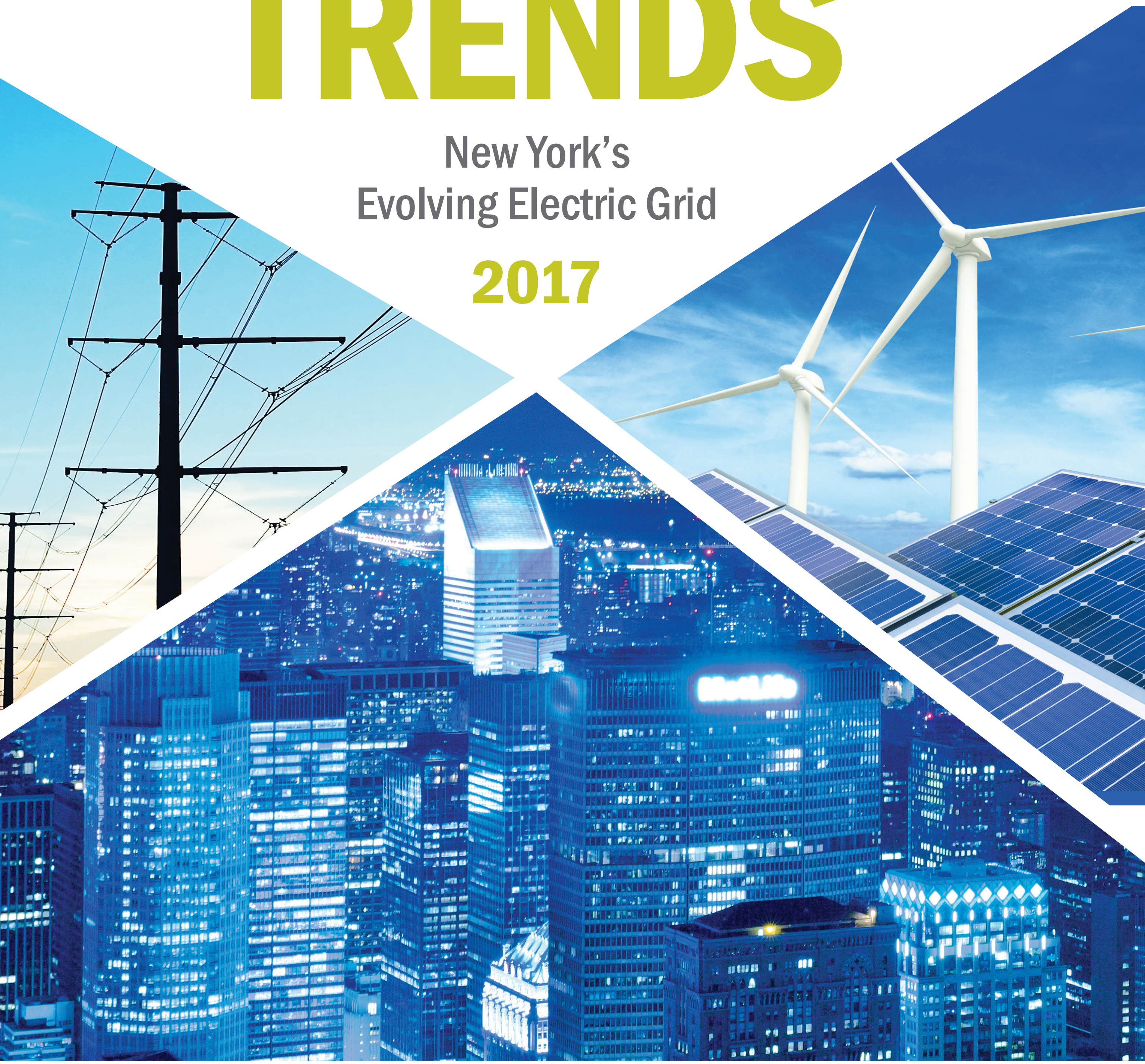
POWER TRENDS

New York's Evolving Electric Grid

2017



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

BRADLEY C. JONES

Welcome to *Power Trends 2017*. The New York Independent System Operator (NYISO) is proud to produce this annual review of New York's power grid and the factors that shape the future of the electric system.

In the pages ahead, *Power Trends 2017* will provide important information on the status of the power grid in New York today, the changes to our power system that we have seen and expect to see in coming years, and insights into how emerging trends affect how the grid is operated, how resources perform in the NYISO's wholesale markets, and how we plan for the future of the power grid in New York.

Technological, social, economic, and policy trends have combined to make this a time of exciting innovation for our electric system. In the Empire State, the NYISO is at the heart of those changes, serving the needs of consumers, addressing public policy goals, and ensuring that the power to drive our economy is where it is needed, when it's needed.

Since 1999, the NYISO's competitive markets for wholesale electricity have powered reliability, increased efficiency, and supported the secure operation of the grid. NYISO markets saved an estimated $7.8 billion in fuel costs for New Yorkers, outpaced gains in efficient operation of the grid by 300% over the national average, and saved nearly $613 million by reducing energy reserves needed to maintain reliability. In the period since competitive wholesale markets have been in place, New York's power sector has reduced Carbon Dioxide emissions by 43%, Nitrogen Oxide emissions by 87%, and emissions of Sulfur Dioxide by 98%.

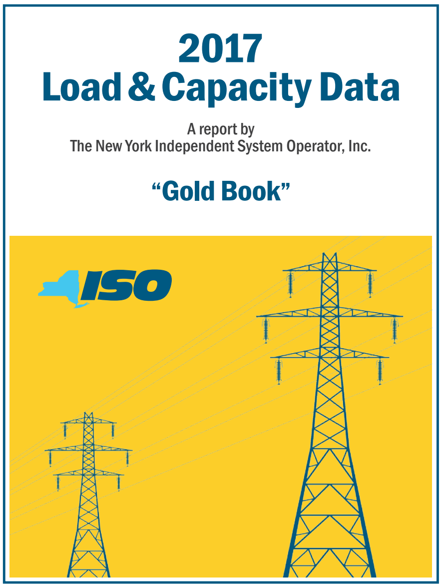
Power Trends 2017 focuses on the impacts from the growth in distributed energy resources; public policy initiatives and resulting regulatory oversight challenges; the economic impacts of sustained low natural gas prices on future asset investment and plant operations; and the challenge of developing large scale renewable resources in upstate with our largest demand in southeastern New York and New York City.

New York is at the forefront of innovation in the energy landscape. The NYISO is proud to play an important role in that innovation. Together with our Market Participants, federal and New York State policymakers, the NYISO will continue to advance New York's electric system towards an efficient, affordable, and reliable future.

Sincerely,

Bradley C. Jones

Bradley C. Jones
President and CEO



DATA USED IN POWER TRENDS 2017
is from the 2017 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

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Executive Summary

A Grid In Transition

The power grid has been described as the greatest engineering achievement of the 20th century.[1] Without it, according to the National Academy of Engineers, "…that ready surge of electrons would not exist — nor would the modern world as we know it."[2] We live in a period of unmatched technological innovation, shaping how we consume electricity and how investors and market participants will serve the needs of consumers in the future. Marching headlong into the 21st century, the impact of the power grid on our daily lives becomes ever more apparent. The complexities of operating and planning the system are increasing.

The grid and its capabilities underpin all aspects of the NYISO's competitive markets. When the grid is constrained and power is unable to flow freely, markets are less efficient. The emerging story of the New York electric system is a tale of two grids — a tale of clean energy abundance and surplus generating capacity upstate and fossil-fuel dependence and high demand downstate. Limited transfer capability from upstate to downstate means that this tale of two grids is also a tale of two markets — where the expansion of clean energy resources is unable to reach downstate load centers, suppressing upstate wholesale prices to the point where the economic viability of generation needed for reliability is jeopardized.

It is a time of both continuity and change for the grid. The centralized grid exists as a dependable mainstay, yet faces unprecedented growth and evolution as large-scale renewables and distributed energy resources connect and place new demands on grid functionality.

Historically, power flowed instantaneously from generators across a vast network of transmission and distribution lines before reaching consumers, who used it for home lighting, office electronics, and powering subway systems that move millions through our nation's largest city. Growing demand for energy from the grid was met through physical expansion of the grid to increase its generating and delivery capacity.

"The power grid has been described as the greatest engineering achievement of the 20th century."

— The National Academy of Engineers

Today's grid has grown in complexity as historical patterns give way to emerging trends that reflect technological advances in how electricity is generated and consumed. The grid of the future will not only deliver energy from distant power plants across the system in support of individual needs, it will deliver energy produced by homeowners and businesses that can support local system needs, whether on "blue-sky" days with moderate energy demand or in times of constraints and severe weather.

Public policy at the federal and state levels has aided, if not hastened, this transformation. While changes in federal leadership bring new perspectives to the political and regulatory framework, an emerging trend driven by technological, social, and economic forces, which are increasingly looking for opportunities to expand the capabilities and flexibility of the grid, rather than expanding the grid itself, remains. This means historical, predictable demand patterns that characterized infrastructure planning over much of the last century are shifting. Consumers, increasingly empowered with intelligent digital technologies and advanced communications tools, are transitioning from traditional purchasers of energy to becoming active participants on the grid, adjusting their energy use patterns to reflect grid conditions and tailoring their energy use to meet their own needs for reliability and clean power.

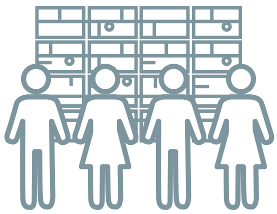
The New York Independent System Operator (NYISO) is at the center of this changing landscape. Working with New York State and federal policymakers and over 400 Market Participants, the NYISO serves as an independent organization responsible for operating New York's bulk power grid and wholesale energy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

This evolving landscape introduces new variables that the NYISO, through its expertise in operating New York's power grid, advanced energy market design, open and transparent system planning, and collaboration with policymakers and market participants, is uniquely poised to meet in order to continue to reliably and efficiently respond to the energy needs of New Yorkers.

