solutions to climate change and grid resilience can align with the economic principles that serve as the foundation of competitive wholesale electricity markets.

Policies can, and should, be achieved with a reasoned understanding of the physical requirements and the economic benefits of reliably delivering that energy in a least-cost, competitive process where financial risk is retained by developers and investors. In addition to its mission of meeting reliability through efficient wholesale electricity markets, a core element of the NYISO's mission is to promote such a reasoned understanding by providing independent, authoritative information that is focused on bulk power system reliability and market efficiency.

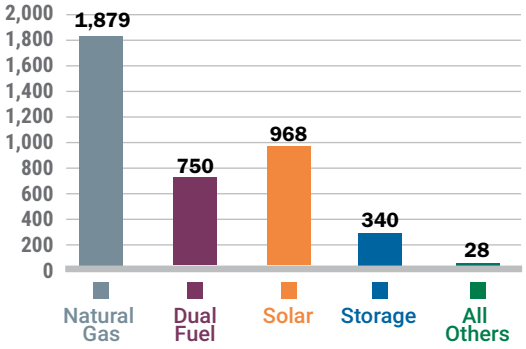
▸ Proposed Generation By Region (MW)

NYISO interconnection queue as of March 1, 2019

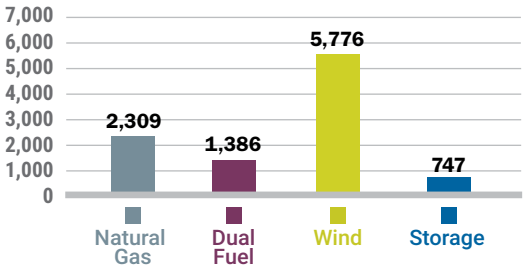
Upstate (zones A-E)



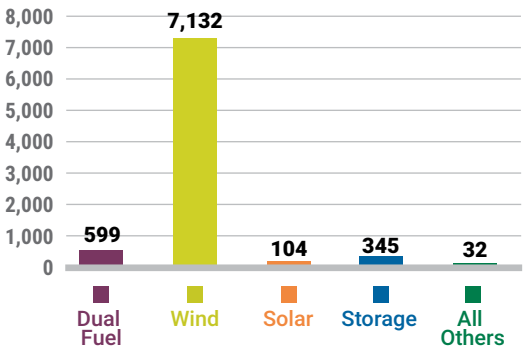
Capital Region & Hudson Valley (zones F-I)



New York City (zone J)



Long Island (zone K)



Wholesale electricity markets can achieve reasoned public policy objectives responsibly and efficiently. The NYISO intends to adapt to the state's increasingly ambitious environmental goals by leveraging its experience in delivering reliability through markets.

In collaboration with stakeholders and policymakers, the NYISO is developing a proposal to incorporate the societal costs associated with carbon dioxide emissions into its energy market to better reflect the state's policy of reducing emissions. Similar to how competitive markets created incentives for generators to improve efficiency, a social cost of carbon priced in the energy market would create stronger incentives for those types of efficiency improvements, as well as stronger incentives for developing zero-emitting resources like wind and solar in locations where they will have the greatest effect on emissions. This carbon pricing proposal would further promote economic competition among suppliers in the NYISO's markets by directly pricing a key environmental attribute in the markets. The NYISO believes carbon pricing can help the state more efficiently attain its clean energy goals.

To address New York's public policy objectives, other tools and market products may be necessary to continue sending proper price and investment signals to support bulk power system reliability. In addition to carbon pricing, the NYISO plans further enhancements to its markets to establish stronger price signals for resources, such as energy storage, that are capable of ramping up and down quickly in response to variable output from the growing level of wind and solar resources. The NYISO has developed a comprehensive proposal to integrate DERs into its markets. Further, the NYISO is evaluating its planning processes to identify opportunities to be more flexible in response to the increased volume of proposals from smaller resources seeking to interconnect.

The challenge ahead for the NYISO is to design and implement a portfolio of market products that achieves the proper balance of supporting environmental public policies while building upon the strong foundation of reliability and economic efficiency.

It is from this perspective that the NYISO examines the myriad public policy initiatives detailed below, and engages stakeholders and policymakers to identify the challenges these initiatives may present to bulk power system reliability and efficiency.

Summary Table of Key Environmental Regulations & Energy Policies

PUBLIC POLICY INITIATIVE	POLICY GOAL	POLICYMAKING ENTITY	POLICY IMPLICATIONS
Accelerated Energy Efficiency Targets (Dec. 2018)	Reduce end-use energy consumption by 185 trillion BTU by **2025**, including potential electrification to reduce fossil fuel use in buildings	New York State Public Service Commission (PSC) / New York State Energy Research and Development Authority (NYSERDA)	Declining load and potentially changing load patterns, such as electrification of building heating systems, impact long-term forecasting and investment signals
Clean Energy Standard (CES) (August 2016)	50% of electricity consumed in New York State generated from renewable resources by **2030**. Retain upstate nuclear capacity	New York State Public Service Commission (PSC) / New York State Energy Research and Development Authority (NYSERDA)	Incent about **17,000 MW** of new, largely intermittent capacity to enter grid and markets. Avoid premature deactivation of more than 3,100 MW of nuclear capacity
Indian Point Deactivation	Deactivate Indian Point units 2 and 3 by **2020** and **2021**, respectively	Agreement between New York State and Entergy	NYISO Deactivation Assessment found no reliability need with loss of **2,311 MW** based on addition of expected resources
New York City Residual Oil Elimination	Eliminate combustion of fuel oil numbers 6 and 4 in New York City by **2020** and **2025,** respectively	New York City	**2,946 MW** of installed capacity affected
Offshore Wind Development	Develop 2,400 MW of offshore wind capacity by **2030**	New York State Public Service Commission (PSC) / New York State Energy Research and Development Authority (NYSERDA)	As much as **2,400 MW** of new intermittent capacity interconnecting to the grid in southeastern New York by 2030
CO_2 Performance Standards **for Major Electric Generating Facilities**	Establish restrictions on carbon dioxide emissions for fossil fuel-fired facilities in New York by **2020**	New York State Department of Environmental Conservation (DEC)	**Approximately 860 MW** of coal-fired capacity expected to deactivate or re-power
Regional Greenhouse Gas Initiative (RGGI)	Reduce carbon dioxide emissions cap by 30% from **2020** to **2030** and expand applicability to currently exempt "peaking units" below current 25 MW threshold	New York and other RGGI states	**26,100 MW** of installed capacity participate in RGGI
"Peaker Rule" **Ozone Season Oxides of Nitrogen (NOx) Emissions Limits for simple cycle and regenerative combustion turbines**	Reduce ozone-contributing pollutants associated with New York State-based peaking unit generation	New York State Department of Environmental Conservation (DEC)	DEC rule proposal impacts approximately **3,300 MWs** of peaking unit capacity in New York State
Storage Deployment Target	Reduce costs, support renewable resource integration, and increase storage capacity through bulk system, distribution, and customer-based installations	New York State Public Service Commission (PSC) / New York State Energy Research and Development Authority (NYSERDA) / New York Power Authority (NYPA)	Installation and market integration of **1,500 MW** of battery storage capacity by 2025 and **3,000 MW** by 2030
U.S. Clean Water Act	Adoption of "Best Technology Available for Cooling Water Intake" to protect aquatic biota	U.S. Environmental Protection Agency / New York State Department of Environmental Conservation (DEC)	**16,900 MW** of installed capacity must achieve compliance upon licensing renewal

Discussion of Key Environmental Regulations & Energy Policies

Accelerated Energy Efficiency Targets

On December 13, 2018, the PSC issued an order adopting accelerated energy efficiency targets for the state's investor-owned utilities. [14] The new target reflects an incremental reduction in end-use energy consumption of 31 trillion British Thermal Units (BTUs) through 2025, for a total statewide goal of reducing end-use consumption by 185 trillion BTUs by 2025. The PSC's order directs that the targets will be achieved via building retrofits, upgrades to heating and cooling equipment, and innovative technologies like heat pumps. The order expands New York's long-standing commitment to using energy efficiency as a policy tool to mitigate the environmental impacts associated with energy production and use. The order specifically encourages the electrification of building heating systems, which offers improved emissions efficiency over conventional fossil-fuel based heating systems, while adding electric demand to the bulk power system.

185

trillion BTUs in reduced end-use consumption, statewide, by 2025.

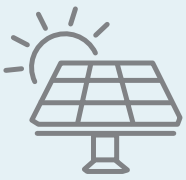
Clean Energy Standard (CES)

In August 2016, the PSC adopted a CES, requiring that 50% of the electricity consumed in New York State be generated from renewable resources by 2030 (50-by-30 goal). Under the CES, electric utilities and others serving load in New York are responsible for securing a defined percentage of the load they serve from eligible renewable and nuclear resources. The load serving entities will comply with the CES by either procuring qualifying credits or making alternative compliance payments.

In order to achieve the 50-by-30 goal, the PSC estimated that approximately 70,500 GWh of total renewable energy will need to be generated in 2030. This included approximately 29,200 GWh of new renewable energy production beyond the existing levels of production that were in place at the time the order was adopted. NYSERDA will continue to offer 20-year contracts for RECs associated with eligible renewable resources. In addition, the CES directs NYSERDA to award eligible nuclear capacity Zero Emission Credit (ZEC) payments for every megawatt hour of energy produced from these nuclear facilities in an effort to retain their capacity in the market through 2029.

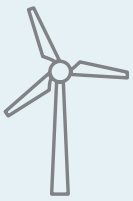
70,500 GWh

of total renewable energy will need to be generated in 2030



29,200 GWh

of new renewable energy production beyond exisiting renewable energy production



Indian Point Deactivation

On January 9, 2017, Entergy and New York State announced an agreement to close Indian Point units 2 and 3 in 2020 and 2021, respectively. Following receipt of a deactivation notice from Entergy on November 13, 2017, the NYISO evaluated the proposed deactivation as part of the required generator deactivation assessments it performs on all proposed generator retirements. In its analysis, the NYISO assumed that certain power plants then under construction would enter into service. The NYISO issued its analysis of the proposed Indian Point deactivation on December 13, 2017.

2020 & 2021

deactivation years for Indian Point units 2 and 3, respectively.

The assessment did not identify a reliability need following the deactivation of Indian Point for the study period under base case assumptions. However, the assessment did determine that following the deactivation, the reliability of the existing system could only be maintained if sufficient replacement sources of power are added within the lower Hudson Valley. In the absence of the new generation facilities projected to be available at the time of the analysis, resource needs would have to be met through other solutions, as identified in the assessment. [15]

New York City Residual Oil Elimination

New York City passed legislation in December 2017 that will prohibit the combustion of fuel oil Numbers 6 and 4 within utility boilers in New York City by 2020 and 2025, respectively. The rule is expected to impact 2,946 MW of generation in New York City. Many generators in New York City that are connected to the local gas distribution network are required to maintain alternative fuel combustion capabilities — most notably oil. The New York State Reliability Council (NYSRC) has a minimum oil-burn requirement rule that is intended to provide assurance that electric system reliability can be maintained in the event of gas supply interruptions during winter months when gas is also needed for heating, and peak electric demand conditions during the summer.

2,946 MW

of New York City generation may be affected by the residual oil elimination legislation.

These generators will need to make decisions about whether to invest in the equipment necessary to convert their facilities to comply with the law. While oil accounts for a relatively small percentage of the total energy production in New York State, it is often called upon to fuel generation during critical periods when severe cold weather limits access to natural gas. **Dual-fuel capability serves as both an important tool in meeting reliability, and as an effective economic hedge against high natural gas prices during periods of high demand for natural gas as a heating fuel.** Uncertainty over generator compliance strategies and future fuel oil combustion capabilities compounds the consequences of the other public policy initiatives described here.

Offshore Wind Development

In his January 2017 State of the State address, Governor Cuomo called for the development of up to 2,400 MW of offshore wind to be constructed by 2030. In his 2018 address, the governor called for a solicitation for as much as 800 MW of offshore wind. **In 2019, Governor Cuomo expanded this goal further, calling for 9,000 MW of offshore wind development by 2035.**

In response to the governor's 2017 objectives, the NYISO assessed a variety of scenarios to determine whether 2,400 MW of offshore wind production could be injected into the bulk power system without thermal overloads. The NYISO's analysis concluded that it was feasible to accommodate the injection of 2,400 MW of offshore wind without overloading transmission lines and violating thermal reliability criteria. This assessment did not examine system upgrade costs or other interconnection costs that would likely be associated with reliably delivering new capacity on the bulk power system. These costs will be determined as specific proposed projects are examined through the NYISO's interconnection study process. In addition, large amounts of offshore wind could possibly be more efficiently interconnected to the New York bulk power system through the development of an offshore transmission system separate from individual generator leads. Additional study work is necessary to understand the economics and effectiveness of such a plan.

9,000 MW

proposed goal for offshore wind development by 2035.

NYSERDA issued the *New York State Offshore Wind Master Plan* in January 2018 that discusses many issues around the siting of such facilities, as well as options for various approaches the state may take to procure the resource. On February 21, 2019, NYSERDA announced that four developers submitted a total of 18 bids for up to 1,200 MW of offshore wind capacity in response to its request for proposals. It anticipates issuing awards in the Spring of 2019.

860 MW

of remaining coal-fired generation is expected to exit the market in 2020.

CO_2 Performance Standards for Major Electric Generating Facilities

The DEC initiated a rule-making process that seeks to limit carbon dioxide emissions from fossil fuel-fired generators. Approximately 860 MW of remaining coal-fired generation in New York State is expected to exit the market in 2020. New York's coal-fired generation accounted for less than 1% of the total energy produced in the state in 2018. Upon receipt of deactivation notices from the generators, the NYISO's planning processes will assess whether such deactivations trigger potential reliability needs.

Regional Greenhouse Gas Initiative (RGGI)

RGGI is a multi-state carbon dioxide emissions cap-and-trade initiative that requires affected generators to procure emissions allowances enabling them to emit carbon dioxide. The cost for these allowances is factored into the costs of operating fossil fuel-fired generators, and recovered through the NYISO's wholesale market. Through this initiative, each participating state is allotted a set number of allowances, which are collectively auctioned to generators or other stakeholders. For the initiative to be successful at reducing carbon dioxide emissions, the level of available allowances must be established in advance and lowered over time to encourage generators to invest in emissions reduction strategies or prepare for increasing costs associated with procurement of the allowances. Based on previous program reviews, the RGGI states had a schedule of allowances through 2020.