How consumers think about and use electricity is changing as quickly as the technology that generates and delivers it. The NYISO's *Power Trends 2017* report is intended to provide information and analysis on current and emerging trends that are working to transform the power grid and wholesale electricity markets. Shifting patterns of demand for electricity serve to influence how investors, policymakers, and consumers view electricity production, transmission, and consumption.

These patterns include:

- Energy efficiency and distributed energy resources.
- Infrastructure replacement and expansion.
- Economic influences led by low natural gas prices and changing consumption forecasts.
- Public policies aimed at reducing emissions.
- Expanding renewable power resources.
- Providing customers more power choices.



►**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 grid and wholesale energy markets, 24 hours a day, every day of the year.

Changing Energy Usage & Moderating Peak Demand

Government, utility, and community programs are changing historical consumption patterns. The emergence of distributed energy resources such as rooftop solar are transforming historical patterns of consumption and affecting consumer reliance on electricity provided by the bulk electric system.

For instance:

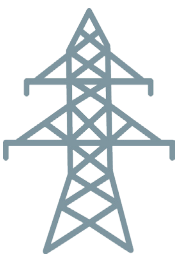
As we saw in Power Trends 2016, year-over-year growth in the overall usage of electric energy from New York's bulk electric system continues to be flat or to decline slightly over the next decade. Peak demand, which is a critical element to reliable system planning, is projected to grow at a more moderate pace than previous forecasts. Reliability standards, based on projected peak demand, drive the total amount of power capacity that must be purchased to meet the system's reliability needs.

Energy efficiency efforts and expansion of solar resources on the distribution system continue to have a strong influence on future consumption forecasts. Energy efficiency is expected to reduce peak demand on New York's bulk power system by 230 MW in 2017 and by 1,721 MW in 2027. Distributed solar resources and other behind-the-meter resources are also reducing demand for power from the bulk electric system as consumers install on-site systems to meet some portion of their electricity needs.

Aging Infrastructure

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 attention. At the same time, new and upgraded transmission capacity will help to address concerns about maintaining or replacing aging transmission infrastructure.

- Across the nation, the capacity-weighted average age of U.S. power generation facilities was 29 years at the close of 2016.[3] New York's fleet of power plants had an average age of 36 years, with nearly 2,000 MW of steam-turbine and gas-turbine capacity of an age at which 95% of capacity using these technologies retires.
- Over 80% of New York's high-voltage transmission lines went into service before 1980. Of the state's more than 11,000 circuit-miles of transmission lines, nearly 4,700 circuit-miles will require replacement within the next 30 years, at an estimated cost of $25 billion.[4]



▸230 MW reduction in peak demand for 2017 due to current energy efficiency efforts.

As investment in clean and distributed energy resources grows, the economic viability of older generating units is increasingly challenged. While many of these resources are operating beyond their initial design life, they still offer reliability benefits to the grid. It will be important to plan for this transition toward clean and distributed energy resources to ensure that as older units retire, remaining and newer resources replacing them are integrated into the grid and wholesale markets in a manner that continues to promote reliability.

Transmission Expansion to Meet Public Policy Needs

A cleaner, greener, integrated grid to serve New York requires a modernized, upgraded, and expanded transmission system to enable the new resource mix of a changing energy landscape in New York. Upgraded transmission capability is vital to meeting public policy goals and efficiently moving power to address regional power needs.

In New York, the tale of two grids includes distinct differences between upstate and downstate regions in terms of power resources and consumer demand.

- All of New York's existing major hydropower resources and wind power projects, and nearly all currently proposed land-based wind power projects are located in northern and western regions of the state — hundreds of miles from the high-demand metropolitan regions of southeastern New York. Transmission enhancements would relieve constraints on the system, making more effective use of current and future renewable resources.
- The downstate region of New York (Long Island, New York City, and the Hudson Valley - Zones F-K) annually uses 66% of the state's electric energy. Yet, that region's power plants generate only 53% of the state's electricity. Enabling upstate resources to better serve downstate consumers provides benefits such as grid resiliency, resource diversity, and enhanced market competition.

Cultivating Green Power

New York State continues to be a national leader on environmental quality initiatives. **The Regional Greenhouse Gas Initiative, and New York's Clean Energy Standard and Reforming the Energy Vision are expected to shape the future emission profiles of New York State's electric generation and the mix of resources used to produce power.** Competitive wholesale electricity markets administered by the NYISO and overseen by federal regulators have complemented environmental regulations and efforts to expand renewable power, integrating renewable resources and fostering efficiencies that reduce emissions:

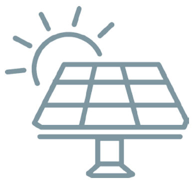
- From 2000 through 2016 New York's air quality improved as power plant emission rates dropped significantly. SO_2 emissions rates declined 98%. NO_X emission rates declined 87%. CO_2 emission rates declined 43%.
- In 2016, 24.13% of New York's electricity was produced by renewable resources. Electricity produced from water, wind, solar and other renewable sources accounted for 33,192 gigawatt-hours (GWh) of the 137,532 GWh of electric energy generated in New York last year.

The greatest engineering achievement of the 20th century is evolving to meet the changing needs and priorities of the 21st century. Cleaner energy production and engaged, responsive energy consumers are starting to reshape the grid. During this period of transformation, the NYISO will enhance its markets to integrate these trends into the grid in an efficient and reliable manner.

Demand Trends & Forecasts

Energy Usage

The first decade and a half of the 21st century can be characterized as a time of transition for the grid. **From 2000 through 2008 the NYISO managed the grid through a period of growing energy use. Since that time, electricity provided by the grid has decreased while energy production from distributed energy resources, such as solar, has increased.** Distributed Energy Resources (DER) are beginning to displace energy that was traditionally supplied by the grid. However, displacement is not the same as elimination, and the power provided by many distributed energy resources is not continuous, but intermittent. When those intermittent resources are unavailable to supply the homes and businesses that have installed them, the grid must still provide power to those homes and businesses. As a result, planning for the reliable operation of the grid requires consideration of the direct use of energy by consumers as well as the power provided to them on an intermittent basis. Additional factors influencing the trend toward reduced energy use from the grid include "slowing population growth, market saturation of major electricity-using appliances, efficiency improvements in appliances, and a shift in the economy toward a larger share of consumption in less energy-intensive industries."[5]



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

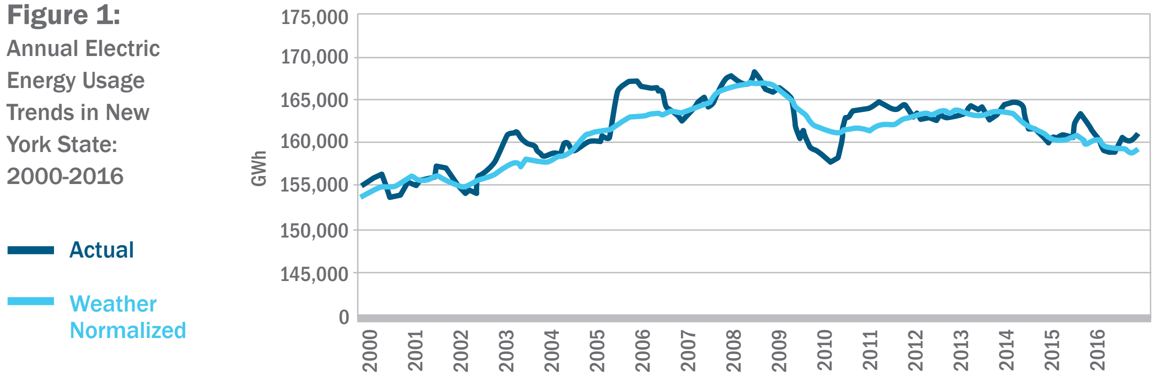
The energy usage trend for the past several years in New York State has been relatively flat. At the same time, there has been growth in behind-the-meter solar and other customer-based DER. When usage and the energy production of customer-based distributed energy resources like solar are accounted for, we obtain a better picture of how much energy the transmission system must be capable of delivering. The NYISO forecasts energy usage (including the impacts of energy efficiency and customer-based DER) in New York to decrease at an annual average rate of -0.23% from 2017 through 2027. The energy requirement for load without those impacts is growing at an annual average rate of 0.7% over the same period.

As recently as 2014, long-term forecasts of energy usage projected 10-year average growth at 0.16%. The 2015 forecast projected no (0.00%) energy growth and the 2016 forecast projected a moderate decline (-0.16%) in energy use.

Peak Demand

Peak demand is the maximum amount of energy use for a one-hour period during the year. It represents a small fraction of annual overall electrical energy use.[6] However, it is an important metric because it defines the amount of energy producing resources, or power capacity that must be available to serve customers maximum demand for energy.

Figure 1: Annual Electric Energy Usage Trends in New York State: 2000-2016



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

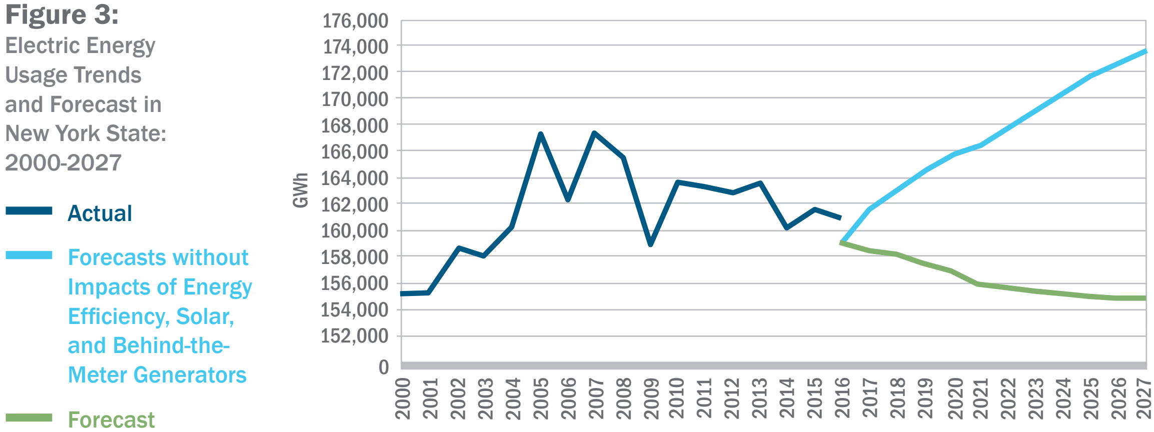
New York's all-time record peak demand is 33,956 MW, reached in July 2013 at the end of a week-long heat wave.