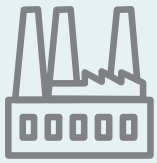
Through a program review in 2017, the RGGI states agreed to a number of program changes, including a 30% cap reduction between 2020 and 2030, essentially ratcheting down the availability of allowances to generators that produce greenhouse gases. More recently, in his 2018 State of the State address, Governor Cuomo directed the DEC to expand RGGI in New York by grouping together currently exempt peaking generators below 25 MW in nameplate capacity. Virginia and New Jersey have indicated an intent to join the initiative beginning in 2020, with rule-making processes to do so currently ongoing. The expansion of the RGGI region and anticipated program design features may affect the dynamics of allowance cost and availability going forward.

Tighter requirements through RGGI are not likely to trigger reliability concerns, but again, when combined with the numerous public policy action described in this section, raises uncertainties about the resource makeup and diversity of the future grid.

Peaker Rule: Ozone Season Oxides of Nitrogen (NOx) Emission Limits for Simple Cycle & Regenerative Combustion Turbines

In February 2019, the DEC proposed requirements to reduce emissions of smog-forming pollutants from peaking units.

"Peakers ," as they are commonly known, typically operate to maintain bulk power system reliability during the most stressful conditions, such as periods of high demand. Many of these units also maintain transmission security in certain regions of New York City and Long Island — known as load pockets. Load pockets represent transmission-constrained geographic areas where energy needs can only be served by local generators due to transmission limitations during certain high-demand conditions. According to the DEC, these peaking units "typically run on hot summer days when there is a strong likelihood of high ozone readings. Many peaking units in New York have high NOx emission rates, are inefficient and are approaching 50 years of age. It is difficult to install after-market controls on most of these units because of their age and site limitations." [16]



▸ **Peakers:** Peaking power plants, also known as peaker plants or just "peakers", are power plants that generally run only when there is a high demand — known as peak demand — for electricity.

The proposed new rule, which contemplates phasing in compliance obligations between 2023 and 2025, could impact approximately 3,300 MW of simple-cycle turbines located mainly in New York City and Long Island. The draft rule would require peaking unit owners to submit compliance plans to the DEC in March, 2020. Among the potential compliance plans expected could be a series of unit deactivations.

The draft rule includes a provision to allow an affected generator to continue to operate up to two years, with a possible further two-year extension, after the compliance deadline if the generator is designated by the NYISO or the local transmission owner as needed to resolve a reliability need until a permanent solution is in place. These generator plans will inform the next *NYISO Reliability Needs Assessment* (RNA).

The NYISO is actively engaged in the rule development process and will work to inform policymakers, market participants, and investors of the implications of the rule to system reliability. The NYISO is developing its *Comprehensive Reliability Plan* (CRP) for 2019-2028, which includes a study scenario evaluating the reliability impacts of a potential retirement of 3,300 MW of peaking generators affected by the DEC's proposal. See *Building the Grid of the Future* for details of that evaluation and a broader discussion of the implications of this new emissions rule.

up to 3,000 MW

of energy storage capacity procured by investor-owned utilities by 2030.

Storage Deployment Target

Governor Cuomo's 2018 State of the State address also called for the development and deployment of 1,500 MW of energy storage capacity by 2025. The goal of the initiative is to drive down costs for storage while strategically deploying storage resources in locations where they best serve the needs of the grid. NYSERDA initially focused on storage pilot programs and activities that reduce barriers to deploying storage, including permitting, customer acquisition costs, interconnection, and financing costs.

The PSC has established an initiative to procure 1,500 MW of storage capability by 2025 and 3,000 MW by 2030. The New York Green Bank is providing low-cost financing in order to reduce the costs of storage projects with funding levels up to $200 million. On March 11, 2019 NYSERDA filed its proposed implementation plan for PSC consideration, detailing its incentive payment structure for storage technologies participating in retail as well as wholesale power markets.

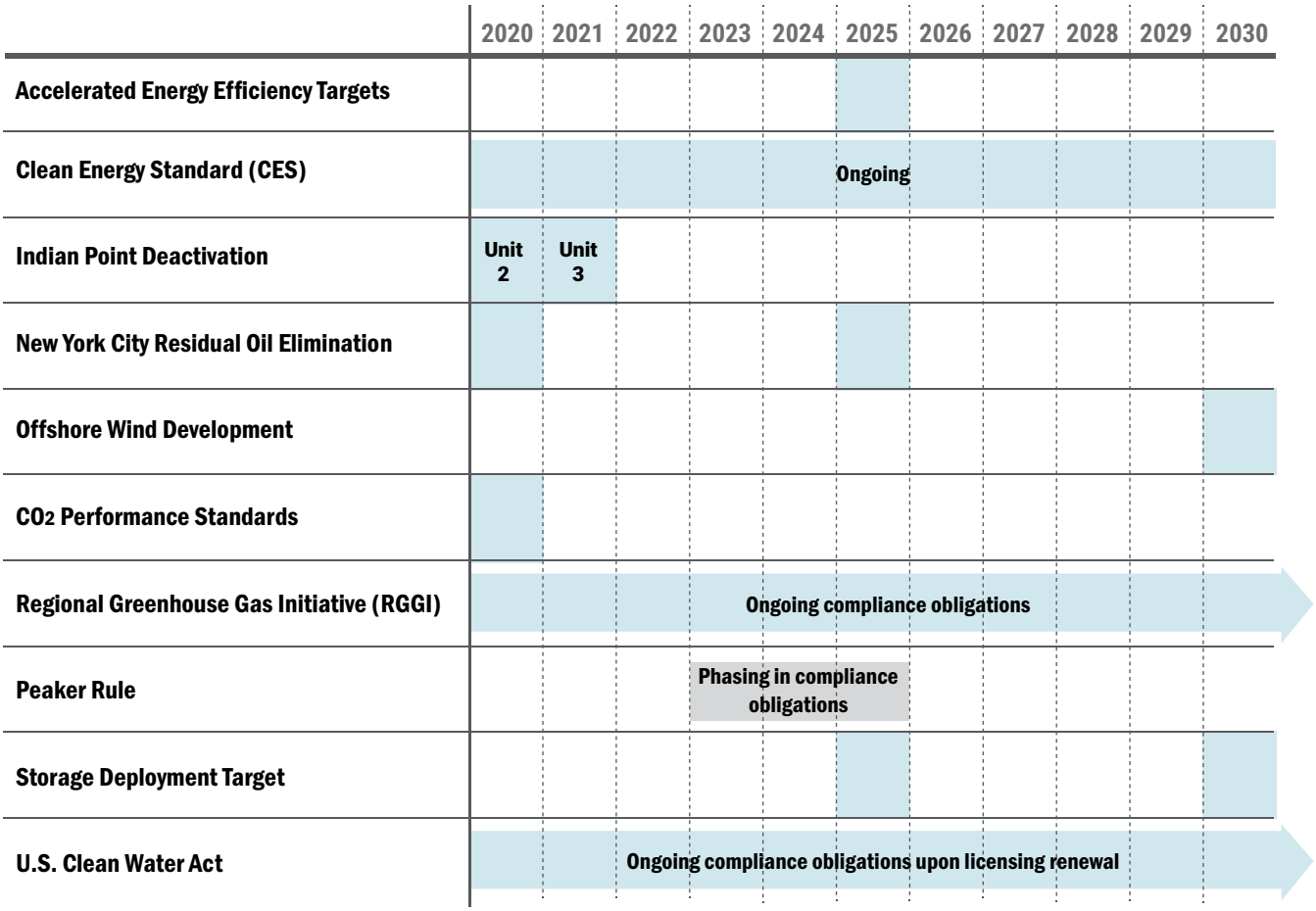
U.S. Clean Water Act: Best Technology Available for Plant Cooling Water Intake

The U.S. Environmental Protection Agency (EPA) has issued Clean Water Act Section 316(b) rules providing standards for the design and operation of power plant cooling systems. The DEC has finalized a policy for the implementation of the Best Technology Available for plant cooling water intake structures. This policy is activated upon renewal of a plant's water withdrawal and discharge permit. Based upon a review of current information available from the DEC, the NYISO has estimated that 16,900 MW of nameplate capacity is affected by this rule. Some of the generators involved could be required to undertake major system retrofits, including closed cycle cooling systems.

16,900 MW

of nameplate capacity affected by the DEC's policy.

▸ Public Policy Initiatives Timeline 2020-2030



Making Policy Work

> **Substituting a price signal for cumbersome regulations will promote economic growth and provide the regulatory certainty companies need for long-term investment in clean energy alternatives.**
>
> — Economists' Statement on Carbon Dividends,
> signed by 27 Nobel Laureate Economists, 4 Former Federal Reserve Chairs,
> 15 Former Chairs of the Council of Economic Advisors and
> 2 Former Secretaries of the US Department of Treasury

While ambitious public policy goals can be critical to shifting investment in the power sector, the lessons learned in the transition to competitive markets can be informative to the challenges before us. History has shown that out-of-market programs that create a dependency on long-term contracts to drive innovation risk exposing ratepayers to higher costs for energy as technology costs decline and alternative technological innovations emerge. As we see rapid change in clean energy technologies and declining costs, policymakers need to balance the level of risk to which they expose ratepayers with the desire for change on the grid.

There is no historical precedent for pursuing the types of changes on the grid envisioned by New York policymakers. Complicating achievement of the goals is the fact that these changes must be pursued in the context of a bulk power system that operates to the strictest reliability rules in the nation. [17]

In addition to challenges around investment risk and ratepayer protections, there are physical realities on the bulk power system that policy must take into account. Among these realities is the bulk power system's ability to move energy from where it is generated to where it is consumed.

In order to achieve its objectives for renewable energy and carbon emissions, New York will need additional transmission capability to deliver renewable resources from upstate New York to consumers throughout the state. Moreover, the proposed development of wind resources off the Atlantic coast to meet the PSC's Offshore Wind Standard could require an offshore transmission network to deliver offshore wind resources to the New York electric grid via Long Island and New York City.

The NYISO is currently engaged with the PSC and stakeholders in two transmission expansion efforts brought about by the need for additional transfer capability on the bulk power system from upstate to downstate. The Western New York and AC Public Policy Transmission projects will improve the flow of clean energy from renewable generation in the western and northern regions of the state to the state's largest region of energy demand in the lower Hudson Valley and New York City.

Even with the Western New York and AC Transmission projects already selected by the NYISO, congestion on the system will persist, complicating the state's ability to meet its renewable energy goals. The inability of the transmission system to deliver increasing amounts of renewable supply from upstate New York to downstate consumers jeopardizes achieving the state's public policy goals.

For example, the state's Clean Energy Standard anticipates as much as 17,000 MW of new renewable energy development upstate. In its most recent award of REC contracts announced in January 2019, NYSERDA noted that it was supporting 20 large-scale renewable projects representing 1,654 MW of installed capacity.[18] 93% of the awarded capacity will be located upstate (in load zones A-E), where clean energy resources are already abundant and access to load centers in southeastern New York is heavily constrained.

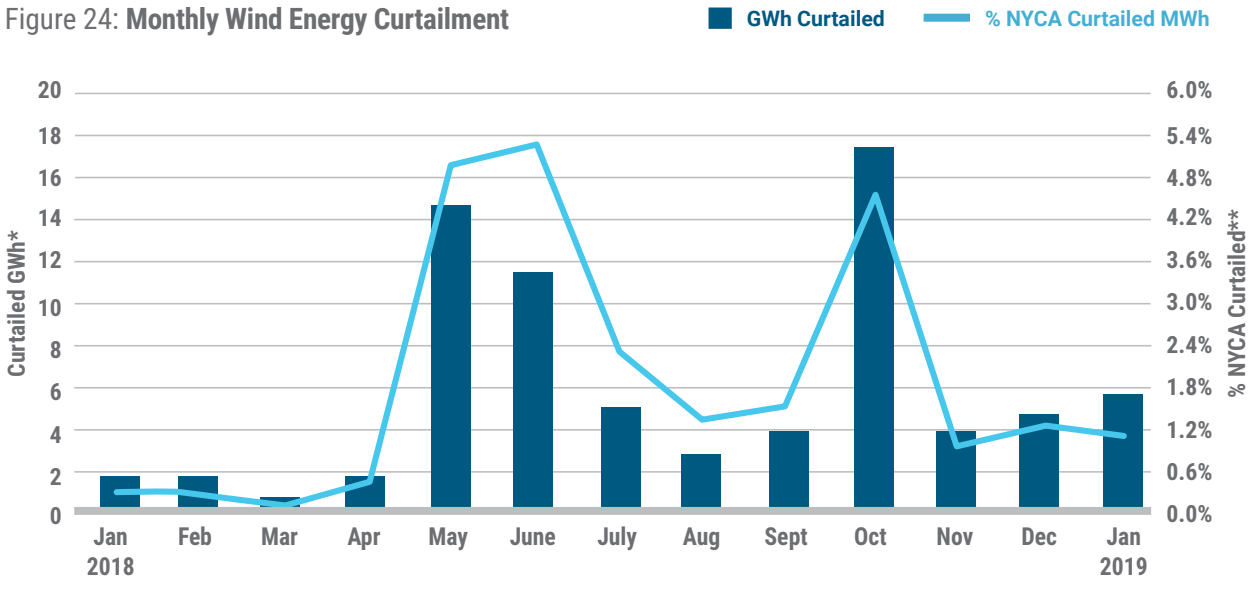
Absent investment to expand the transfer capability of the bulk power system, investment in renewables in upstate load zones runs the risk of bringing diminishing returns in terms of progress toward both renewable energy production and carbon dioxide emissions reduction goals. This is largely because nearly 90% of the energy produced in upstate New York already is derived from carbon-free resources. Because load in the region is not projected to grow, the addition of new renewable resources increasingly displaces other sources of clean generation in the region.

Based on the NYISO's operating experience, there are already high levels of wind curtailment in northern New York. Analysis performed by the NYISO in 2018 indicates that further wind development upstate could lead to increased levels of wind curtailment without additional transmission upgrades, including targeted enhancements to certain local transmission networks. Figure 24 summarizes the percentage and GWh from the existing wind generation that were curtailed.

Ultimately, without market-based incentives for investment in renewable resources and a robust transmission system to move power to load, state policies could promote a resource mix where new renewable resources increasingly displace the output from existing renewable or other zero-emitting resources.

Furthermore, additional renewable resources upstate will place downward pressure on wholesale energy prices, placing upward price pressure on the state's REC payments. This dynamic not only reduces the effectiveness of competitive markets as a mechanism to provide reliable service,

Figure 24: **Monthly Wind Energy Curtailment**



* Curtailed GWh - Difference Between Real-Time Wind Forecast and Economic Wind Output Limit
** % NYCA Curtailed - Ratio of Curtailed Energy to Total Production

it also jeopardizes the economic viability of resources lacking access to out-of-market revenues.Such resources may include generating capacity necessary for reliability as well as existing renewable resources whose REC contracts with NYSERDA have expired. These out-of-market contracts drive increasing amounts of revenue away from New York's efficient competitive wholesale markets, shifting economic risks and costs from investors to ratepayers.

Carbon pricing is one potential market-based approach to addressing this scenario. The NYISO's carbon pricing proposal would incorporate a cost associated with carbon dioxide emissions directly into the price of energy, allowing all generators that operate the opportunity to earn more revenue by minimizing carbon dioxide emissions. The concept was evaluated in 2018 to compare outcomes anticipated from the state's 50% renewable Clean Energy Standard. Analysis showed that investment patterns in renewable resources are expected to shift from upstate regions to downstate where they would receive more market revenue and have a greater benefit in terms of displacing carbon-emitting energy resources. [19] With higher goals for renewable energy production being discussed, carbon pricing could shift more investment toward downstate and advance the state's goals more efficiently.

▸ More on carbon pricing: Visit our website, www.nyiso.com/carbon for carbon pricing proposal, press coverage, blogs, and more.

Grid Principles for Successful Renewable Integration

Carbon pricing represents only one aspect of how the NYISO believes competitive markets can reflect the state's policy goals. Through a comprehensive plan developed in conjunction with its stakeholders, the NYISO outlined its longer-term view for integrating renewable resources into market structures that will support reliable bulk power system operations.

As a starting point, the NYISO identified overarching principles that it believes will be essential to sustaining reliability on a renewable-intensive grid. These principles include resource flexibility, grid resilience, and proper price formation. With these principles in mind, the NYISO's plan identifies necessary enhancements to its existing market products, as well as new market products designed to attract the necessary investment in resources that complement renewable intermittency.

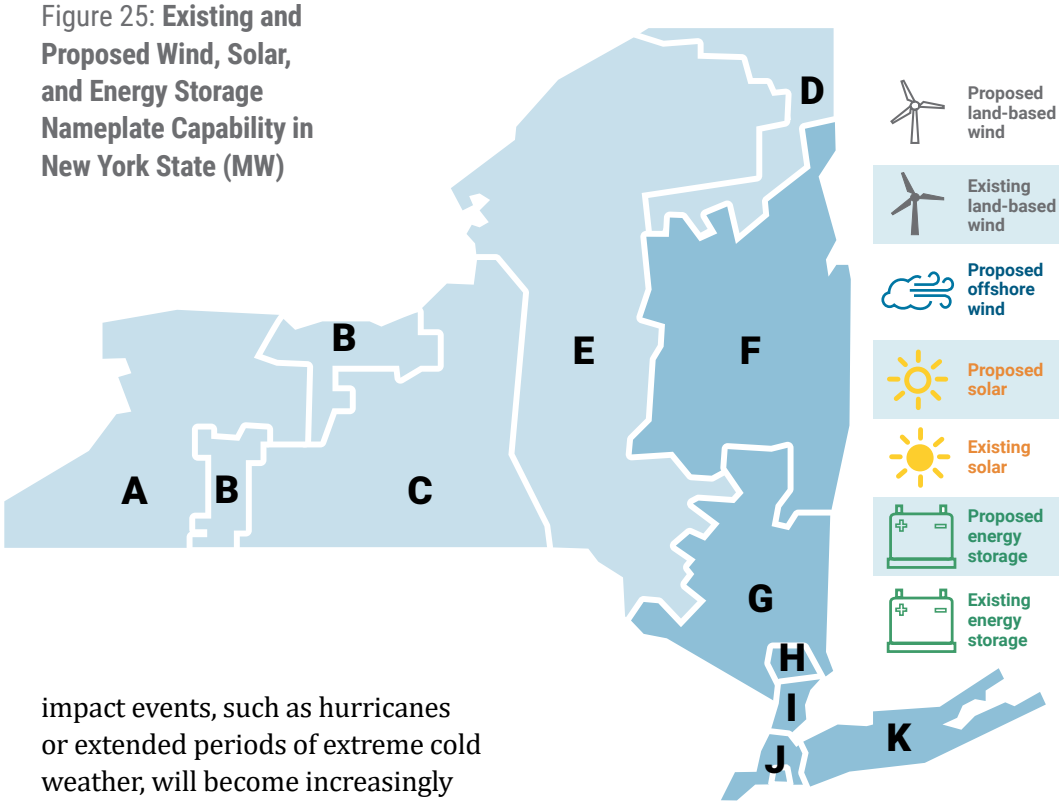
Resource Flexibility

The addition of renewable resources expected as a result of the Clean Energy Standard will create a more dynamic grid, where supply is heavily influenced by weather conditions. This necessitates a look at the incentives for maintaining and adding flexible resources needed to balance intermittent renewables, as well as alternative market designs that preserve revenue adequacy for suppliers needed for reliability. These flexibility attributes include the ability to respond rapidly to dynamic system conditions, provide controllable ramping capability with fast response rates, and the ability to startup and shutdown quickly and frequently in response to system needs. Incentivizing resource flexibility will be a key element to the market enhancements the NYISO is developing.

Grid Resilience

The NYISO is evaluating opportunities to leverage competitive wholesale market products and services to bolster the resilience of New York's bulk power system. As system resources and demand patterns evolve, the ability to maintain reliability in the face of low frequency, but potentially high

Figure 25: **Existing and Proposed Wind, Solar, and Energy Storage Nameplate Capability in New York State (MW)**



	UPSTATE (zones A-E)	DOWNSTATE (zones F-K)
Proposed land-based wind	4,313	0
Existing land-based wind	1,985	0
Proposed offshore wind	0	12,908
Proposed solar	2,966	1,072
Existing solar	0	57
Proposed energy storage	540	1,432
Existing energy storage	0	30

impact events, such as hurricanes or extended periods of extreme cold weather, will become increasingly important to long-term system reliability. The changing portfolio of resources serving the electric needs of New York will require a careful and comprehensive review of the NYISO's existing market products, planning processes, and operational practices to reliably serve New York's electricity requirements.

Price Formation

The NYISO recognizes the importance that markets and effective wholesale price signals play in attracting and retaining resources that are best positioned to maintain bulk power system reliability. In order to provide efficient operational and investment signals to an increasingly diverse mix of supply resources, our markets must continue to evolve. The NYISO continually focuses on improving price formation and market transparency, supporting efficient investment for resources to locate in the right places and operate at the right time.

Market Products for Reliable Renewable Integration

Effective price signals incentivize investment in support of resource flexibility and grid resilience. The NYISO is proposing initiatives focused on integrating emerging technologies and resources as well as enhancing market products to elicit improved performance and resilience. These efforts are targeting energy storage integration, distributed energy resource integration, large-scale solar generation integration, and enhancements to ancillary services market products.

The initiatives described below reflect the near-term steps that must be taken to prepare for the grid of the future.

What's an ESR?

Energy Storage Resources are devices used to capture energy produced at one time for use at a later time.

Capacitors
Components that store potential energy in an electric field

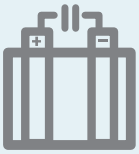
Superconductors
Systems that store energy in a magnetic field

Pumped Hydro
Water stored in a reservoir to provide energy on demand

V2G
Vehicle-to-grid systems that use electric cars for energy storage

Thermal
Excess heat stored for later use

Flow Batteries
Batteries that contain liquid chemicals that store energy



Lithium Batteries
Move lithium ions between positive and negative electrodes to store energy

Energy Storage Integration

The NYISO filed a comprehensive set of rules with FERC that will allow the expansion of wholesale market participation for Energy Storage Resources (ESRs). ESRs have unique capabilities that can help grid operators handle peak demand, manage the variability of intermittent resources, and potentially defer transmission upgrades in some instances. Their unique ability to withdraw from, and inject energy into the grid can provide resource flexibility and grid resilience. Additionally, energy storage can help improve the cost effectiveness of the system by charging during periods of low demand and low prices, and supplying energy to the grid during periods of high demand when prices typically rise.

The NYISO's ESR participation model will allow storage resources to either self-manage their energy levels or to use the NYISO's energy level monitoring capabilities. The option of relying on the NYISO's capabilities to monitor and manage energy storage levels will optimize storage resource availability for periods when they can best support bulk power system reliability.

Longer-term goals for the NYISO include exploring market rules to facilitate participation from intermittent renewable resources that also integrate energy storage capabilities. State and federal incentives encourage developers to couple storage and intermittent renewable assets, with the goal of improving renewable resource flexibility. The NYISO's market rules that enable participation from intermittent resources like wind and solar were developed to specifically accommodate that intermittency and remove barriers to market entry for these resources.

The NYISO will consider market rules that account for large-scale, weather-dependent resources coupled with storage behind a single interconnection point. For small resources, market rules for renewable resources that incorporate a storage component are considered through the NYISO's DER Integration initiative.

DER Integration

The NYISO is in the midst of a multi-year effort that, at its completion, will open New York's wholesale Energy, Ancillary Services, and Capacity Markets to DER technologies. In December 2017, the NYISO released its *DER Market Design Concept Proposal,* representing the second step in the overall market design process. The proposal builds on the ideas outlined in NYISO's February 2017 *DER Roadmap* and subsequent stakeholder discussions. Currently, the NYISO is nearing completion a comprehensive set of rules for DER integration and implementation in 2021.

▸ Distributed Energy Resources: A broad category of resources that includes distributed generation, energy storage technologies, combined heat and power systems, and microgrids.

The NYISO has initiated a pilot project program to test innovative technology and assist with potential further refinement of the DER participation model. The pilot framework allows developers and the NYISO to gain knowledge about the technology's capabilities, and will support the PSC's REV demonstration efforts. Pilot projects will help guide the NYISO's continued development of market rules to appropriately incorporate new technology capabilities and meet bulk power system needs. The pilot framework provides the opportunity to test new capabilities and operating paradigms that DERs present.

Large-Scale Solar Integration

4,000 MW

of proposed solar capacity from 75 large-scale projects in the NYISO's interconnection queue as of March 2019.

While rooftop solar has expanded greatly in New York State, large-scale solar installations are relative newcomers. However, their participation in the NYISO's wholesale markets is expected to grow significantly in the coming years. There are currently more than 75 large solar projects in the NYISO's interconnection queue, totaling more than 4,000 MW. In preparation for this shift in the resource mix, the NYISO implemented rules to better accommodate large-scale solar generators. Pursuant to these rules, participating large-scale solar plants will be required to provide meteorological data and pay a forecasting fee to cover the NYISO's costs to procure plant-specific forecasts. Similar requirements exist for wind generators today.

In fact, the NYISO expects to treat these large-scale solar resources similarly to wind resources currently operating in NYISO markets. In addition to forecasting requirements, the rules would require solar plants to submit flexible energy market offers that indicate their willingness to generate at various price levels, and respond to economic dispatch instructions to curtail output when prices reach those levels.

▸ Ancillary Services: Services that support the reliable operation of the power system, which can include voltage support, frequency regulation operating reserves, and black start capabilities.

By enabling solar plants to indicate their economic willingness to generate, system operators will be better able to efficiently dispatch solar energy production. This project supports the NYISO's continued focus on both price formation and resource flexibility.

Ancillary Services

In 2017, the NYISO examined the implications of 50% renewable penetration for its markets' ability to send appropriate price signals. [20] The assessment demonstrated that characteristics such as the ability to ramp up or down, respond rapidly to dispatch instructions, or start up quickly will be critical to the continued resilience of the bulk power system as the

participation of intermittent renewables increases. In the future, energy revenues alone may not adequately compensate suppliers for the value that their ancillary services provide.

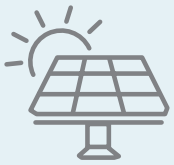
Enhancing the wholesale market's ancillary service offerings will help bolster the revenue adequacy of flexible generators and enhance the operational flexibility of the bulk power system. The initiatives listed below reflect the NYISO's assessment of ancillary services enhancements that will facilitate renewable resource integration. They can be roughly divided into initiatives focused on reserve products and regulation products.

Operating Reserve Product Enhancements

The NYISO's energy market ensures that sufficient capacity is available to meet demand in the near term to address any misalignment between supply and demand through the procurement of operating reserves. Suppliers participating in this market must generally be capable of providing the capacity they offer within ten- or 30-minute timeframes. Historically, this market served to maintain reliability in the event of unplanned contingencies, such as generator or transmission line outages. **As intermittent renewable resources expand across the bulk power system, the NYISO's reserve market will be increasingly important to respond to changes in renewable energy output attributable to weather conditions as well.** With this added operational complexity in mind, the NYISO is pursuing a number of enhancements to its reserves market to spur investment in the types of flexible resources that can support reliability and resilience.

Among the enhancements being pursued are:

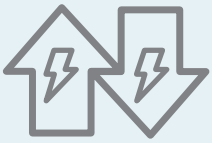
- **Reserves for Resource Flexibility:** The NYISO is considering increasing the level of reserves procured in the market to promote resource flexibility and support grid resilience by recognizing their value in responding to unanticipated, real-time operating needs, such as a sudden large loss of solar or wind generation. The NYISO anticipates a competitive auction design that can aid in providing a cost-effective "insurance policy" against unforeseen disruptions on the bulk power system.
- **More Granular Operating Reserves:** The penetration of behind-the-meter solar can potentially lead to more dynamic load, particularly in concentrated communities like New York City. These load swings require that sufficient resources deliverable to those communities be available to respond to unexpected load increases. The NYISO is working to establish and secure additional reserve requirements for New York City, which will provide location-specific market signals consistent with any reliability need.
- **Ancillary Services Shortage Pricing:** Shortage pricing is a mechanism to more accurately price energy and operating reserves when supply is scarce. Stronger price signals are needed during these times to secure system reliability. While occurring infrequently, shortage pricing events were observed in the 2017 study, which the NYISO believes is an indication that regulation and operating reserves may become more valuable as more intermittent renewable resources come online. The NYISO will be examining its shortage pricing rules to ensure that they reflect system conditions and elicit investment and performance where reserves are most needed.



▸ **"Behind-the-meter" (BTM):** A generation unit that supplies electric energy to an end user on-site without connecting to the bulk power system or local electric distribution facilities.

Regulation Service Product Improvements

Regulation is procured by the NYISO to balance supply and load in real time. **The NYISO signals suppliers in the regulation services market to adjust their output every six seconds in response to real-time changes in system conditions.** Maintaining this balance is critical for reliable system operations. When the NYISO modeled the performance of its markets with high penetration levels of renewable energy resources, it concluded that high regulation prices may become more common. The NYISO is considering market enhancements that will support flexibility on the bulk power system when load and supply become more dynamic. Among the potential changes under consideration are:



Regulation Services
Every six seconds the NYISO signals suppliers to adjust their output in response to real-time changes in system conditions.