In 2016, the annual peak reached 32,076 MW. It was 5.5% below the record, but 2.9% above the 2015 peak of 31,138 MW.

Figure 2: Annual Electric Energy Usage by Region: 2015-2016

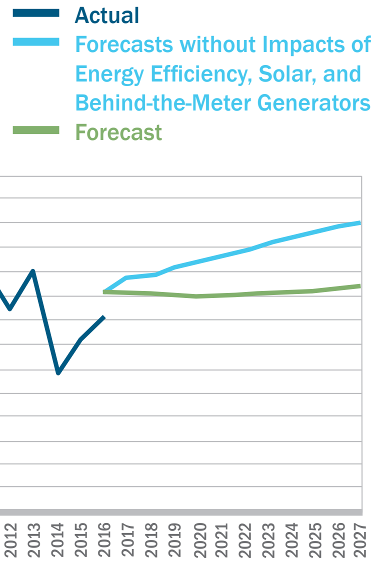
REGION	2015 GWh	2016 GWh	% CHANGE
New York State (NYCA)	161,572	160,798	-0.48% ↓
Upstate (Zones A-E)	54,548	54,286	-0.48% ↓
Downstate (Zones F-I)	31,633	31,268	-1.15% ↓
New York City (Zone J)	53,485	53,653	0.31% ↑
Long Island (Zone K)	21,906	21,591	-1.44% ↓

Figure 3: Electric Energy Usage Trends and Forecast in New York State: 2000-2027



Peak demand in New York is forecast to grow at an annual average rate of 0.07% from 2017 through 2027. The NYISO's long-term forecasts of peak demand have decreased from a projected 0.83% annual growth in 2014; 0.48% in 2015; and 0.21% in 2016 to 0.07% in 2017. Absent the impacts of energy efficiency programs and DER, the 2017 peak demand growth rate is 0.73%, down from 0.84% in 2016.

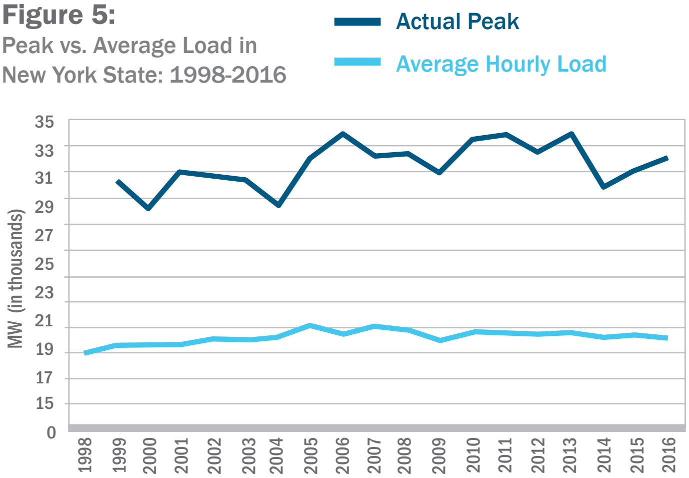
Figure 4:
Electric Peak Demand Trends in New York State — Actual & Forecast: 2000-2027



Energy Efficiency & Distributed Energy Resources

Energy efficiency programs, distributed solar, and non-solar distributed resources such as energy storage or small generators are combining to moderate the growth of energy supplied by the grid, as well as peak demand.

Figure 5:
Peak vs. Average Load in New York State: 1998-2016



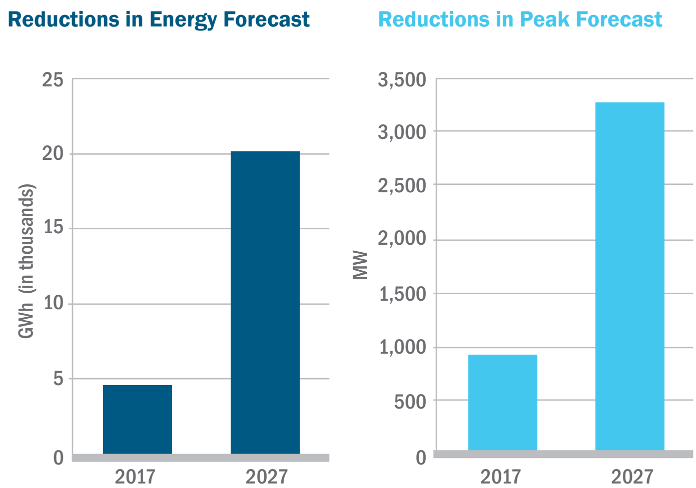
Energy efficiency is improving with new building codes and appliance standards, along with the proliferation of government, utility, and community programs designed to encourage usage of energy efficient products. These energy efficiency gains are expected to reduce peak demand on New York's bulk power system by 230 MW in 2017 and by 1,721 MW in 2027. They are also expected to lower annual energy usage served by the bulk power system by 1,330 GWh in 2017 and by 12,533 GWh in 2027.

▸33,956 MW
all-time peak demand record set July 2013 at the end of a week-long heat wave. In 2016, the annual peak demand reached 32,076 MW.

Distributed solar resources in New York are expected to reduce peak demand on the bulk power system by 450 MW in 2017and by 1,176 MW in 2027. They are also expected to lower annual energy usage served by the bulk power system by 1,845 GWh in 2017 and by 5,324 GWh in 2027.

In addition to distributed solar, other behind-the-meter resources are expected to reduce peak demand on the bulk power system by 233 MW in 2017 and by 375 MW in 2027. They are also expected to lower annual energy usage served by the bulk power system by 1,584 GWh in 2017 and by 2,463 GWh in 2027. (See page 65 'Integrating Distributed Energy Resources' section for more discussion.)

Figure 6:
Projected Impact of Energy Efficiency Programs and Distributed Energy Resources on Peak Loads and Energy Usage: 2017 & 2027



Daily & Seasonal Demand Patterns

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

In New York, the periods of peak demand occur during the summer when heat waves prompt greater use of air conditioning and other climate controls. 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 7: Seasonal Hourly Demand Patterns: 2016

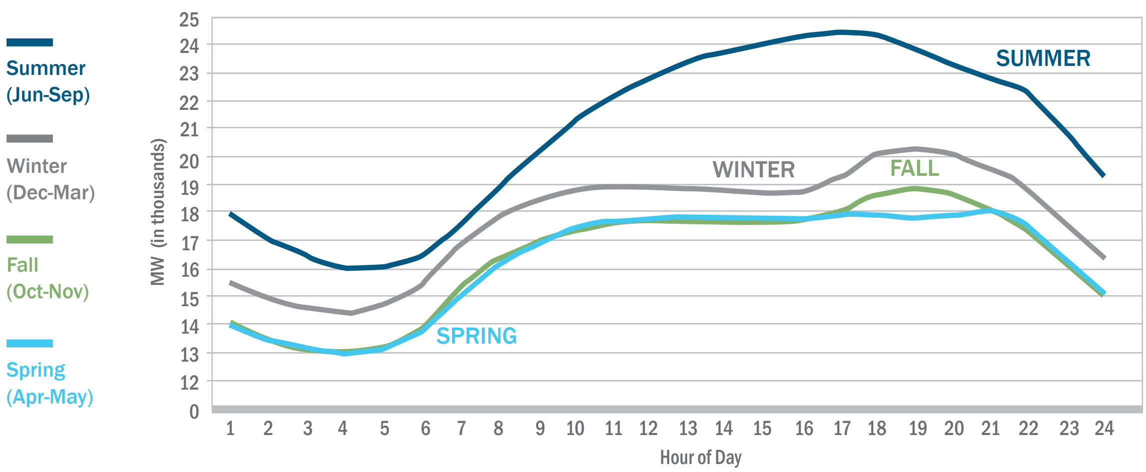
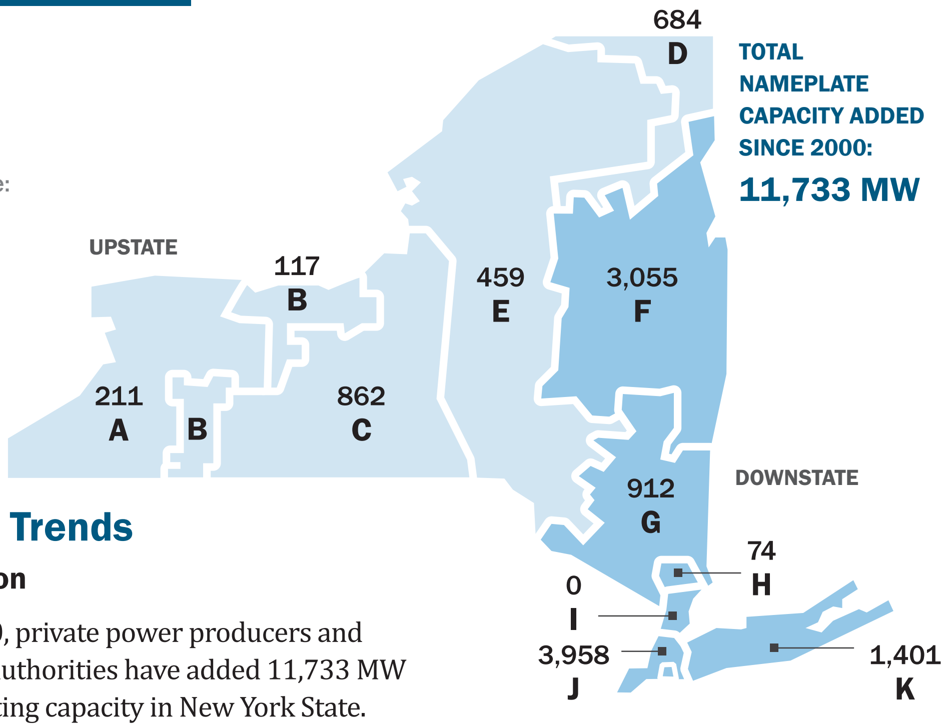


Figure 8:
New Generation in New York State: 2000-2017

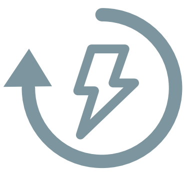


Resource Trends

Generation

Since 2000, private power producers and public power authorities have added 11,733 MW of new generating capacity in New York State. This additional generation represents approximately 30% of New York's current generation.