- **Separate Regulation Service Products:** Current market rules require that regulation service providers be capable of both increasing output as well as decreasing output when called upon to do so by the NYISO. Separating regulation service into two products: regulation-up and regulation-down, would provide the opportunity for certain types of resources to participate in the market. For example, a combined-cycle plant operating at its minimum generation point could provide regulation-up, and a wind turbine producing energy at its maximum output could provide regulation-down. Today, neither would be able to provide regulation at those operating points due to the requirement that suppliers must offer both services.
- **Improve Regulation Movement Pricing:** Although the regulation capacity price includes the impacts of shortage pricing when regulation capacity is scarce, the same is not true for regulation movement pricing. Today, the offer of the last dispatched resource is used to set the regulation movement price. To incent an appropriate amount of resource movement in a future with significantly more renewable resources, it will be necessary to revisit the pricing of regulation movement to incentivize regulation service suppliers to respond to the second-to-second dispatch signals from the NYISO.

Performance Assurance

The NYISO compensates resources for maintaining capacity availability so that they can be called upon when needed. While many of the NYISO's active and proposed market design projects have performance implications for market participants, the following projects will focus exclusively on improving capacity market expectations to incent resource availability in the NYISO's energy markets.

- **Tailored Availability Metric:** The NYISO is reviewing how resource availability is used in establishing capacity values, and whether adjusting the capacity value calculation to put additional emphasis on critical operating periods is warranted. The NYISO's current method of evaluating a resource's availability treats availability in all time frames equally. In reality, the NYISO's need for capacity is heightened during peak operating windows in the summer and winter. The current method may not accurately represent a resource's preparedness during critical operating periods. Enhancing these measurements could help NYISO markets

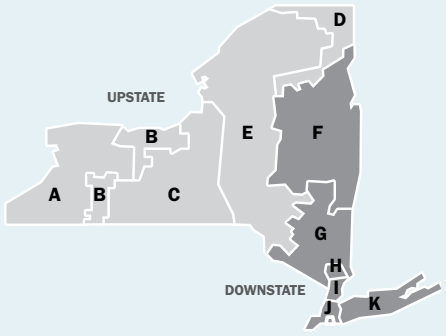
accommodate significant renewable generation, as well as create a more efficient cost structure for consumers.

- **Expanding Capacity Eligibility:** In 2018, as part of its efforts to develop a participation model for DERs, the NYISO conducted an evaluation to compare the value of resources with different maximum duration capabilities, including energy storage technologies. The results of the analysis support the NYISO's proposal to extend its capacity market duration requirement beyond the current 4-hour performance obligation. The study also demonstrated that shorter-duration resources have value in meeting the NYISO's capacity needs, but not the same value to reliability as longer-duration resources.

  Through its shared governance process, the NYISO is engaging stakeholders on a proposal to modify capacity market compensation rules. The intent is to value the reliability contributions of shorter-duration resources while recognizing sufficient resources must be available to address the longer peak-operating conditions occurring on the bulk power system. The proposal contemplates that resources would be allowed to aggregate to meet duration requirements and that payments to limited-duration capacity suppliers would depend on the specific resource's performance duration.

Enhancing Fuel & Energy Security

The mix of fuels used to generate electricity affects the reliability and resilience of the bulk power system. **A balanced array of resources enables the system to better address issues such as price volatility, fuel availability and stressed/abnormal operating conditions. Historically, New York's electric generation fleet consisted of a diverse mix of fuel types including hydro, nuclear, oil, coal, natural gas, and renewable resources.**



▸ **Downstate regions** (New York City, Long Island, and the Hudson Valley — zones F-K) consumed 66% of the state's electric energy in 2018.

▸ **Upstate regions** (zones A-E) accounted for 34% of the electricity consumed in the state in 2018.

Currently, more than 80% of the gas-fired generating units have dual-fuel capability, with natural gas serving as a primary fuel and oil as an alternate fuel. This gas-fired generation is also served by a diverse array of natural gas pipelines and local gas distribution company (LDC) systems. The fuel diversity in New York provides significant reliability and resilience benefits, supporting operational flexibility and resource availability during periods of natural gas supply constraints.

The current price advantage of natural gas is driving development of gas-fired generation and placing economic pressure on generation using more expensive fuels and resources that have higher costs. These factors have resulted in a greater reliance on production from gas-fired facilities to meet load.

To serve the needs of retail gas customers, gas utilities purchase long-term firm gas transportation service equivalent to nearly 100% of the gas pipeline capability in New York. During mild and hot weather conditions, when

retail gas demand is lower, some of the gas pipeline capacity is either sold, released, or becomes available as interruptible gas service. During cold-weather conditions, however, when retail gas demand peaks, gas pipeline capability becomes scarce, especially in the New York City and Long Island regions. As a result, gas pipeline constraints, especially during peak winter conditions, are a growing focus of bulk power system operations.

Environmental regulations also affect the generation mix as emissions caps and pollution control standards require fossil fuel fired generators to limit production, procure allowances to cover emissions, and/or install new emissions control technologies. **Evolving environmental constraints and public policies are expected to accelerate the transition from higher-emitting to lower-emitting resources through a continued transformation of generation resources on the grid.** This shift will place the downstate region — where 70% of the energy produced to serve load is derived from fossil fuels — at increased risk of energy supply disruption. The transition to greater reliance on intermittent clean energy technologies will also require greater operational flexibility to adapt to real-time changes in how energy is produced and delivered.

These conditions present challenges in meeting electric system demands under stressed conditions, such as prolonged cold-weather, natural gas supply constraints, or other disruptions. To address these risks, the NYISO is examining the fuel and energy security of the New York electric grid to identify potential reliability challenges. The results of the assessment are intended to inform recommendations for market or operational enhancements related to fuel and energy security.

The primary objectives of the assessment are to:

- Evaluate potential vulnerabilities and reliability gaps across a wide range of fuel-related risks during extreme weather and other stressed operating conditions
- Provide information regarding similar fuel and energy security initiatives underway by other ISOs/RTOs
- Develop recommendations for potential market and/or operational enhancements to improve grid resilience in response to identified risks

Grid In Transition

Building the Grid of the Future

Nationwide, electric companies are continuing to build stronger, smarter energy infrastructure to provide consumers a more reliable and resilient grid. These efforts seek to increase access to new supply resources and technologies that promote economic competition and environmental stewardship. As the Edison Electric Institute (EEI) notes,

> **"Transmission planning is even more complex than it has been in the past when utilities planned for reliability based on load growth, local generation and load interconnections. Now transmission planners must not only plan for reliability, but also to relieve market congestion, accommodate ever changing public policy needs and mitigate the uncertainty inherent in those needs.** [21]

According to the EEI, in 2017 total transmission investment reached $21.9 billion and is expected to increase by another $89 billion through 2021.[22] Similarly, The Brattle Group reported in 2018 that U.S. transmission investments have stabilized at approximately $20 billion per year after rising steadily from $2 billion per year in the 1990s. [23]

Nevertheless, the demands on the bulk power system are changing. As the North American economy looks toward further electrification to meet energy needs previously supplied by fossil fuels, such as transportation and heating, significant funding will need to be spent to upgrade transmission infrastructure. [24] A Brattle Group study released in March 2019 finds that $30-$90 billion of incremental transmission investments will be necessary in the U.S. by 2030 to meet the changing needs of the system, with an additional $200-$600 billion needed from 2030 to 2050.

The trend toward higher levels of transmission investment will continue as the current infrastructure ages. **EEI finds that, "much of the nation's transmission system is more than 40 years old, with some facilities many decades older."** [25] **New York State is also facing the need to replace its aging transmission, more than 80% of which went into service before 1980.**

New and upgraded transmission capacity will help to:

- Address concerns about maintaining or replacing aging infrastructure
- Enhance access to diverse supply resources
- Provide greater operational flexibility for meeting the reliability and resilience needs of the bulk power system
- Expand access to competing resources providing energy, capacity, operating reserves and ancillary services

To facilitate investment in new and upgraded transmission, the NYISO's planning processes provide independent and authoritative information to investors, stakeholders, and policymakers. These planning processes are designed to support the reliability and efficiency of the electric grid and the ability of the electric grid to support public policy goals.

NYISO's Planning Processes for a Reliable Electric Grid

- Long-term reliability planning processes, including the *Comprehensive Reliability Plan* and the *Reliability Needs Assessment*
- Interregional planning that coordinates system planning across neighboring regions to evaluate how changing system conditions within and across our regions influence system needs
- Resource interconnection processes designed to ensure that new resources effectively interconnect to the grid while maintaining bulk power system reliability and efficiency
- Generator deactivation planning that identifies potential reliability impacts resulting from the deactivation of existing supply resources

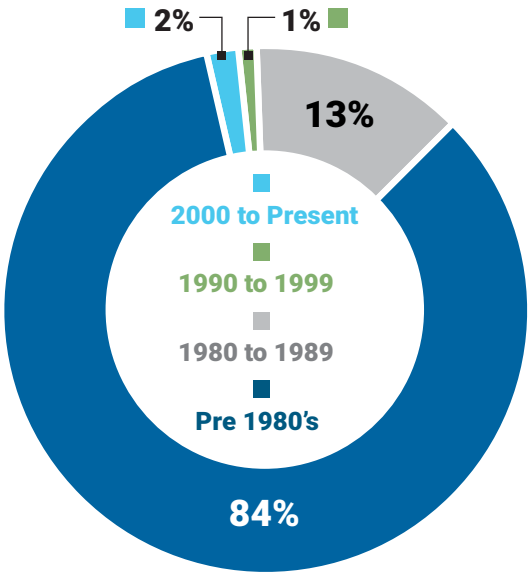
Planning for an Economically Efficient Grid

- Economic planning processes that evaluate and identify opportunities for economic transmission investment

Planning for Public Policy Requirements

- Public policy transmission planning processes that address transmission needs driven by federal and state public policies

▸ Age of New York Transmission Facilities by Percentage of Circuit Mile



The NYISO's planning studies use sophisticated models to assess the capability of the transmission system and the adequacy of resources to meet New York's electric needs

There are numerous factors included in these models to determine system needs, including:

- The impact of changes in generation and transmission resources available to the electric system
- Forecasts of consumer demand and peak loads
- Economic outlook data
- Weather models
- The impact of demand response resources that are paid to reduce energy usage at peak times

Comprehensive Reliability Plan & Reliability Needs Assessment

The NYISO's *2018 Reliability Needs Assessment* (RNA) evaluated expected supply resources, demand levels, and transmission capability of New York's bulk power system for the study period 2019 through 2028. The NYISO develops the RNA in conjunction with market participants as the first step in the NYISO's 2018-2019 Reliability Planning Process. The RNA is conducted every two years and serves as the foundational study used in the development of the NYISO *Comprehensive Reliability Plan* (CRP). Each RNA is performed to evaluate electric system reliability for both resource adequacy

and transmission security over a 10-year study period. If the RNA identifies any violation of reliability criteria for the bulk power system in New York State, the NYISO issues a report which quantifies the amount of megawatts of capacity and the needed location of that capacity necessary to resolve the identified reliability need.

Leveraging the power of competition and seeking to minimize ratepayer costs, the NYISO responds to the identification of reliability needs by soliciting market-based solutions, which may entail investment in transmission, new supply resources, or demand reduction measures. To assure that solutions are available where and when needed, the NYISO also designates one or more responsible transmission owners to develop regulated backstop solutions to address each identified reliability need, while other developers can also provide alternative regulated solutions. Although conducted by the NYISO's planning staff, the RNA is the result of significant stakeholder engagement, culminating in approval by stakeholders in the shared governance process, and final approval by the NYISO's independent Board of Directors.

Following the issuance of the RNA, the CRP details the NYISO's plans for continued reliability of the bulk power system over the ten-year planning horizon. The CRP also updates assumptions critical to determining system needs and evaluates solutions proposed to resolve identified reliability needs found in the RNA. Market-based solutions developed in response to market forces are favored over regulated solutions to reliability needs. If the market does not adequately respond to an identified need, reliability will be maintained by either regulated backstop solutions developed by the transmission owners, which are obligated to provide reliable service to their customers, or alternative regulated solutions developed by other developers.

▸ Download the RNA & CRP Reports:
Visit www.nyiso.com/library under Planning Reports to download the CARIS, Gold Book, Public Policy Planning Reports, and other NYISO planning reports.

Reliability Planning for the NYS DEC's "Peaker Rule"

Issued in draft form in February 2019, the DEC's new peaker rule would require approximately 3,300 MW of peaking unit capacity to file compliance plans outlining how they intend to meet the requirements of the rule. Among the potential compliance plans expected could be a series of unit deactivations. The NYISO, stakeholders, investors, and policymakers have recognized that the potential magnitude of change associated with this proposed rule needs to be assessed to identify what reliability needs may arise if these units are no longer available to supply the bulk power system.

NYISO's CRP & RNA

The *2019-2028 CRP* is a critical first step to effectively plan for the DEC's peaker rule. **The 2019-2028 CRP will include an assessment of the impacts to system reliability from the potential deactivation of all generators impacted by the new rule. The scenario will also reflect the planned deactivation of the Indian Point nuclear units and the remaining coal units in accordance with the DEC rule on emissions from existing sources. This scenario will identify potential reliability needs associated with the loss of those units, and the amount of resources that would be needed to maintain reliability when the rule's lower emission limits take effect in 2023 and 2025.** The *2020 Reliability Needs Assessment* will re-evaluate and refine these findings as the NYISO is made aware of specific compliance plans by each affected unit. Any reliability needs identified as a result of

the 2020 RNA will trigger the NYISO to solicit solutions to ensure the need is satisfied prior to the loss of specific generators.

Generator Deactivation Assessments

Any generating unit that submits a compliance plan to the DEC indicating that it plans to deactivate will be subject to the NYISO's generator deactivation assessment process. Based on these assessments, the NYISO may designate certain units as necessary to maintain system reliability, extending operation of these units while new solutions to the reliability need are being developed.

Recognizing the significance of these peaking units in supporting bulk power system reliability, the DEC's proposed rule acknowledges the role of the NYISO in determining reliability needs and soliciting appropriate solutions for those needs. The challenge before policymakers, investors, peaking unit owners, and the NYISO will be to consider proposed projects in response to identified reliability needs in an effective and timely manner. While the DEC's proposed rule aligns closely with state public policy initiatives designed to promote storage investment, the breadth and scope of the rule and its implications to bulk power system reliability require careful consideration of all proposed infrastructure investments.

To ensure that the emissions benefits and system reliability needs are met in an efficient and cost effective manner, policymakers must be open to a portfolio of solutions that may include fossil fuel generators to replace an identified amount of existing peaking units. In certain load pockets, where transmission constraints require that local generators be available to serve load, energy storage solutions may not be sufficient to meet resource needs in compliance with mandatory reliability standards. For instance, energy storage units must be charged in order to be available to serve load, yet the nature of load pockets is such that importing energy into the pocket is constrained, complicating the charge/discharge cycle for energy storage.

Planning Transmission Infrastructure for Public Policy Requirements

Under the NYISO's public policy transmission planning process, interested entities propose, and the New York State Public Service Commission (PSC) identifies, transmission needs driven by public policy requirements. A public policy requirement is defined in the tariff as a federal or state law or regulation, including a PSC rulemaking order, which drives the need for additional transmission capability in the state.

▸Public Service Commission (PSC):

The Department of Public Service (DPS) is the staff arm of the Public Service Commission (PSC). The PSC regulates the state's electric utilities and exercises jurisdiction over the siting of major electric transmission facilities in New York State.

In response to a declared public policy need, the NYISO requests that interested entities submit proposed solutions and evaluates the viability and sufficiency of those proposed solutions to satisfy each identified need. The NYISO then ranks the solutions and may select the more efficient or cost-effective transmission solution to each identified need. The NYISO issues its findings through a *Public Policy Transmission Planning Report*, which is reviewed by NYISO stakeholders and approved by the Board of Directors.

As discussed throughout this report, environmentally focused public policies are shaping the way energy is supplied and consumed in New York. Those policies have a significant impact on current transmission system conditions and future transmission needs. NYISO studies indicate that achieving public policy objectives will require additional transmission

capacity in New York State to deliver renewable resources from upstate and northern regions to consumers downstate.

Much of New York's existing and proposed renewable energy capability is upstate. The resource mix and geographic distribution of new renewable resources are expected to dramatically change power flows. To maximize the load served by renewable generation, cross-state energy transfers will increase — even as statewide load decreases — due to the fact that more renewable generation is available upstate to serve the downstate load.

As renewable energy production in the upstate regions exceeds the load in those same regions, additional energy transfers from upstate renewable resources to downstate load centers are necessary.

- **Failure to expand transmission capabilities from upstate to downstate will induce market inefficiencies,** including increased curtailment of renewable generation and additional generator deactivation notices from units needed for reliability.
- Further, if markets are unable to produce appropriate price signals due to the expansion of renewable capacity without an adequate expansion of transmission capability, **the Clean Energy Standard goal of achieving 50% renewable energy generation by 2030 will be jeopardized** because energy delivery from renewable resources to downstate load centers will be constrained.
- **A robust and flexible transmission system will become even more essential** if the state enacts proposed legislation to generate 70% renewable energy by 2030 and carbon neutral electricity supply by 2040.

▸ Federal Energy Regulatory Commission (FERC):

The federal regulatory agency that approves the NYISO's tariffs and regulates its operation of the bulk power system wholesale power markets, and planning.

Western New York Public Policy Need

In October 2017, the NYISO's Board of Directors selected a proposal from NextEra to address the public policy need for new transmission in Western New York to support the state's goal of maximizing the flow of energy from renewable resources in the region. The decision represented the first selection of a transmission project by the NYISO using the Public Policy Transmission Planning Process approved by FERC under Order No. 1000. It is the culmination of a joint effort by the NYISO, the PSC, developers, and stakeholders to address transmission needs in Western New York. Those needs are driven by New York State public policy requirements to more fully utilize renewable energy from the Robert Moses Niagara Hydroelectric Power Station as well as imports from Ontario.

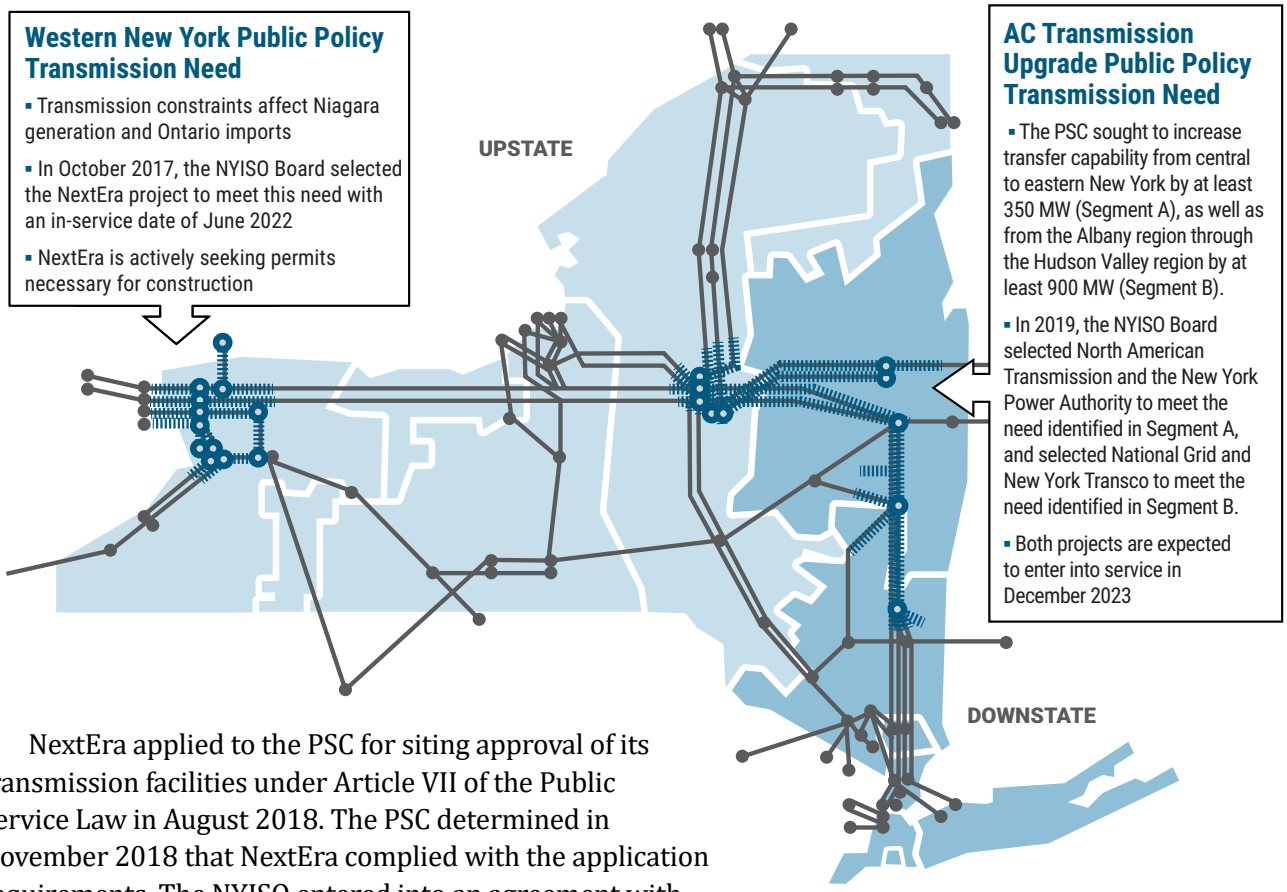
While maximizing the flow of energy from renewable resources, the transmission upgrades are also expected to provide reliability, environmental and economic benefits, including:

- Improving transmission security
- Reducing emissions
- Increasing consumer access to lower-cost resources

Utilizing existing rights-of-way, NextEra's proposal includes:

- Two new 345 kV substations near Dysinger and Elma
- A 20-mile 345 kV line connecting the new substations
- A phase angle regulator (PAR) to control power flows

Figure 26: **Public Policy Transmission Needs in New York State**



NextEra applied to the PSC for siting approval of its transmission facilities under Article VII of the Public Service Law in August 2018. The PSC determined in November 2018 that NextEra complied with the application requirements. The NYISO entered into an agreement with NextEra for the development of the transmission project, including a schedule for siting, permitting, interconnection and construction. NextEra and the NYISO will also enter into an operating agreement for the new facility, which is expected to enter into service by June 2022.

AC Transmission Public Policy Need

In December 2015, the PSC advanced its AC transmission proceeding to a competitive process managed by the NYISO. The proceeding identified a Public Policy Transmission Need to relieve congestion on the Central East and UPNY/SENY interfaces, which run from central New York, through the Capital Region to the lower Hudson Valley.[26] The PSC action sought to increase transfer capability from central to eastern New York by at least 350 MW (Segment A) and from the Albany region through the Hudson Valley region by at least 900 MW (Segment B).

In April 2016, developers submitted 15 transmission projects and one non-transmission project in response to NYISO's solicitation of proposed solutions. Following a stakeholder review and comment period, the NYISO issued the AC Transmission Public Policy Transmission Need Viability and Sufficiency Assessment. [27] Out of the 16 proposed projects, the NYISO identified 13 viable and sufficient projects, and filed its assessment with the PSC. On January 24, 2017, following consideration of public comments, the PSC issued an order confirming the AC Transmission Needs and determined that the NYISO should proceed with its public policy process. [28]

Figure 27: **Wind Generation in New York – Nameplate Capacity: 2003-2019**

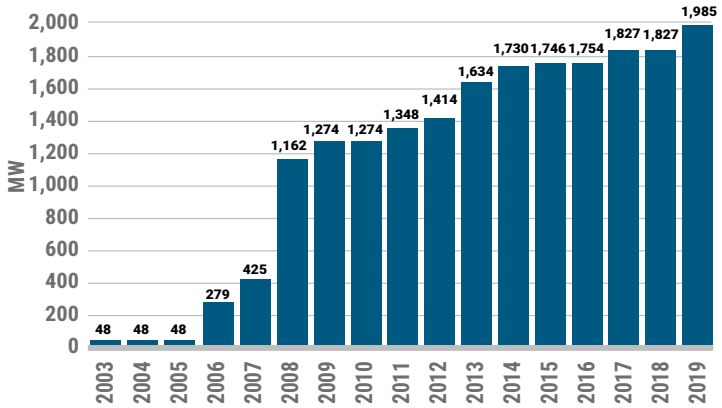
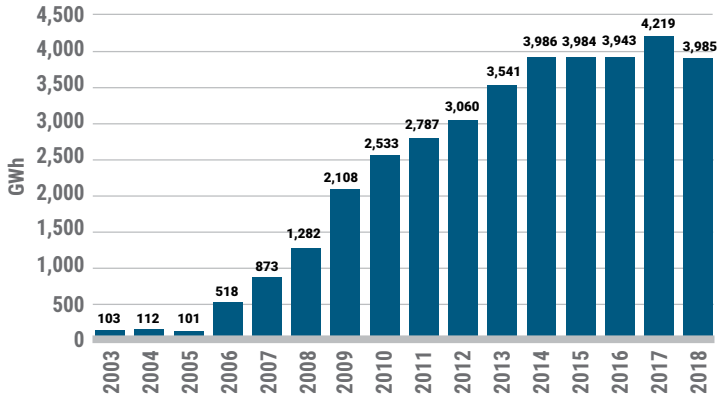


Figure 28: **Wind Generation in New York – Energy Produced: 2003-2019**



Following a detailed evaluation of the benefits and costs of the proposals, and careful consideration of stakeholder comments, the NYISO's Board of Directors issued a decision on April 8, 2019, finding that a joint proposal by North American Transmission and the New York Power Authority (NYPA) was the more efficient or cost-effective solution for Segment A. For Segment B, the Board found that the more efficient or cost effective solution was a joint proposal by National Grid and New York Transco. The selected developers are responsible for entering into agreement with the NYISO for the development of their transmission projects, and for submitting the projects to appropriate governmental agencies and authorities to obtain approvals to permit, site, construct and operate them.

Both the Central East and UPNY/SENY interface projects are expected to enter into service by December 2023. When completed, the AC Transmission projects will add the largest amount of free-flowing transmission capacity to the New York bulk power system in more than 30 years. These projects will add significant transfer capability to deliver renewable resources from upstate solar, wind, and hydro resources to meet the power needs of downstate New York and help the State of New York fulfill the Clean Energy Standard. The projects are also expected to lower total system electricity production costs, lower system capacity procurement costs, replace aging transmission infrastructure, improve system performance, reduce emissions, and add resilience and operating flexibility to the New York power grid.

Identifying New Public Policy Transmission Needs

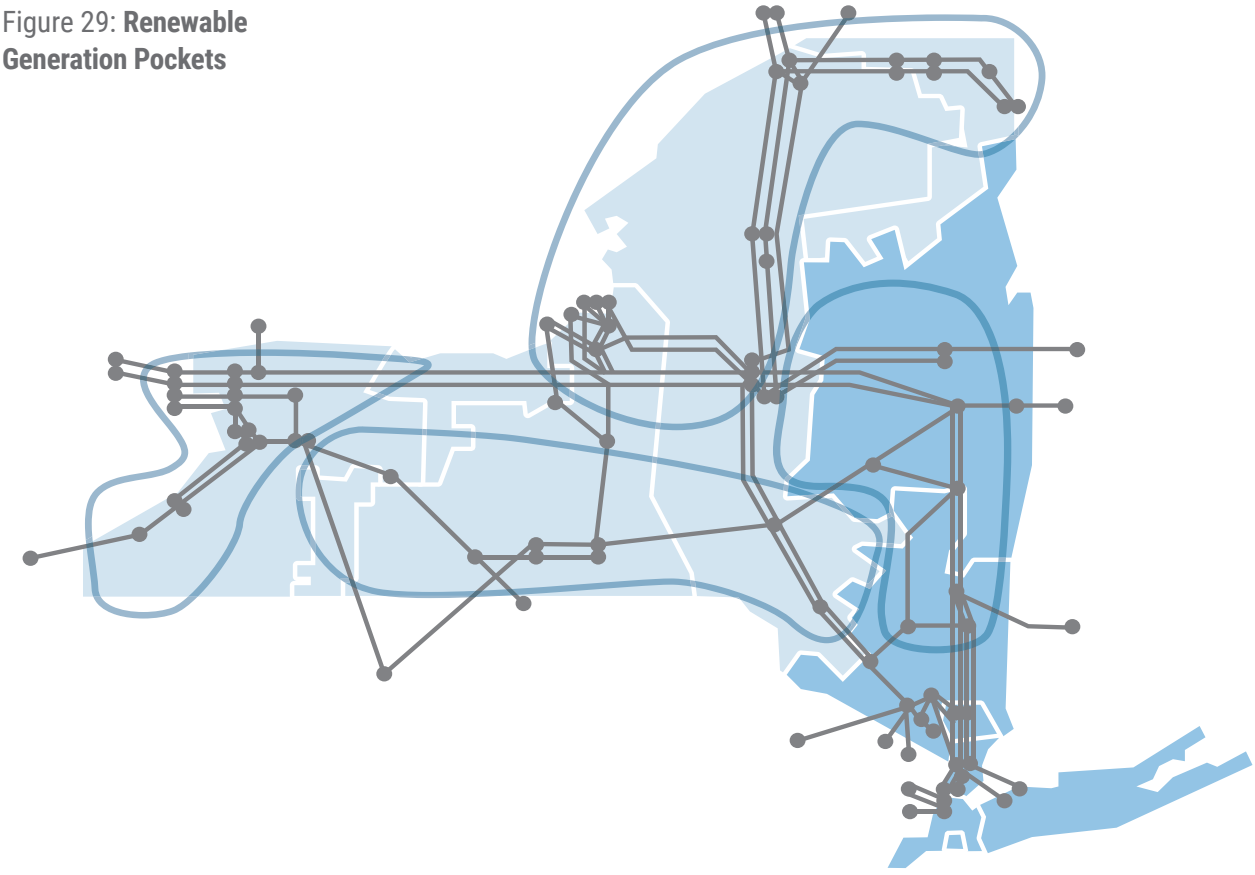
The NYISO initiated a third cycle of the public policy process on August 1, 2018 by inviting stakeholders and interested parties to submit proposed transmission needs that they believe are being driven by Public Policy Requirements.[29] Fifteen entities representing a broad spectrum of interests, from utilities to developers to public interest groups, identified the Clean Energy Standard as a Public Policy Requirement driving transmission needs, and many of the submissions encouraged the PSC to act to expand transmission system capability as soon as possible in order to meet the state's renewable energy goals.