Over 80% of that new generation has been developed in southern and eastern New York, 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 the demand for electricity is the highest.



▸ **80% of new generation** has been developed downstate (Zones F-K) since 2000.

Other additions to New York's power-producing resources resulted from upgrades to existing power plants in upstate regions, or were largely influenced by physical factors, such as the suitability of wind conditions in the northern and western regions of the state.

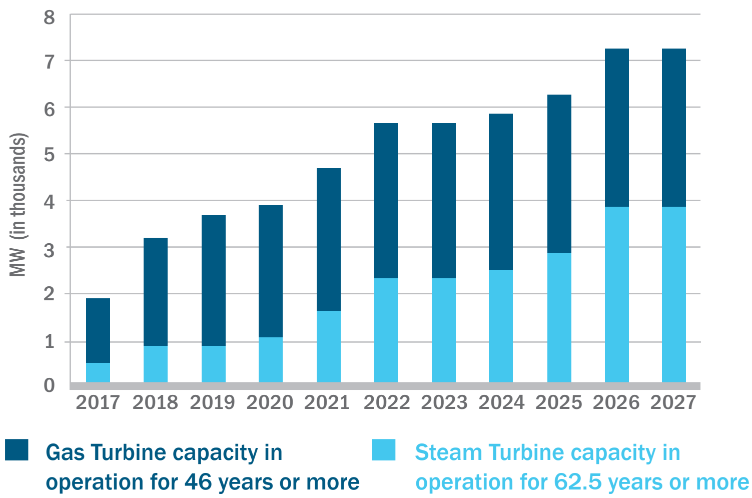
While there have been significant additions to New York's generating capacity since 2000, power plants age like all physical infrastructure. The need to maintain, upgrade or replace aging generation infrastructure requires attention.

Across the nation, the capacity-weighted average age of U.S. power generation facilities was 29 years at the close of 2016. New York's fleet of power plants had an average age of 36 years.[7]

Renewable power projects such as wind and solar units are among New York's newest generating facilities, averaging 8 years and 3 years respectively. Combined cycle units fueled by natural gas, many of which were built after the start of New York's wholesale electricity markets, have an average age of 16 years. The average age of New York's hydropower facilities is 55 years, although the major hydropower projects have undergone life extension and modernization within the past decade and a half. New York's nuclear power projects average 40 years old and the only three remaining coal-fired power plants in New York have an average age of 43 years. A growing amount of New York's steam-turbine and gas-turbine capacity is reaching an age at which, nationally, a majority of similar capacity has been deactivated. In 2017, 520 MW of steam-turbine generating capacity in New York State is 62.5 years of age or older, an age at which, nationally, 95% of such capacity has ceased operations. For gas turbines, 1,400 MW of capacity in New York State is 46 years of age or older. Nationally, 95% of capacity using this technology has deactivated by this age. By 2027, more than 7,250 MW of gas-turbine and steam-turbine based capacity in New York will reach an age beyond which 95% of these types of capacity have deactivated. These metrics suggest that deactivation of these important capacity resources is imminent, and replacement capacity may need to be commissioned.

Figure 9:
Aging Capacity: Gas Turbines & Steam Turbines Nearing Retirement

Nationally, 95% of Steam Turbine plants retire by the time it reaches 62.5 years of operation. Similarly, 95% of Gas Turbine plants cease operating by the time it reaches 46 years of operation. The chart shows the amount of capacity in operation in New York which is approaching these ages.

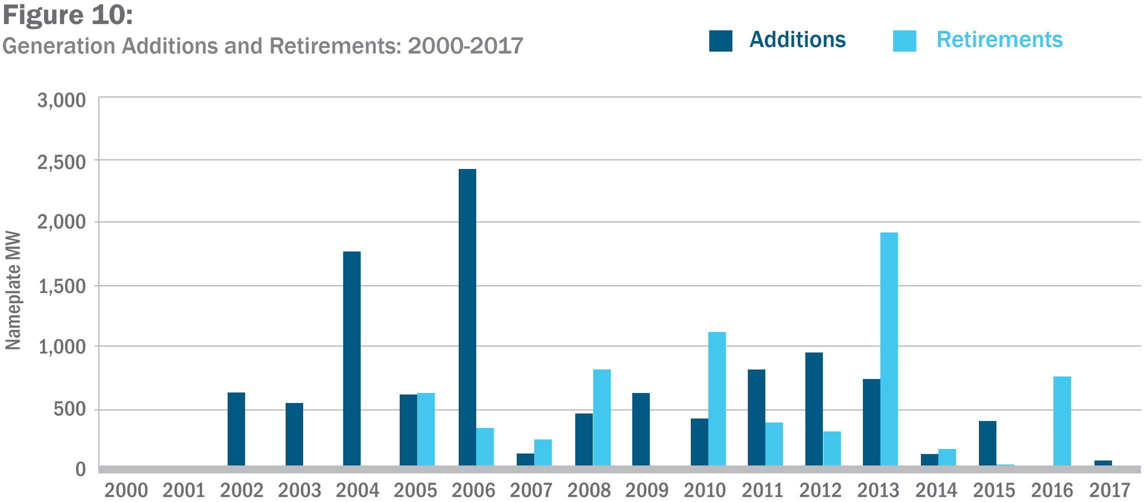


Expansion & Contraction

New power plants are built and existing facilities are upgraded to expand generating capacity as the demand for electricity and available supplies of power warrant new investment. Alternatively, power plants may elect to retire or suspend operation (i.e., “mothballing”) in response to economic circumstances, physical plant conditions, or regulatory requirements.

According to the U.S. Energy Information Administration (EIA), more than 27,000 MW of generating capacity was added nationwide in 2016, the largest amount of added capacity since 2012. The additions offset the retirement of 12,000 MW of capacity, yielding a net capacity gain of 15,000 MW, the largest change since 2011. 2016’s net gain followed a 4,000 MW decline in net capacity in 2015 — the largest net drop in capacity recorded in the United States.[8]

Figure 10:
Generation Additions and Retirements: 2000-2017



Since 2000, 11,733 MW of new generation have been added to New York's electric system *(and existing facilities have improved their generating capacity),* while nearly 7,000 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 and 2006 to a net reduction of more than 1,100 MW between 2012 and 2013.[9]

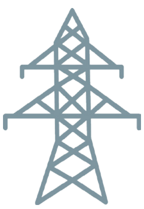
Generation additions were primarily natural gas-fueled or wind-powered. Since 2000, approximately 2,000 MW of generation fueled by coal have retired or suspended operation.

The pattern of expansion and contraction has continued in recent years, with price signals from the NYISO's markets encouraging more efficient resources to enter the market while signaling less efficient generation that is no longer viable to exit the market. These locational signals serve to inform investors not only when to add generation, but where to invest in new resources on the grid to most efficiently serve consumer needs. In parallel, new renewable generation is responding to state and federal policies supporting its deployment. In 2012, statewide power resources exceeded peak demand and reserve requirements by more than 5,000 MW. By 2015, the margin had declined to approximately 2,340 MW. In 2017, the surplus of power resources beyond reliability requirements totaled 1,649 MW.

The narrowing margin between available capacity and peak system demand reflects the balance that markets provide in maintaining sufficient resources to meet reliability while encouraging the closure of those resources that offer less value to the grid. The NYISO's markets have maintained this balance through price signals that sustain reliability in an economically efficient manner. However, power plant retirements can present challenges to electric system reliability.

Extending Plant Operations for Reliability

Federal and state regulations require advance notice of plant retirements. The NYISO conducts what is referred to as a "deactivation assessment" to determine the reliability impact of the planned retirement. If the assessment identities a reliability need, it may be addressed by the long-term planning process or alternate means.



▸**11,131 circuit miles** of high voltage transmission lines move energy throughout NYS.

A 2015 FERC order concluded that Reliability Must Run (RMR) agreements that pay a generator to remain in service because they are needed to maintain reliability on the bulk power system should be a "last resort" and "be of a limited duration so as to not perpetuate out-of-market solutions that have the potential, if not undertaken in an open and transparent manner, to undermine price formation."[10] Pursuant to a 2016 FERC order, the NYISO made further tariff revisions to select from among the resources that should be used to meet reliability needs caused by generator deactivations and to allocate and recover the costs of regulated solutions through its tariffs when necessary.

Transmission

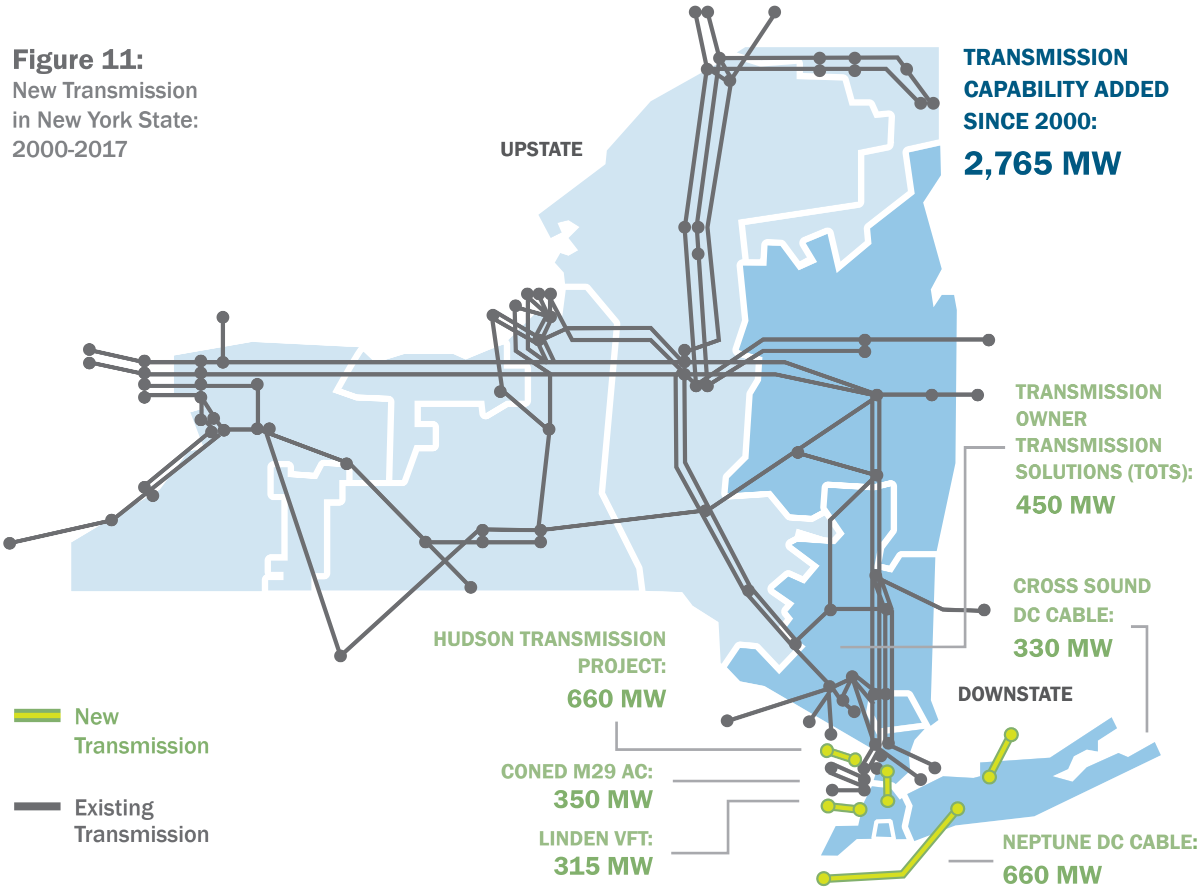
New York's bulk power system moves electricity over 11,131 circuit-miles of high-voltage transmission lines to meet the needs of energy consumers from the remote and sparsely populated regions of the Adirondacks to the densely packed heart of Manhattan.[11] Over 80% of the transmission system went into service before 1980, with nearly 4,700 circuit-miles likely needing replacement within the next 30 years, at an estimated cost of $25 billion.

The power demands of the downstate metropolitan New York region have attracted the development of various transmission projects, primarily interregional high-voltage direct-current projects connecting the Southeastern New York region to neighboring electricity markets. More than 2,700 MW of transmission capability have been added to serve New York's electric system since 2000.

These investments include:

- **The Cross-Sound Cable,** which links Long Island with ISO-New England.
- **The Neptune Regional Transmission System,** connecting Long Island with PJM.
- **The Hudson Transmission Partners project.**
- **The Linden Variable Frequency Transformer** project also link New York with PJM.

Figure 11: New Transmission in New York State: 2000-2017



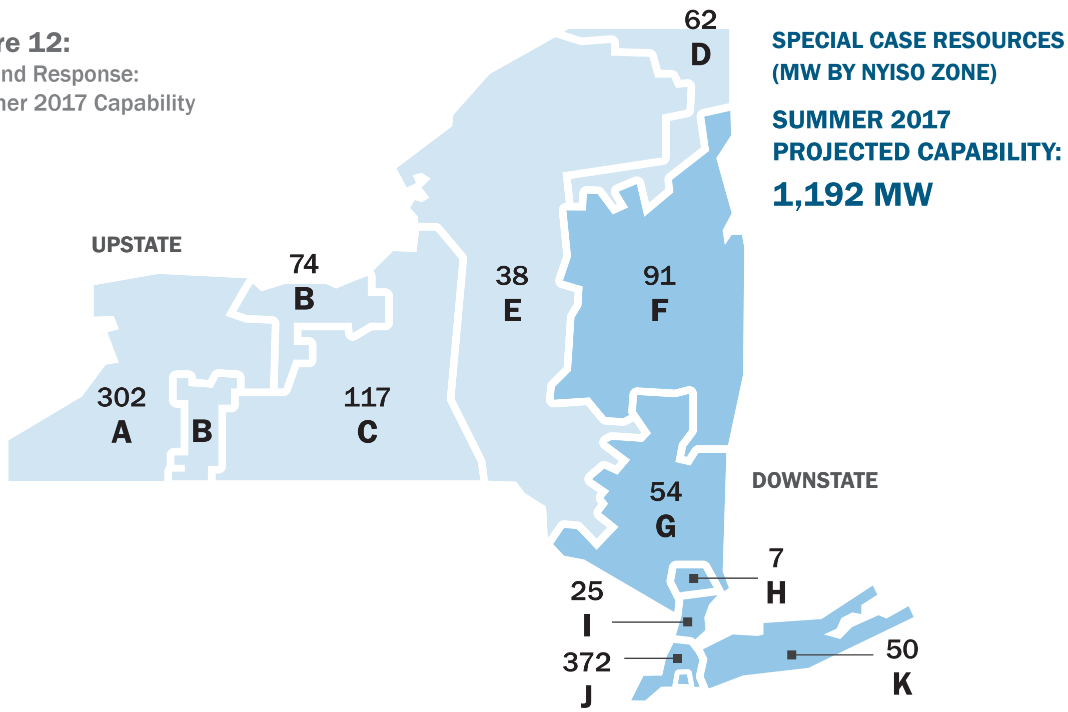
In June 2016, three intrastate projects collectively named the Transmission Owner Transmission Solutions (TOTS) were placed in service. They are estimated to increase transfer capability into Southeastern New York by 450 MW.

Further upgrades and enhancements of New York's transmission infrastructure are being planned to address congestion concerns, deliver renewable power resources from remote locations, and make better use of the full range of New York's power resources.

Distributed Energy Resources & Demand Response

Demand response enlists large electricity consumers and aggregations of smaller energy users to reduce consumption from the grid 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.[12]

Figure 12:
Demand Response:
Summer 2017 Capability



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 by incentivizing and coordinating consumers to reduce their use of electricity from the grid.

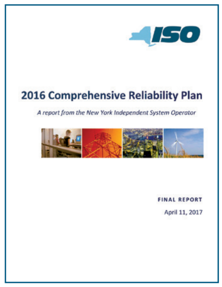
According to the Federal Energy Regulatory Commission, demand response resources in the nation's seven ISO/RTO regions totaled 31,754 MW in 2015 (up from 28,934 MW in 2014), representing 6.6% of peak load (up from 6.2% in 2014).[13]

Large power customers and aggregated groups of smaller consumers participate in several demand response programs developed in the NYISO markets.[14] In summer 2016, the programs involved 3,593 end-use locations providing a total of 1,266.7 MW of load reduction capacity, representing 3.9% of the 2016 summer peak demand. The 2016 enrollment level represented a 4.4% decline in demand response capacity compared to the 2015 level.

For the summer of 2017, the NYISO's largest demand response program, Special Case Resources, is projected to be capable of providing up to 1,192 MW. Additionally, the Emergency Demand Response Program is expected to be able to provide 75 MW.

Distributed Energy Resource Roadmap

The NYISO's Demand Response Programs have historically offered opportunities for Distributed Energy Resources (DER) to participate in wholesale markets as capacity suppliers. In keeping with advances in the technologies, **the NYISO issued a *DER Roadmap* in February 2017 outlining a series of market enhancements that are designed to more fully integrate these resources into NYISO markets and operations. DER offer the potential to make load more dynamic and responsive to wholesale market price signals, potentially improving overall system efficiencies.** The NYISO's market enhancements seek to permit dispatchable DER (i.e., controllable resources) with various capabilities to participate in the wholesale markets. Integrating DER in this manner will require enhancements to system planning and grid operations as well as market design to better align resource investments and performance with system needs and conditions. The NYISO contemplates implementing these enhancements over the next three to five years consistent with the timing of state and federal energy policies.



▸ **Comprehensive Reliabilty Plan**

▸ **Reliability Needs Assessment** for more visit www.nyiso.com.

Resource Outlook

Reliability Assessment

The NYISO conducts comprehensive system planning to maintain the long-term reliability of New York's bulk electric system. Every two years, the NYISO's Comprehensive Reliability Planning Process examines the reliability of the state's electric system over a 10-year planning horizon. Using a multi-faceted approach, the NYISO's planning process strives to achieve market-based solutions whenever possible. This allows developers and investors to assess and assume the risks of such investments to avoid imposing the costs on rate-paying consumers.

Reliability planning is the key to maintaining the integrity of the electric grid. The NYISO regularly performs an evaluation through its *Reliability Needs Assessment*.

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 grid reliability. Then, a *Comprehensive Reliability Plan* 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 most efficient or cost-effective transmission project. The costs of a transmission project can be allocated to, and recovered from, those customers benefitting from the upgrade through the NYISO's tariffs following regulatory approval.