The NYISO submitted the proposed transmission needs it received to the PSC in October 2018. In January 2019, the NYISO filed its own comments addressing additional public policy transmission needs supporting the delivery of renewable resources from constrained regions within upstate New York to statewide load, and for delivery of offshore wind to the bulk power system.

Relieving Renewable Energy Bottling in Upstate New York

Based upon the NYISO's experience, high-voltage transmission in the northern corridor would un-bottle the renewable generating capacity in that region. This would allow existing capacity to operate at its full output while simultaneously allowing for the delivery of additional renewable resources from upstate New York and Canada to consumers in the eastern and southern load centers of New York State.

Figure 29: **Renewable Generation Pockets**



Furthermore, new transmission capacity could allow developers to explore sites that are attractive for wind and solar resources, but are underserved by the existing transmission system. Access to the transmission system becomes an issue, as many sites with convenient access to the grid have already been taken or are under development. Conceptually, expanding transmission in certain key locations could facilitate the interconnection of new wind and solar resources that are not in proximity to the system, as well as un-bottle energy from existing wind resources. For example, expansion of the New York State transmission system in the St. Lawrence to Marcy corridor would afford opportunities for renewable resources to provide additional output to consumers statewide.

▸ **Wind Curtailment:** Signals from the NYISO directing wind resources to reduce output based on transmission constraints and price offers from wind generators in the wholesale energy market.

Absent additional transmission, these curtailments will only grow as additional wind and solar resources are added to the upstate grid. In 2018, the NYISO conducted a study of transmission that identified constraints in four regions, which limit the ability for the state as a whole to receive energy from new renewable energy investments in those regions. Additional transmission will be needed to allow renewable energy to reach consumers from these renewable generation pockets.

Offshore Wind Transmission Network

Spurred by a growing demand for renewable energy, offshore wind development is accelerating along the coastlines of New England, New York and the Mid-Atlantic.[30] The State of New York has established an Offshore Wind Master Plan calling for construction of offshore wind off the coast of Long Island and New York City to help meet the Clean Energy Standard goals. [31] Recently, Governor Cuomo called for the construction of up to 9,000 MW of offshore wind by 2035.

In 2017, the NYISO conducted a technical feasibility assessment, at the request of DPS Staff, to evaluate the feasibility of a potential injection of up to 2,400 MW of offshore wind into New York City and Long Island by examining thermal bulk power transmission security. [32] From that assessment, the NYISO concluded that it may be feasible to implement offshore wind considering a variety of potential injection points. A closer examination will be required to identify underlying planning and operational issues. If the PSC identifies a need for an offshore transmission network, the NYISO's Public Policy Process would allow for the technical assessment of those needs and the development of creative and innovative transmission solutions. Such a transmission project, if selected in the NYISO's process, would be eligible for cost allocation and recovery under the NYISO's tariffs.

Interregional Planning

Under FERC Order No. 1000, and in collaboration with its New England (ISO-NE) and Mid-Atlantic (PJM Interconnection) neighbors, the NYISO expanded its interregional planning process based upon the existing Northeastern ISO/RTO Planning Coordination Protocol that had been in place for more than a decade. In May 2018, the three ISO/RTOs issued the 2017 Northeast Coordinated System Plan, which did not identify a need for new interregional transmission projects at that time. [33]

As a member of the Eastern Interconnection Planning Collaborative (EIPC), the NYISO also conducts joint evaluations with planning authorities across the entire Eastern Interconnection, a region that includes 40 states and several Canadian provinces from the Rocky Mountains to the

Atlantic Ocean, and from Canada south to the Gulf of Mexico. The NYISO was a leader in the formation of the EIPC, which involves 20 electric system planning authorities, and was created in 2009 as the first organization to conduct interconnection-wide planning analysis across the eastern portion of North America.

Among its efforts, the EIPC conducted studies assessing a range of possible energy futures which found the reliability plans of electric system planners in the Eastern Interconnection integrated well to meet potential reliability needs.

In October 2018, the EIPC issued the *State of the Eastern Interconnection Report* that summarizes the work completed by the EIPC since its inception in 2009. Specific topics include reports that combine the individual plans of each of the major planning coordinators in the Eastern Interconnection and verify that that the individual plans work together to maintain bulk power system reliability throughout the interconnection. These reports are also used to analyze various future scenarios of interest to policymakers and other stakeholders. They also extend the collaborative activities started under a U.S. Department of Energy grant in 2010 to study the Eastern Interconnection transmission system under a wide variety of future scenarios and resource mixes.

The State of the Eastern Interconnection Report concludes that the individual power systems in the Eastern Interconnection are being planned in a coordinated manner. Studies completed by the EIPC demonstrate that the respective transmission planning and interconnection processes have yielded transmission plans that are well coordinated on a regional and interconnection-wide basis. EIPC studies also show that planning coordinators' regional transmission plans, including generator retirements and additions, will require continued study enhanced by broader interconnection-wide coordination to ensure that individual regional plans do not conflict with other regional plans.

Congestion Assessment & Resource Integration Study (CARIS)

The NYISO evaluates congestion on the New York bulk power system as part of its planning processes with its biennial *Congestion Assessment and Resource Integration Study* (CARIS). The study is an economic analysis of transmission congestion on the New York bulk power system and the potential costs and benefits of relieving transmission congestion.

Solutions to congestion may include:

- Building or upgrading transmission lines and related facilities
- Building generation within constrained areas
- Employing measures to reduce annual energy consumption for electricity in the congested locales
- Employing measures to reduce peak demand for electricity in the congested locales

The CARIS process analyzes generic transmission, generation, energy efficiency, and demand response solutions in regions that could ultimately yield congestion cost savings for power consumers. [34]

▸ Download the CARIS Report:
Go to www.nyiso.com/library under Planning Reports to download a PDF file of the report. While you are there check out other reports, videos and ebooks.

The *2017 CARIS study* published in April 2018 identified the most congested parts of the New York State bulk power system based upon historical data (2012-2016) as well as estimates of future congestion (2017-2026).

The CARIS study shows the most congested areas of the transmission system are associated with the Central East Interface that runs between Utica and Albany. The study also shows increasing congestion towards the downstate load areas and that system production cost savings would be realized by relieving constraints between Central East and the lower Hudson Valley. These findings reinforce many prior studies demonstrating the benefits of relieving transmission constraints between upstate and downstate New York. By relieving these constraints, energy from existing upstate resources would economically flow to where it is needed downstate. It would also support the development of new renewable sources of power upstate and greater use of renewable energy resources from Canada.

▸ Interconnection Queue:

A queue of merchant transmission and generation projects that have submitted an Interconnectoin Request to the NYISO to be interconnected to the state's electric system. Depending on the level of proposed capacity, most projects must undergo three studies before interconnecting to the grid: a *Feasibility Study* (unless parties agree to for go it), a *System Reliability Impact Study* (SRIS), and a *Facilities Study*.

Merchant/Class Year Transmission Proposals

Several merchant plans for transmission have emerged and are in various stages of development. Merchant transmission projects are not necessarily associated with transmission projects driven by reliability, public policy, or CARIS-like needs for transmission expansion. Merchant transmission investment, much like merchant supplier investment, seeks to put private capital to work to expand bulk power system capability. Rather than regulated rates of return, revenue for these transmission projects is driven by the grid's use of these merchant facilities.

The NYISO interconnection queue includes several merchant transmission projects under development. Like proposed generation projects in the NYISO's interconnection queue, inclusion in the queue and the completion of various stages of the interconnection studies does not indicate that individual facilities will be completed and enter into service. However, the interconnection queue includes more than 7,500 MW of additional transmission capacity within the state, including projects that seek to expand capability from upstate New York and Canada to downstate New York and projects seeking to export power to neighboring regions.

These transmission proposals are in addition to those being developed under the NYISO's Public Policy Planning Process described above.

Further Enhancing the NYISO's Planning Processes

Generator Interconnection Queue Process Enhancements

In order to safely interconnect to the bulk power system, new generation must go through a robust interconnection study process to ensure that it will not cause any adverse reliability impacts. The NYISO, in coordination with the connecting utility and any potential affected systems, such as neighboring utilities, assesses the reliability impacts of a connecting generator to the grid. If reliability issues are identified, the NYISO's interconnection study process identifies upgrades and estimates costs associated with those upgrades to allow the generator to interconnect reliably.

As the composition of the power grid changes, and the pace of new technology development accelerates, the NYISO interconnection process will need to continue to evolve to facilitate new entry. The NYISO regularly reviews its interconnection processes and works collaboratively with its stakeholders to evaluate opportunities for improvement. In December 2017, FERC accepted a comprehensive reform to the NYISO's interconnection processes to improve the efficiency of the processes, while ensuring system reliability and the equitable treatment of developers. Subsequent to FERC's acceptance, the NYISO began implementing these process enhancements. In April 2018, FERC issued a nation-wide rule adopting ten specific reforms to the pro forma interconnection processes it created for grid operators to follow in its interconnection evaluations of large generators. FERC intended for the revised procedures to provide more certainty, transparency and options for obtaining interconnection services through RTOs and ISOs. These required process changes dovetail with the comprehensive reforms the NYISO recently implemented as well as current efforts to further improve the process.

NYISO's Comprehensive System Planning Process Enhancements

The process of transmission planning is rapidly evolving to meet the challenges of meeting infrastructure needs in a power system that is rapidly changing its resource mix. The NYISO is undertaking myriad initiatives with its stakeholders aimed at addressing the evolving nature of the electric system in New York. The objective of this effort is to identify potential enhancements and efficiency improvements across the NYISO's comprehensive planning process for reliability, economic, and public policy planning responsibilities. As the Edison Electric Insitute (EEI) notes.

> **"Continued investment in transmission infrastructure will be required to maintain reliability, enhance grid security, support shifts in the nation's generation portfolio, offer greater flexibility in transmission operations with the increase in distributed energy resources, and meet public policy requirements."** [35]

In 2018, the NYISO began an initiative to examine how to further integrate and improve its Comprehensive System Planning Process (CSPP) to be more responsive to evolving reliability, economic and public policy needs. FERC has already approved one set of process changes to streamline the NYISO's Public Policy Process ahead of additional public policy transmission needs that could be identified this year to fulfill the Clean Energy Standard, Offshore Wind Master Plan and other state policy initiatives.

In 2019, the NYISO will make further improvements to its public policy process and propose changes to further integrate its planning for reliability, economic and public policy needs. This effort seeks to enable the NYISO to continue effectively performing its mission of providing independent and authoritative information to market participants, investors, and policymakers. The NYISO project also intends to identify key infrastructure the state needs to make progress toward its ambitious clean energy and climate change policies.

Enhancing Resilience through Markets, Operations, & Planning

Over 1,000

FERC, NERC, NPCC and NYSRC requirements that the NYISO must adhere to in the operation and planning of the grid.

Appropriate levels of reliability and security are clearly defined in the reliability standards, operating and system planning requirements, and security and infrastructure protection rules established by FERC, the North American Electric Reliability Corporation (NERC), the Northeast Power Coordinating Council, Inc. (NPCC), and the New York State Reliability Council (NYSRC). Together, these entities define over 1,000 requirements the NYISO must abide by in its operating and planning of the bulk power system, and in its administration of New York's competitive wholesale electricity markets.

Reliability and resilience are not necessarily separate and distinct concepts in relation to the electric system. Rather, these two concepts are highly intertwined and often indistinguishable. For example, maintaining reliability encompasses resilience measures such as:

- **Forward looking design of the system** to withstand multiple contingency events and enable the capability to absorb the impact from the loss of multiple facilities
- **Advance operational planning** by operating the system to meet single contingency events, thereby ensuring that the failure of one system component will not disrupt the continued operation of the system
- **Redundancy and rapid recovery** in the form of procuring voltage support, regulation service, and operating reserves to assist with responding to unanticipated disturbances that may arise
- **Emergency preparedness,** such as black start capability, coordination of system restoration, and procedures for addressing geomagnetic disturbances
- **Disciplined focus on cyber and physical security** to protect the assets that run our bulk power system and markets
- **Redundancy in infrastructure design** for critical infrastructure
- **Development of business continuity plans** to provide for continued operation of critical functions in the event that unplanned disturbances or interruptions arise

Resilience that goes beyond traditional measurements of reliability includes measures that could assist in more expeditious recovery from disruptive events.

In this way, resiliency is closely linked to the importance of:

- **Maintaining and expanding interregional interconnections**
- **The building out of a robust transmission system**
- **Evaluation of additional resources, resource capabilities, and services in critical areas, such as energy storage, which could support rapid recovery from system disturbances**

NYISO Planning for Resilience

The NYISO, in coordination with its stakeholders, is undertaking a comprehensive re-evaluation of its current planning processes (i.e., reliability, economic, and public policy). This assessment is intended to identify potential enhancements to improve the overall speed and efficiency of the

NYISO's current planning processes. More efficient transmission planning processes are critical to achieving a more robust and resilient transmission system that serves as the catalyst for the industry's continued transformation.