The NYISO's planning studies use complex computer models to assess the capability of the transmission system and the adequacy of resources that connect to that system to meet New York's electric needs. There are numerous factors included in these models to determine whether there are any reliability 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, and the impact of demand response resources that are paid to reduce energy usage at peak times.

The *2016 Comprehensive Reliability Plan*, issued in April 2017, contains the NYISO's most recent analysis of potential reliability needs. It found no new resources need to be added, meaning that the bulk power system is expected to be capable of meeting peak electrical demand even if a contingency event occurs, such as the loss of a large generator. Further, the *Plan* determined that updated local transmission plans from utilities for their local transmission systems will address previously identified needs. The *Plan* concluded the system, as studied, will meet reliability criteria over the 2017-2026 period.

While finding no reliability needs, the 2016 plan noted that reliability margins could change over the study period based upon the following changes in assumptions and potential risk factors.

- **On January 9, 2017, Entergy and Governor Cuomo announced an agreement to close Indian Point units 2 and 3 in 2020 and 2021, respectively.**[15] The NYISO will perform the appropriate reliability impact analysis for this scenario through a Generation Deactivation Assessment as well as the *2018 Reliability Needs Assessment.* Using the most up-to-date information of the resource mix, system conditions, and forecasted system needs in New York, the NYISO will conduct its studies and provide federal and state policymakers, market participants, investors, and the public with clear information to determine the impact of the Indian Point retirement. If a reliability need is revealed, the NYISO will address the need through market-based solutions or with a regulated solution, if necessary.

▸ Here's how the NYISO planning process works:

Identifying needs: Using a market-oriented process, NYISO examines a 10-year horizon to assess the future reliability of the power system.

Encouraging market-based solutions: NYISO's market-based approach encourages private-sector investment in projects to improve New York's energy infrastructure.

Evaluating proposed solutions: When projects are proposed, NYISO rigorously studies them to be sure they will operate safely and securely if connected to the grid.

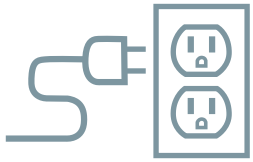
Since launching its planning process in 2005, NYISO has conducted seven assessments, five of which identified emerging reliability needs. In each case, the markets responded to address the needs and the NYISO did not need to implement a regulated solution through its tariff.

- **Based on the best information available at the time the evaluation was initiated in March 2016, the *2016 Reliability Needs Assessment* assumed the R.E. Ginna and James FitzPatrick nuclear power plants would be deactivated.**[16] With the Public Service Commission's approval of a Zero Emission Credit (ZEC) policy for the upstate nuclear facilities in 2016, both plants are continuing to operate, which increases the reliability margin compared to what was included in the study.
- **The *2016 Reliability Needs Assessment* includes over 1,000 MW of assumed generation additions.** If anticipated resources do not materialize within the assumed timeline, the resource adequacy margin will decrease.
- **The retirement or unavailability of generating units** beyond those already contemplated in the study could accelerate resource adequacy needs, transmission security violations and reduce transmission transfer capabilities.
- **Generation resources could elect to offer capacity into neighboring markets,** which would either reduce or eliminate availability in the New York Control Area (NYCA). Accordingly, the NYISO will continue to monitor imports, exports, generation and other infrastructure.

In the spring of 2018, the NYISO will begin developing the *2018 Reliability Needs Assessment.* Scheduled for completion in the fall of 2018, it will evaluate the 2019-2028 planning horizon, identify any potential reliability needs and establish the process for soliciting solutions, if necessary.

The NYISO continually examines the reliability of the state's bulk electric system by monitoring the implementation of local transmission plans and potential risk factors. In addition to its regular reliability planning processes, the NYISO conducts a facility-specific Generator Deactivation Assessment to address any short-term reliability needs that could result from a generator deactivation.

1. Under NYISO rules, a generator must provide the NYISO with at least 365 days' notice of its intent to deactivate.
2. Within 90 days of receiving a formal deactivation notice, the NYISO assesses whether any reliability needs will arise over a five-year period.
3. This process addresses near-term reliability needs that could result from a generator's deactivation.
4. If a reliability need must be addressed before the NYISO's next comprehensive reliability assessment, the NYISO can seek solutions, which can include transmission or, as a last resort, a Reliability Must Run (RMR) agreement with a generator.



▸3,000 MW of potential generator deactivations were examined as part of the 2017-2026 RNA study.

Potential generator deactivations in the 2017-2026 study period total more than 3,000 MW.

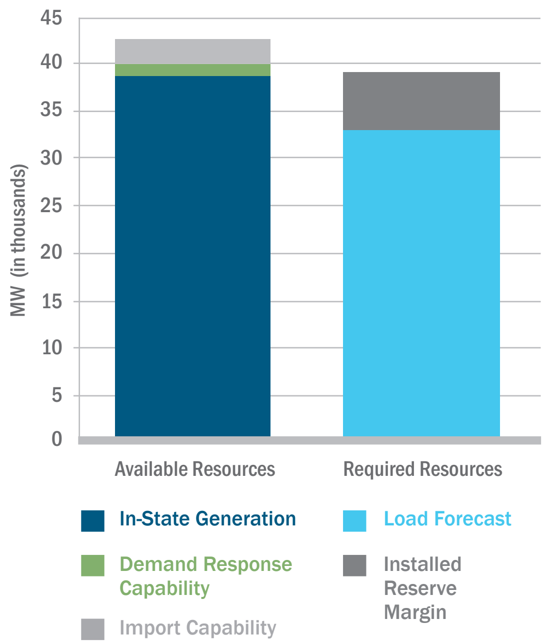
Reliability Outlook

For the summer of 2017, power resources available to serve New York State total 40,799 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.

While the total power resources available in 2017 is 753 MW below last year's level, available power resources remain above the projected peak demand of 33,178 MW plus the reserve requirement, a combined total of 39,150 MW.

This estimate of total resources measures the maximum potential of 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. Weather extremes could produce peak demand ranging from 29,980 to 35,487 MW in 2017.

Figure 13: Statewide Resource Availability: Summer 2017



► New York's Installed Reserve Margin:

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 and the New York State Public Service Commission.

Installed Reserve Margins

New York's electric system maintains generating capacity beyond projected need, akin to a household emergency fund. These reserves mean the electric system is prepared to cope with equipment breakdowns, severe weather, or other unplanned events that could affect system reliability.

The availability of more supply than may be required by the highest anticipated level of demand for electricity is a fundamental requirement for reliable electric system operations. This reliability requirement is known as the Installed Reserve Margin, or "IRM."

Each year the NYISO works with the New York State Reliability Council (NYSRC) to conduct an IRM study. The analysis evaluates the expected load in relation to the anticipated available resources and other system conditions.

The primary reliability criterion examined is the Loss of Load Expectation (LOLE) that requires that the probability of an unplanned system outage should not be more than one instance in a 10-year period. NYSRC reliability rules also include more specific or more stringent criteria that account for special circumstances within the New York Control Area, such as the configuration of the bulk power system and the severe consequences that may result from power interruptions in New York City and Long Island.

Factors that influence the setting of the IRM include load forecasts; variance in load due to uncertainties related to weather; historical performance of generation and demand response resources; constraints on the transmission system; emergency operating procedures that can be deployed during system emergencies; and emergency assistance available from neighboring regions.

The approved IRM for the 2017/2018 Capability Year, including the Summer Capability period that begins on May 1, is 18% up slightly from the previous IRM of 17.5%.,[17] The IRM requires utilities, energy service companies and other load-serving entities to purchase capacity equal to 118% of the forecasted peak summer load. Factors influencing the slight increase to the IRM include reductions in anticipated load, changes stemming from modeling import capabilities, updated modeling of wind generation, and updated assumptions about generator performance based on recent data.

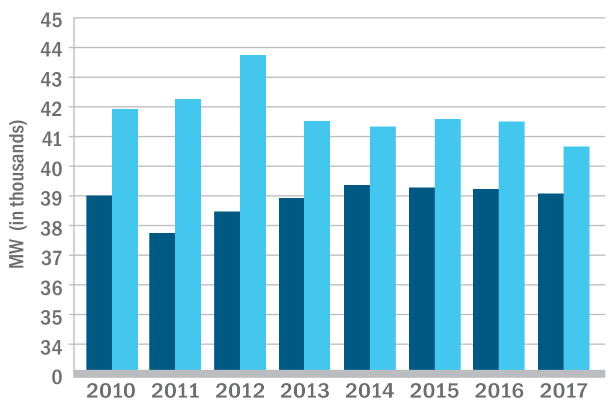
▸ **The approved Installed Reserve Margin (IRM)** for a full year, including the Summer Capability period that began on May 1, is 18%, up slightly from the previous IRM of 17.5%.

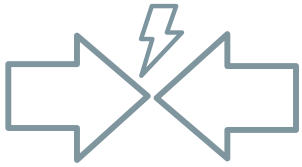
Resource Diversity & Energy Costs

Both the reliability of the electric system and the price of power are affected by the mix of fuels used to generate electricity. 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 and public policy influence the mix of generation technologies and fuels used to produce power. Private investment is driven by economic factors — the relative costs of fuel, operation and maintenance, as well as the costs of siting, permitting, and construction. 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 costs to produce energy.

Figure 14:
Power Resources and Reliability Requirements: 2010-2017





▸ 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.

Policy goals and environmental regulations, which vary regionally and by state, affect fuel mix through overall emissions caps and targeted emissions standards, which require power plants that burn fossil fuels to limit production and/or install pollution controls. New York and 28 other states in the nation have adopted renewable portfolio standards with the goal of having "green power" resources, such as solar and wind, provide a specified portion of generation.

Fuel Mix in New York State

The NYISO's markets, like those of other regions of the country, select the least-cost mix of resources to reliably meet the needs of energy consumers, regardless of the type of fuel used to supply energy to the grid. While fuel mix is not a determinant in which units are selected in the NYISO markets, the diversity of the fuel mix has both reliability and economic implications that are important to operating the grid.

From a statewide perspective, New York has a relatively diverse mix of generation resources. However, in New York, the tale of two grids includes a supply mix that is less diverse within the various regions of the state. For example, the combination of more stringent air quality regulations, limitations to the ability to flow energy across the transmission system, and reliability standards that establish local generation requirements in the downstate region have resulted in the power demands of New York City and Long Island being served with generation primarily fueled by natural gas. However, many of these are dual-fuel units capable of using oil when necessary, which provides fuel diversity and reliability benefits to the system.

In addition to looking at capacity, the maximum potential output of the various types of power plants, it is important to consider the actual energy generated by those power plants.

For example, power plants that run on fossil fuels (natural gas, oil and coal) account for 66% of New York's generating capacity. However, generation powered by fossil fuelsamounted to only 45% of the total electric energy produced in New York during 2016. Nuclear and hydropower generation facilities maximize their output compared to their relative share of capacity.

1. Nuclear, with 14% of statewide capacity, produced 30% of the total electric energy in New York last year.
2. Hydropower, with 11% of statewide capacity, produced 19% of New York's electric energy in 2016.

New York's fleet of fossil fuel power plants includes older facilities with higher operating expenses or fuel costs, which are selected to run only during periods of higher demand. While these facilities add to overall capacity totals, they contribute 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 and are selected in wholesale market auctions to operate more frequently than older and potentially less efficient fossil units.

However, the fuel supplies of these renewable resources are made variable by weather and climate conditions. The intermittency of renewable project operation influences the reliability of their supplies, measured by a metric called "capacity factor." Capacity factor compares how much electricity a generator actually produces with 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 baseload power. They typically have average annual capacity factors 70% or higher. 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.

Consider, for example, nuclear, hydro, wind and solar energy:

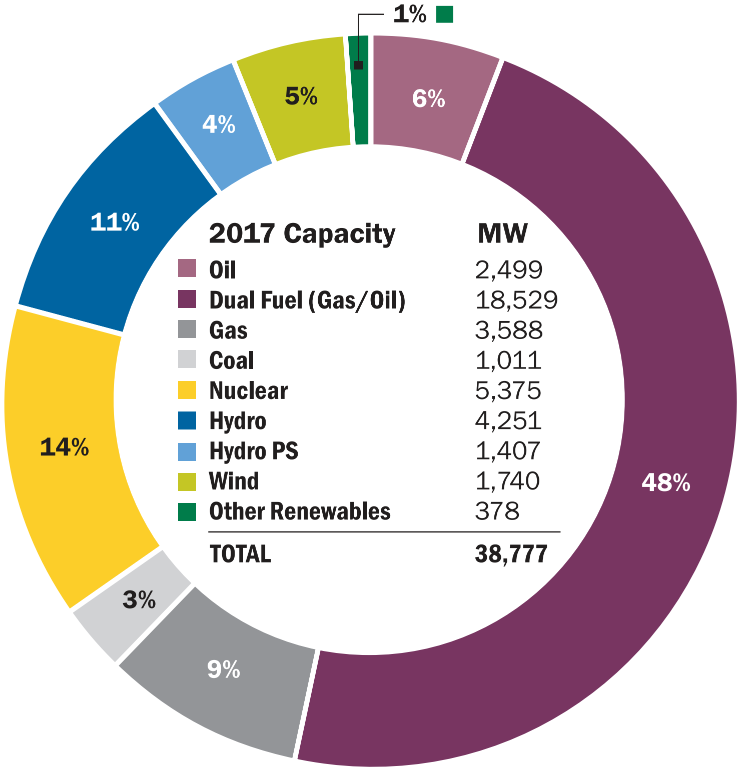
1. Nuclear had an 88% capacity factor and hydropower had a 71% capacity factor in 2016.
2. Wind power performed at a 25% capacity factor.
3. Distribution-level solar performed at approximately 15%.

▶ **Renewable resources,** such as hydro, wind and solar energy, have no fuel costs and are selected in wholesale market auctions to operate more frequently than older and potentially less efficient fossil units.

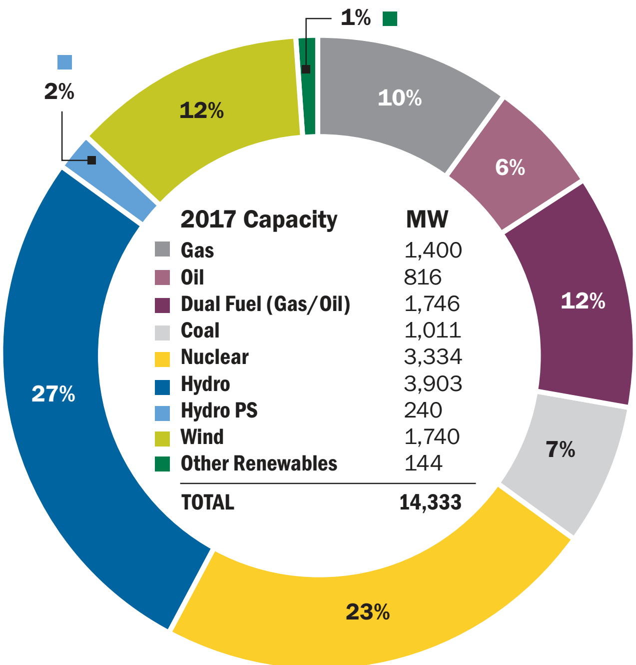
The relative capacity factors of different types of generation are important considerations in planning the future fuel mix. For example, based on 2016 operating performance, it would require approximately 3.5 MW of wind capacity to produce the same amount of energy as 1.0 MW of nuclear capacity over the course of a year. This is due to the variable nature of supply from these intermittent resources. From an operational perspective, the intermittent nature of these resources is further challenging, as they cannot respond to dispatch signals in the same manner that dispatchable supply resources can. For example, these resources can be signaled to supply less energy when reliability conditions warrant such instructions, but cannot increase output in

Figure 15: Generating Capacity in New York State by Fuel Source — Statewide, Upstate New York and Downstate New York: 2017

NYCA CAPACITY



UPSTATE CAPACITY (Zones A-E)



DOWNSTATE CAPACITY (Zones F-K)

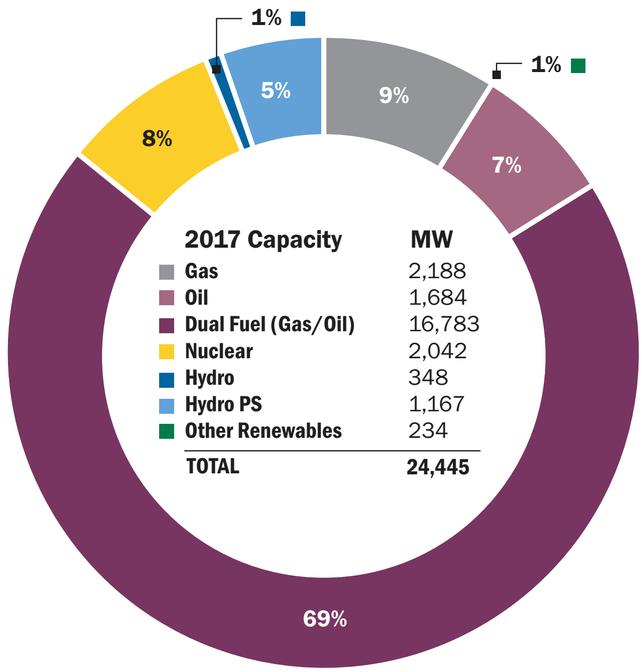
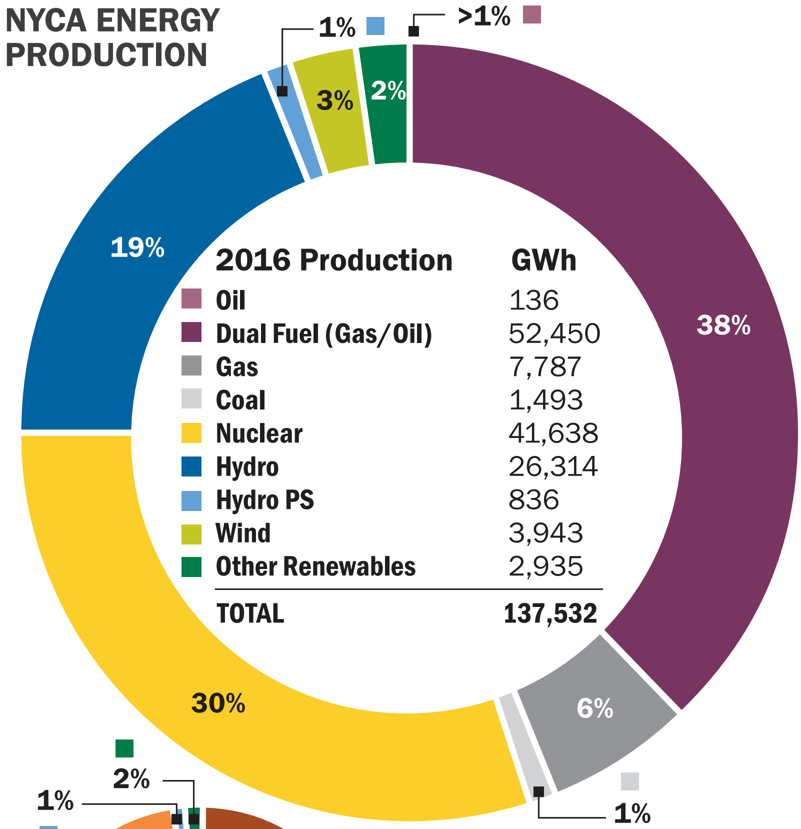
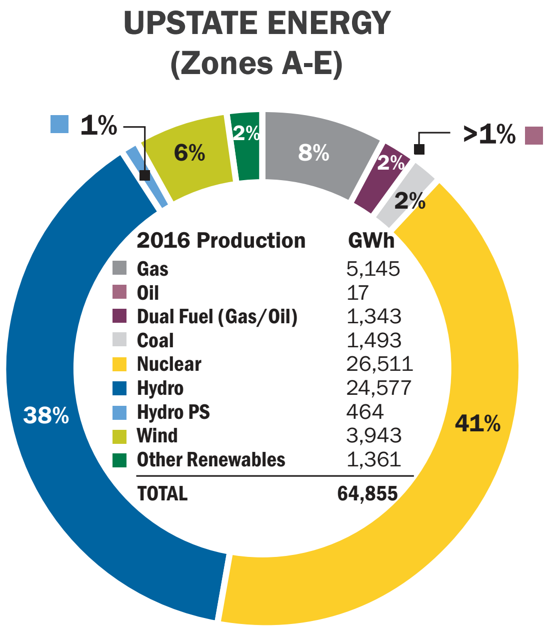
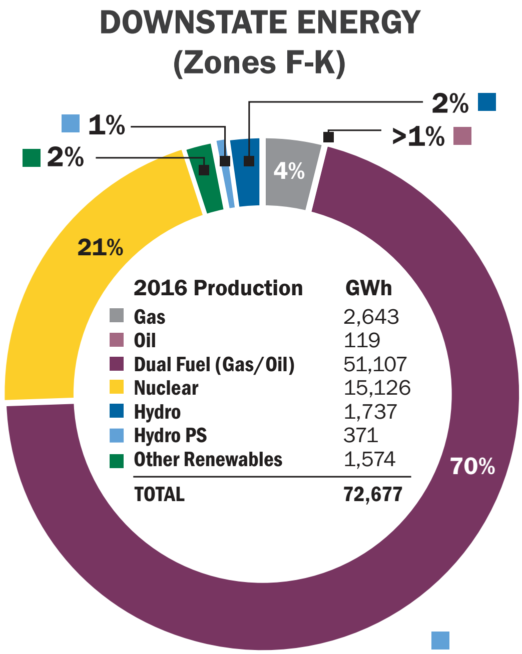
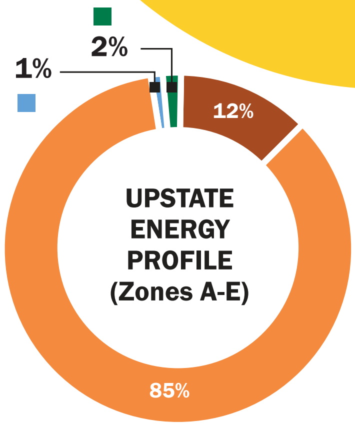