As previously discussed, the confluence of technological advancements, environmental and economic considerations, and public policies are driving significant changes to the portfolio of supply resources in New York. These conditions highlight the potential for future challenges to arise in meeting electric system demands under certain stressed conditions such as prolonged cold weather events and/or natural gas supply or transportation availability constraints or disruptions.

In response, the NYISO is conducting a forward-looking Fuel & Energy Security Initiative to assess the ability of the electric system to meet system needs during stressed operating conditions, such as prolonged cold weather events. This effort is intended to provide key information about the types and magnitude of risks that may be faced by the bulk power system.

NYISO's Wholesale Markets & Grid Operations Enable Resilience

Maintaining power system reliability is the NYISO's primary responsibility, and the role of wholesale electricity markets is critical in carrying out this responsibility. **The NYISO administers both day-ahead and real-time markets to procure the necessary energy and ancillary services to reliably operate the system and continuously meet the electricity demands of customers, at the lowest overall production cost based on the offers submitted by resources competing to provide service.** These market processes also consider system contingencies necessary for maintaining reliability should system conditions change.

▸Day-Ahead vs. Real-Time Markets:

In the Day-Ahead Market, wholesale electricity and ancillary services are auctioned and scheduled one day prior to use.

Real-Time Markets address changes in operating conditions relative to what was anticipated in the day-ahead market.

The NYISO continues to evaluate, with its stakeholders, opportunities to leverage competitive wholesale electricity market products and services to bolster the resilience of New York's bulk power system. The changing portfolio of resources serving the electric needs of New York will require a careful and comprehensive review of the NYISO's existing market products and operational practices to ensure the continued ability to efficiently and reliably serve New York's electricity requirements. The Fuel & Energy Security Initiative will help to inform discussions on potential market and operational enhancements to best prepare the system for the evolving resource mix and operational challenges it may face in the near future.

Collaboration among electric industry participants is essential to the development of solutions to these challenges in an effective and equitable manner. The NYISO's shared governance process has a proven track record of success in addressing the challenges and opportunities facing the bulk power system and wholesale electricity markets in New York.

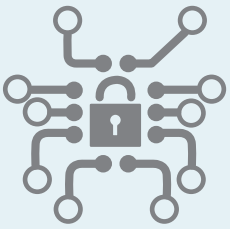
Resilience through Grid Cyber & Physical Security

Threat actors are innovative, adaptive, and will move quickly to exploit any weakness. To address these risks and maintain our ability to operate New York's bulk power system to stringent reliability standards, the NYISO has a comprehensive program for addressing physical and cybersecurity risks.

This risk-based program draws from both mandatory NERC Critical Infrastructure Protection (CIP) standards and other industry standards and guidelines. The NYISO's security posture is premised on continuous evaluation of its assets, vulnerabilities, and threats. The NYISO implements its compliance with mandatory cyber and physical security requirements as part of a layered, defense-in-depth strategy that relies on processes, state-of-the-art technology, and skilled staff to protect its critical infrastructure assets from incursion.

▸Critical Infrastructure Protection (CIP):

A set of standards designed to secure the assets required for operating the bulk power system.



The NYISO implements the cyber and physical security standards as part of a layered, "defense-in-depth" posture that seeks to defend its critical infrastructure assets from incursions.

— NYISO's stance on the CIP standards

NERC CIP standards require that the NYISO conduct in-depth, risk-based analyses to identify, classify, and protect cyber assets based on their potential impact on electric system reliability. The NYISO is actively engaged in enhancing cyber and physical security practices to address evolving risks by collaborating with various state and federal agencies, other ISOs/RTOs, and other industry partners. This collaboration includes information sharing to enhance situational awareness and grid security exercises that simulate the electric sector's response to potential cybersecurity and physical security threats and incidents.

At the national level, the NYISO is engaged with FERC, NERC, the Electricity Information Sharing and Analysis Center, Cybersecurity Risk Information Sharing Program (CRISP), Department of Energy, Department of Homeland Security, and the Federal Bureau of Investigation. The NYISO actively participates in the cyber and physical security policy and standard development activities undertaken by these entities, and is fully engaged in collaborative relationships with these entities for classified briefings and real-time cybersecurity information sharing and threat detection.

In October 2018, FERC approved new mandatory reliability standards designed to enhance supply chain risk management protections for the nation's bulk electric system. These standards are designed to mitigate threats to power grid operations by threat actors seeking to circumvent the strong security programs of electric sector organizations. The NYISO has implemented these supply chain security standards to ensure vendors and other external partners employ strong security practices.

Recognizing that the capabilities of threat actors could be amplified if there is inadequate threat intelligence and sharing of information throughout the New York electric sector, the NYISO regularly collaborates on security initiatives with a number of New York State and local agencies. These partnerships include the Department of Public Service, Division of Homeland Security and Emergency Services, New York State Police, and New York City Police Department. In coordination with local, state and federal agencies, electric and gas utilities, and other industry organizations, the NYISO has developed and led New York State cybersecurity exercise events. These exercises facilitate the testing of incident response plans, identify opportunities for improvement, and enhance collaboration and information sharing among state agencies and the industry.

The NYISO also participates in GridEx, a biennial sector-wide grid security exercises conducted by NERC. As NERC stated in its recent testimony before the United State Senate Energy and Natural Resources Committee, "NERC's biennial GridEx exercise is the largest of its kind in the sector and helps industry and government exercise their emergency response plans, and drive new and innovative approaches to reduce security risk to the electric grid." [36]

While national in scope, GridEx involves coordination with New York State agencies and market participants. GridEx is designed to enhance coordination of cyber and physical security resources and practices within the electric industry, improve communication and coordination between the industry and government partners, and support continuous improvement through lessons learned.

Conclusion

For nearly 20 years, the NYISO's competitive wholesale markets, bulk power system operations, and comprehensive system planning processes have played a central role in transforming the energy landscape in New York. Underlying all NYISO processes in this time has been the belief that open, competitive markets for wholesale electricity result in the most efficient allocation of resources and serve New Yorkers best by minimizing the costs of producing the energy, while shifting investment risk from ratepayers to developers. Gains in system efficiency, improved environmental performance, and reduced costs have been the hallmark of the NYISO's management of the bulk power system.

Driven by public policy, technological innovation, and economic factors, the pace of change is accelerating rapidly. Speaking to the U.S. Senate Energy and Natural Resources Committee in February 2019, former Energy Secretary Ernest Moniz addressed the challenges and opportunities of our changing energy landscape: **"Accelerating this transformation won't be easy: the U.S. energy system has considerable inertia and risk aversion, since the industry is highly capitalized and must provide essential services all the time. This creates an inherent tension between the energy incumbents and the technology disruptors that must instead be harnessed to advance innovation, with incumbents and disruptors each playing an essential role."**

The transformative mission before the NYISO is to align the critical objectives of reliability and economic efficiency with public policy initiatives. New York State is a national leader in accelerating change and promoting a cleaner grid. As policymakers seek a more rapid and widespread change in how energy is produced and consumed, the NYISO believes its markets and planning processes must continue to serve as a platform to facilitate this transformation.

Through engagement with policymakers, regulators, and stakeholders, the NYISO intends to develop the innovative market products and planning tools designed to address the needs of the grid of the future.

Glossary

The following glossary offers definitions and explanations of phrases used in *Power Trends 2019*, as well as terms generally used in discussions of electric power systems and energy policy.

Ancillary Services: Services that support the reliable operation of the power system, which can include voltage support, frequency regulation, operating reserves, and blackstart capabilities.

Behind-the-Meter Generation: A generation unit that supplies electric energy to an end user onsite without connecting to the bulk power system or local electric distribution facilities. An example is a rooftop solar photovoltaic system that only supplies electricity to the facility on which it is located.

Bulk Power System: The transmission network over which electricity flows from suppliers to local distribution systems that serve end-users. New York's bulk power system includes electricity-generating plants, high voltage transmission lines, and interconnections with neighboring electric systems located in the New York Control Area (NYCA).

Capability Period: Lasting six months, the Summer Capability Period goes from May 1 through October 31. The Winter Capability Period runs November 1 through April 30 of the following year. A Capability Year begins May 1 and runs through April 30 of the following year.

Capacity: Capacity is the maximum electric output that a generator can produce. It is measured in megawatts (MW).

Capacity Factor: Capacity factor measures actual generation as a percentage of potential maximum generation. For example, a generator with a 1 megawatt capacity operating at full capacity for a year (8,760 hours) would produce 8,760 megawatt-hours (MWh) of electricity. That generator would have an annual capacity factor of 100%.

Carbon Pricing: A market-based approach to create incentives for reduced carbon dioxide emissions by incorporating costs associated with carbon dioxide emissions, such as damage to crops or health care costs, into energy markets.

Clean Energy Standard (CES): A New York State requirement that 50% of the energy consumed in the state be generated by eligible renewable energy resources by 2030. Often referred to as the "50-by-30 goal."

Comprehensive Reliability Plan (CRP): A study undertaken by the NYISO that evaluates projects offered to meet New York's future electric power needs, as identified in the *Reliability Needs Assessment* (RNA). The CRP may trigger electric utilities to pursue regulated solutions to meet reliability needs if market-based solutions will not be available to supply needed resources. It is the second step in NYISO's reliability planning process.

Comprehensive System Planning Process (CSPP): The NYISO's ongoing process that evaluates resource adequacy and transmission system security of the state's bulk power system over a 10-year period and evaluates solutions to meet those needs. The CSPP contains four major components: local transmission planning, reliability planning, economic planning, and public policy transmission planning. Each planning cycle begins with the Local Transmission Plans of the New York transmission owners, followed by NYISO's *Reliability Needs Assessment* (RNA) and *Comprehensive Reliability Plan* (CRP). Using the most recent reliability planning model, economic planning is conducted through the *Congestion Assessment and Resource Integration Study* (CARIS), and projects to meet transmission needs driven by federal, state, and local laws and regulations are analyzed through the Public Policy Transmission Planning process.

Congestion Analysis and Resource Integration Study (CARIS): Part of the NYISO's comprehensive System Planning Process, CARIS evaluates the

economic impact of proposed system changes. It consists of congestion studies developed with market participant input, as well as additional studies that individual market participants may request and fund. CARIS is based on the most recently approved CRP.

Critical Infrastructure Protection (CIP) Standards: A set of requirements designed to secure the assets required for operating the bulk power system. CIP requirements include the security of electronic perimeters, protection of critical cyber assets, personnel training, security management, and disaster recovery planning. CIP standards are developed by NERC, and approved by FERC.

Curtailment: In the context of intermittent sources of generation, refers to signals from the NYISO directing an intermittent resource to reduce its output. Sometimes referred to as economic curtailment, the NYISO's signal is based on the intermittent resources' price offers in the energy market, whereby transmission constraints induce prices that make the continued operation of certain intermittent resources uneconomic, prompting a reduction in output to alleviate the transmission constraint.

Day-Ahead Market (DAM): A NYISO-administered wholesale electricity market in which electricity and ancillary services are auctioned and scheduled one day prior to use.

Demand Response (DR) Programs: A series of programs designed to facilitate economic- and reliability-based load reduction measures by compensating electricity users that reduce consumption at the direction of the NYISO, either by economic dispatch or in response to a reliability condition. The NYISO demand response programs include Day-Ahead Demand Response Program (DADRP), Demand Side Ancillary Services Program (DSASP), Emergency Demand Response Program (EDRP), and Special Case Resources (SCR) program.

Distributed Generation: A generator — typically 10 MW or smaller — attached to the distribution grid. Distributed generation can serve as a primary or backup energy source and can use various technologies, including wind generators, combustion turbines, reciprocating engines, and fuel cells.

Distributed Energy Resource (DER): A broad category of resources that includes distributed generation, energy storage technologies, combined heat and power systems, and microgrids. A DER is generally customer-sited to serve the customer's power needs, but may, in some instances, sell excess energy production or ancillary services to the power system.

Eastern Interconnection: The Eastern Interconnection is one of the three electric grid networks in North America. It includes electric systems serving most of the United States and Canada, from the Rocky Mountains to the Atlantic coast. The other major interconnections are the Western Interconnection and the Texas Interconnection.

Electric Grid: An interconnected network for delivering electricity from suppliers to consumers. It consists of generators that produce power, transmission lines that carry power to demand centers, and distribution lines that connect individual customers.

Electricity Market: In economic terms, electricity is a commodity capable of being bought, sold, and traded. An electricity market is a system enabling purchases. The NYISO stewards the wholesale electricity markets in New York, enabling competing generators to offer their output to retailers. These markets include the Day-Ahead Market (DAM) and others.

Emergency Demand Response Program (EDRP): A NYISO reliability-based demand response program designed to reduce power usage through voluntary electricity consumption reduction by

businesses and large power users. Program participant are compensated for reducing energy consumption upon activation of the program by the NYISO.

Energy: Energy is the amount of electricity a generator produces over a specific period of time. It is measured in megawatt-hours (MWh). For example, a generating unit with a 1 megawatt capacity operating at full capacity for one hour will produce 1 megawatt-hour of electricity.

Energy Storage Resources (ESRs): Energy storage resources are devices used to capture energy produced at one time for use at a later time. ESRs include technologies like batteries and pumped hydro storage.

Federal Energy Regulatory Commission (FERC): The federal agency responsible for regulatory oversight of the NYISO's operation of the bulk power system, wholesale power markets, and planning and interconnection processes. The NYISO's tariffs and foundational agreements are overseen and approved by FERC.

Gigawatt (GW): A unit of power or capacity equal to one billion watts.

Gigawatt-Hour (GWh): A gigawatt-hour is equal to one gigawatt of energy produced or consumed continuously for one hour.

Installed Capacity (ICAP): A qualifying generator or load facility that can supply and/or reduce demand as directed by the NYISO.

Installed Reserve Margin (IRM): The amount of installed electric generation capacity above 100% of the forecasted peak electricity consumption that is required to meet New York State Reliability Council (NYSRC) resource adequacy criteria.

Interconnection Queue: A queue of merchant transmission and generation projects that have submitted an Interconnection Request to the NYISO to be interconnected to the state's electric system. Depending on the level of proposed capacity, most projects must undergo three studies before interconnecting to the grid: a *Feasibility Study* (unless parties agree to forgo it), a *System Reliability Impact Study* (SRIS), and a *Facilities Study*.

Intermittent Resource: An electric energy source whose output varies due to the fluctuating nature of its fuel source. Examples include solar energy which is dependent upon sunlight intensity, or wind turbines where output is dependent on wind speeds.

Intertie: A transmission line that links two or more regional electric power systems.

Load: A consumer of energy, or the amount of energy consumed. Load can also be referred to as demand.

Load Serving Entity (LSE): An entity, such as an investor-owned utility, public power authority, municipal electric system, or electric cooperative that procures energy, capacity, and/or ancillary services from the NYISO's wholesale markets on behalf of retail electricity customers.

Locational Capacity Requirement (LCR): A portion of the statewide installed capacity that must be physically located within a locality to meet reliability standards. Locational Installed Capacity Requirements have been established for the New York City (zone J), Long Island (zone K), and lower Hudson Valley (zones G-J) capacity zones.

Loss of Load Expectation (LOLE): The amount of generation and demand-side resources needed to minimize the probability of an involuntary loss of firm electric load on the bulk power system. The state's bulk power system, is designed to meet a LOLE that is not greater than one occurrence of an involuntary load disconnection in 10 years (expressed mathematically as 0.1 days per year).

Market-Based Solutions: Investor-proposed projects that are driven by market needs to meet future reliability requirements of the bulk power system as outlined in the *Reliability Needs Assessment* (RNA). Those solutions can include generation, transmission, and demand response programs. Market-based solutions are preferred by the NYISO's planning process. The NYISO is responsible for evaluating all solutions to determine if they will meet the identified reliability needs in a timely manner.

Megawatt (MW): A measure of electricity that is the equivalent of 1 million watts. It is generally estimated that a megawatt provides enough electricity to supply the power needs of 800 to 1,000 homes.

Megawatt-Hour (MWh): A megawatt-hour is equal to one megawatt of energy produced or consumed continuously for one hour.

New York Independent System Operator (NYISO): Formed in 1997 and commencing operations in 1999, the NYISO is a not-for-profit organization that manages New York's bulk power system, administers the state's competitive wholesale electricity markets, provides system and resource planning for the state's bulk power system, and works to advance the technology serving the power system. The organization is governed by an independent Board of Directors and a governance structure made up of committees, with market participants and stakeholders as members.

New York Control Area (NYCA): The area under the electrical control of the NYISO. It includes the entire state of New York, divided into 11 load zones.

New York Power Pool (NYPP): Established in 1966 in response to the Northeast Blackout of 1965, a voluntary collaboration of the state's six investor-owned utilities plus New York's two power authorities, created to coordinate the operations of the New York State power grid. The NYISO assumed this responsibility in 1999.

North American Electric Reliability Corporation (NERC): The not-for-profit international regulatory authority whose mission is to assure the effective and efficient reduction of risks to the reliability and security of the grid. NERC's jurisdiction includes users, owners, and operators of the bulk power system.

Peak Load: The maximum power demand on the electric grid measured in megawatts (MW). Peak load, also known as peak demand, reflects the highest average hourly demand experienced on the system.

Peakers: Peaking power plants, also known as peaker plants or just "peakers", are power plants that generally run only when there is a high demand — known as peak demand — for electricity.

Public Policy Transmission Planning: Part of the NYISO's Comprehensive System Planning Process. Public Policy Transmission Planning consists of two steps: (1) identification of transmission needs driven by Public Policy Requirements that should be evaluated by the NYISO; and (2) requests for specific proposed transmission solutions to address those needs, and the evaluation of those specific solutions. The New York State Public Service Commission identifies transmission needs driven by Public Policy Requirements and warranting evaluation, and the NYISO requests and evaluates specific proposed transmission solutions to address such needs.

Real-Time Markets: A NYISO-administered wholesale electricity market in which electricity and ancillary services are settled every five minutes. The Real-Time Market addresses changes in operating conditions relative to what was anticipated in the Day-Ahead Market. For instance, changes to load or anticipated generator

output are accounted for in the Real-Time Market through a competitive auction process.

Regional Greenhouse Gas Initiative (RGGI): The first market-based regulatory program in the United States to reduce greenhouse gas emissions. RGGI is a cooperative effort among the states of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont.

Regulated Backstop Solutions: Proposals required of certain Transmission Owners to meet reliability needs as outlined in the Reliability Needs Assessment. Those solutions can include generation, transmission, or demand response. Non-Transmission Owner developers may also submit regulated solutions. The NYISO may call for a gap solution if neither market-based nor regulated backstop solutions meet reliability needs in a timely manner. To the extent possible, the gap solution should be temporary and strive to ensure that market-based solutions will not be economically harmed. The NYISO is responsible for evaluating all solutions to determine if they will meet identified reliability needs in a timely manner.

Reforming the Energy Vision (REV): The New York State Public Service Commission commenced the Proceeding on Motion of the Commission in Regard to Reforming the Energy Vision (Case 14-M-0101) in April 2014.

Reliability Needs Assessment (RNA): A report that evaluates resource adequacy and transmission system security over a 10-year planning horizon, and identifies future needs of the New York electricity grid. It is the first step in the NYISO's reliability planning process.

Renewable Energy Credit (REC): A mechanism to link the environmental attributes associated with certain forms of renewable energy generators with the energy produced by those generators. One REC equates to one MWh of energy generated from eligible renewable energy resources. In New York State, NYSERDA procures RECs from eligible resources to incentivize development of renewable resources and measure compliance with the renewable energy goals of the state's Clean Energy Standard (CES).

Resource Adequacy: The ability of the electric system to supply electrical demand and energy requirements at all times, taking into account scheduled and unscheduled outages of system elements. A system is considered adequate if the probability of having sufficient resources to meet expected demand is greater than the minimum standards to avoid a blackout.

Special Case Resources (SCR): A NYISO reliability-based demand response program designed to reduce power usage by businesses and large power users qualified to participate in the NYISO's installed capacity (ICAP) market. SCRs are awarded capacity payments for agreeing to reduce their load on the system upon NYISO request.

Thermal Line Limits: The maximum amount of electrical energy that can flow on a transmission line without overheating the line.

Transfer Capability: The amount of electricity that can flow on a transmission line at any given instant, respecting facility rating and reliability rules.

Transmission Constraints: Limitations on the ability of a transmission facility to transfer electricity.

Transmission Security: The ability of the electric system to withstand disturbances, such as electric short-circuits or unanticipated loss of system elements.

Zero-Emission Credit (ZEC): A mechanism to link the environmental attributes associated with the energy produced by certain eligible zero-emission generators. In New York, one ZEC equates to one MWh of energy generated by eligible nuclear generators. NYSERDA procures ZECs to measure compliance with the obligations under the State's Clean Energy Standard.

Endnotes

[1] Statement of the Honorable Ernest J. Moniz Before the US Senate Committee on Energy and Natural Resources, February 7, 2019, https://www.energy.senate.gov/public/index.cfm/files/serve?File_id=761B752E-7181-4091-B04E-5CC69AAC1213

[2] U.S. Energy Information Administration, Annual Energy Outlook 2019: with projections to 2050, https://www.eia.gov/outlooks/aeo/pdf/aeo2019.pdf

[3] *In 2016, for example, demand on the grid exceeded 30,000 MW for only 33 hours, or just 0.38% of the total hours for the year.*

[4] *Today in Energy, U.S. Energy Information Administration, "More than 60% of electric generating capacity installed in 2018 was fueled by natural gas,"* March 11, 2019. https://www.eia.gov/todayinenergy/detail.php?id=38632

[5] Today in Energy, U.S. Energy Information Administration, "U.S. coal consumption in 2018 expected to be the lowest in 39 years, December 4, 2018, https://www.eia.gov/todayinenergy/detail.php?id=37692

[6] *Net capacity figures based on data for respective Summer Capability Periods (May 1- Oct. 31).*

[7] *A circuit-mile is one mile of one circuit of transmission line. For example, two 100-mile lines total 200 circuit-miles. One 100-mile double-circuit transmission line would also total 200 circuit-miles.*

[8] *The Federal Energy Regulatory Commission defines demand response as changes in electric usage by end-use customers from their normal consumption patterns in response to changes in the price of electricity over time, or to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized.*

[9] Federal Energy Regulatory Commission. "2018 Assessment of Demand Response and Advanced Metering." Staff Report. November 2018. https://www.ferc.gov/legal/staff-reports/2018/DR-AM-Report2018.pdf?csrt=17774767290850254171

[10] New York Independent System Operator. "NYISO 2018 Annual Report on Demand Response Programs." January 2019.

[11] Energy-Related Carbon Dioxide Emissions by State, 2005-2016; U.S. Energy Information Administration, January 2019 EIA report; https://www.eia.gov/environment/emissions/state/analysis

[12] *Mitigation of Climate Change: Reducing Greenhouse Gas Emissions;* NYS DEC; https://www.dec.ny.gov/energy/99223.html

[13] *Clean Energy Standard Annual Progress Report: 2017 Compliance Year;* NYSERDA; February 2019.

[14] *In the Matter of a Comprehensive Energy Efficiency Initiative,* New York State Public Service Commission, December 13, 2018, http://documents.dps.ny.gov/public/MatterManagement/CaseMaster.aspx?MatterCaseNo=18-m-0084&submit=Search

[15] *Generator Deactivation Assessment: Indian Point Energy Center,* NYISO, December 13, 2017.

[16] *Regulatory Impact Statement,* NYS Department of Environmental Conservation, February 2019, http://www.dec.ny.gov/regulations/116175.html

[17] The NYISO operates New York's electric grid to the nation's strictest set of reliability standards, which include nearly 1,000 requirements designed to promote reliability for New York's consumers. These requirements are established and enforced on a North America-wide basis, a northeast-regional basis, and on a New York-specific basis, with regulators at FERC and the NYS PSC monitoring the NYISO's compliance.

[18] *Fact Sheet: Large-Scale Renewables 2018 Renewable Energy Standard Solicitation;* NYSERDA, January 2019; https://www.nyserda.ny.gov/-/media/Files/Programs/LSR/RES-Solicitation-Fact-Sheet.pdf

[19] *Benefits and Costs of New York's Carbon Pricing Initiative: A Dynamic, Simulation-Based Analysis; Resources for the Future;* September 2018.

[20] *NYISO Integrating Public Policy Project: Phase 2,* March 28, 2017.

[21] 2016 EEI report at p. iv

[22] *Transmission Investment,* Electric Edison Institute, 2019. www.eei.org/issuesandpolicy/transmission/Pages/default.aspx

[23] *Transmission Solutions: Potential Cost Savings Offered by Competitive Planning Processes,* The Brattle Group, Presentation to National Association of Regulatory Utility Commissioners, November 2018

[24] *The Coming Electrification of the North American Economy;* The Brattle Group, March 2019

[25] *Statement of Philip D. Moeller,* Edison Electric Institute, before Committee on Energy and Natural Resources, United States Senate (February 8, 2018) (emphasis added), at 3.

[26] *PSC Votes to Advance Transmission System Upgrades for Further Review;* New York State Public Service Commission; Dec. 17, 2015.

[27] *AC Transmission Public Policy Transmission Need Viability & Sufficiency Assessment;* New York Independent System Operator. Oct. 27, 2016.

[28] *Order Addressing Public Policy Transmission Need for AC Transmission Upgrades;* New York State Public Service Commission; Case Nos. 12-T-0502, et al. Jan. 24, 2017.

[29] Proposed Transmission Needs Being Driven by Public Policy Requirements for the 2018–2019 Transmission Planning Cycle (Aug. 1, 2018).

[30] *Offshore Wind Transmission Options, Opportunities,* by Seth Parker and Alex Mattfolk, Public Utilities Fortnightly (April 2018), at p. 75

[31] *New York State Offshore Wind Master Plan,* New York State Energy Research & Development Authority, available at: https://www.nyserda.ny.gov/All-Programs/Programs/Offshore-Wind/Offshore-Wind-in-New-York-State-Overview/NYS-Offshore-Wind-Master-Plan

[32] *Offshore Wind Injection Assessment;* NYISO; (Dec. 1, 2017).

[33] *2015 Northeastern Coordinated System Plan;* New York Independent System Operator, et al.; April 11, 2016.

[34] *2017 Congestion Assessment and Resource Integration Study (CARIS) Phase 1 Report;* New York Independent System Operator; April, 2018.

[35] 2016 EEI report at p. iv

[36] *Testimony before the United State Senate Energy and Natural Resources Committee;* February 14, 2019, NERC. https://www.energy.senate.gov/public/index.cfm/files/serve?File_id=9849D816-4D29-42E7-B535-DCCE1CAD2701

NYISO In Brief

The New York Independent System Operator (NYISO) is a not-for-profit corporation responsible for maintaining the safe, reliable flow of power throughout the Empire State.

The mission of the NYISO, in collaboration with its stakeholders, is to serve the public interest and provide benefit to consumers by:

- Maintaining and enhancing regional reliability
- Operating open, fair, and competitive wholesale electricity markets
- Planning the power system for the future
- Providing factual information to policymakers, stakeholders and investors in the power system

The NYISO manages the efficient flow of power on more than 11,000 circuit-miles of electric transmission lines on a continuous basis, 24 hours-a-day, 365 days-a-year — in compliance with the most rigorous reliability requirements in the nation.

As the administrator of the wholesale electricity markets, the NYISO conducts auctions that match the power demands of electric utilities and energy service companies with suppliers offering to sell power resources. The NYISO's markets trade an average of $7.5 billion in electricity and related products annually.

The NYISO's comprehensive planning process assesses New York's electricity needs and evaluates the ability of proposed power options to meet those needs. This planning process involves stakeholders, regulators, public officials, consumer representatives, and energy experts who provide vital information and input from a variety of viewpoints.

The NYISO is governed by a 10-member, independent Board of Directors and a committee structure composed of diverse stakeholder representatives. It is subject to the oversight of the Federal Energy Regulatory Commission (FERC) and regulated in certain aspects by the New York State Public Service Commission (NYSPSC). NYISO operations are also overseen by electric system reliability regulators, including the North American Electric Reliability Corporation (NERC), Northeast Power Coordinating Council (NPCC), and the New York State Reliability Council (NYSRC).

The members of the NYISO's Board of Directors have backgrounds in electricity systems, finance, information technology, communications, and public service. The members of the Board, as well as all employees, have no business, financial, operating, or other direct relationship to any market participant. The NYISO does not own power plants or transmission lines.

The NYISO's independence means that its actions and decisions are not based on profit motives, but on how best to enhance the reliability and efficiency of the power system, and safeguard the transparency and fairness of the markets. The NYISO is committed to transparency and trust in how it carries out its duties, in the information it provides, and in its role as the impartial broker of the state's wholesale electricity markets.

Power Trends is the NYISO's annual analysis of factors influencing New York State's power grid and wholesale electricity markets. Begun in 2001 as *Power Alert,* the report provides a yearly review of key developments and emerging issues.

New York Independent System Operator

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