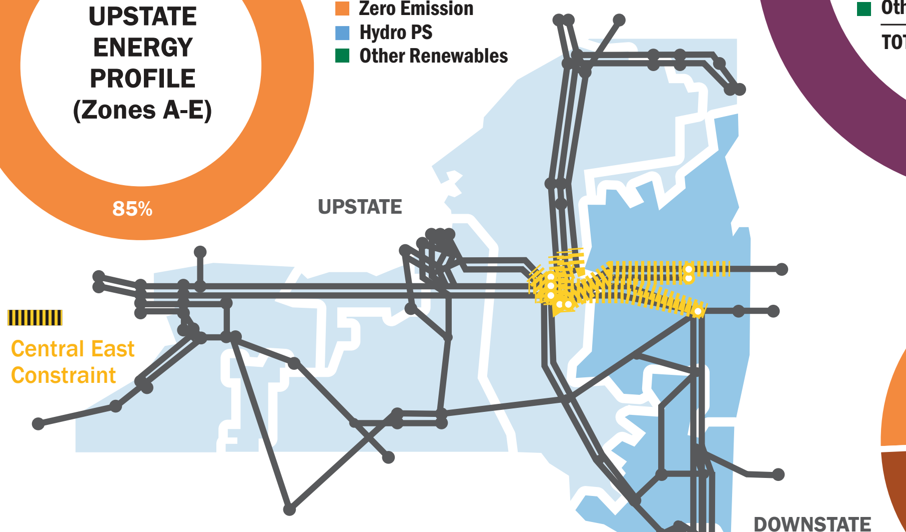
Figure 16:
Electric Energy Production in New York State by Fuel Source — Statewide, Upstate New York and Downstate New York: 2016



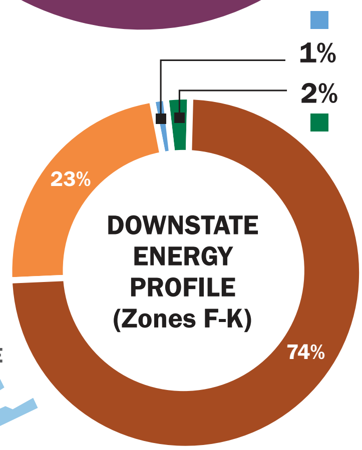








In 2016, the Central East interface limited flows of energy from upstate to downstate 53% of the time in the NYISO's Day-Ahead Market, limiting the delivery of clean energy resources to meet downstate energy needs.



the same manner as dispatchable resources can.

The combination of fuels used to produce power in New York has changed since 2000. New York's capability to produce power from natural gas and wind has grown, as the generating capacity from coal- and oil-fired plants has declined.

The portion of New York's generating capability from natural gas and dual-fuel facilities grew from 47% in 2000 to 57% in 2017. Wind power, virtually non-existent in 2000, grew to 5% of New York State's generating capability in 2017.

In contrast, New York's generating capability from power plants using coal declined from 11% in 2000 to 3% in 2017. Generating capability from power plants fueled solely by oil dropped from 11% in 2000 to 6% in 2017.

Figure 17:
Capacity Factor of Generators by Type

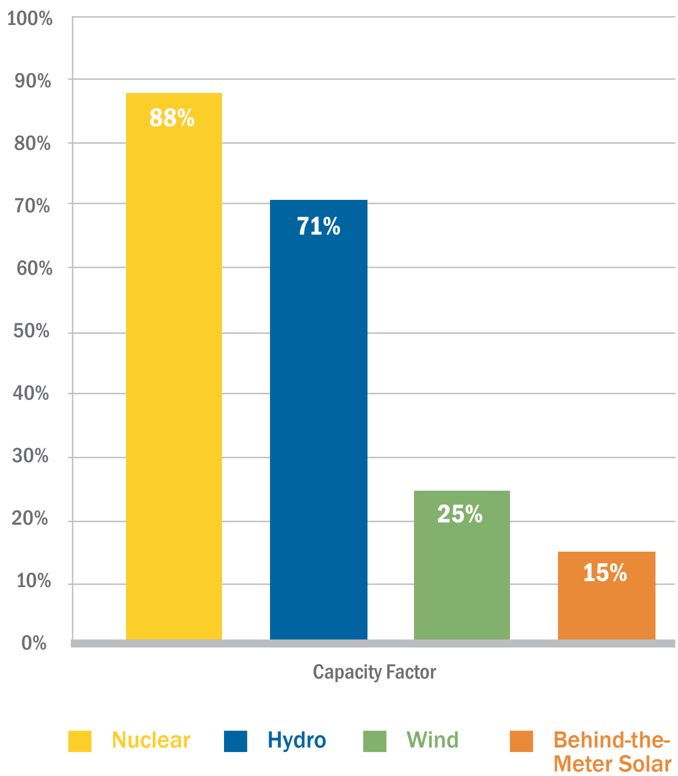
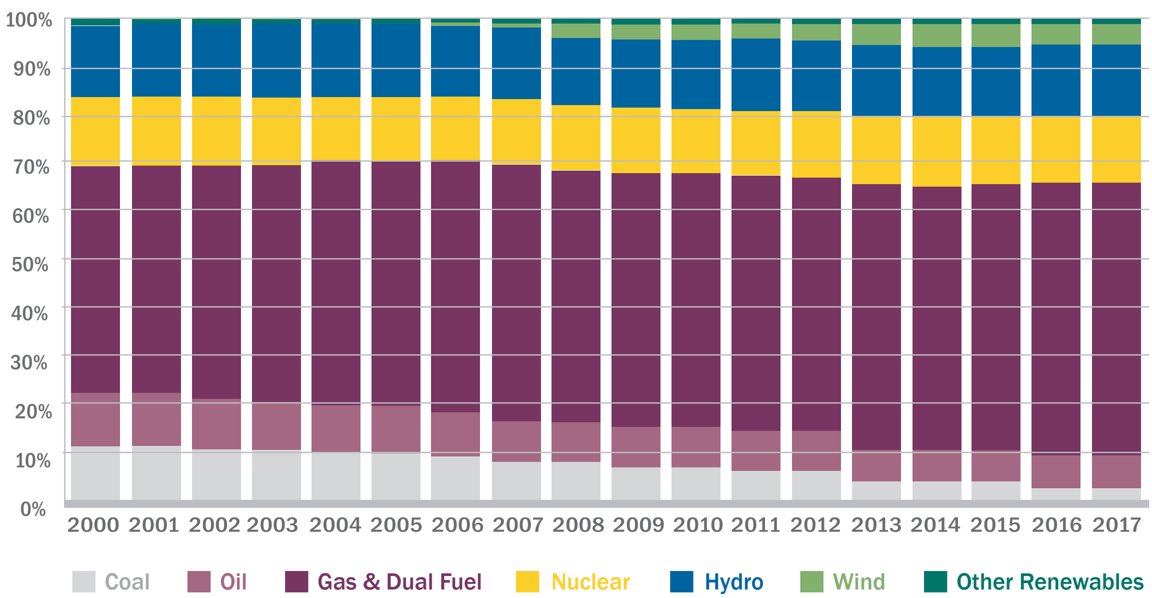


Figure 18: New York State Fuel Mix Trends: 2000-2017



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 and 2017. Hydropower (including pumped storage) represented 15% of the state's generating capability in 2000 and 2017.

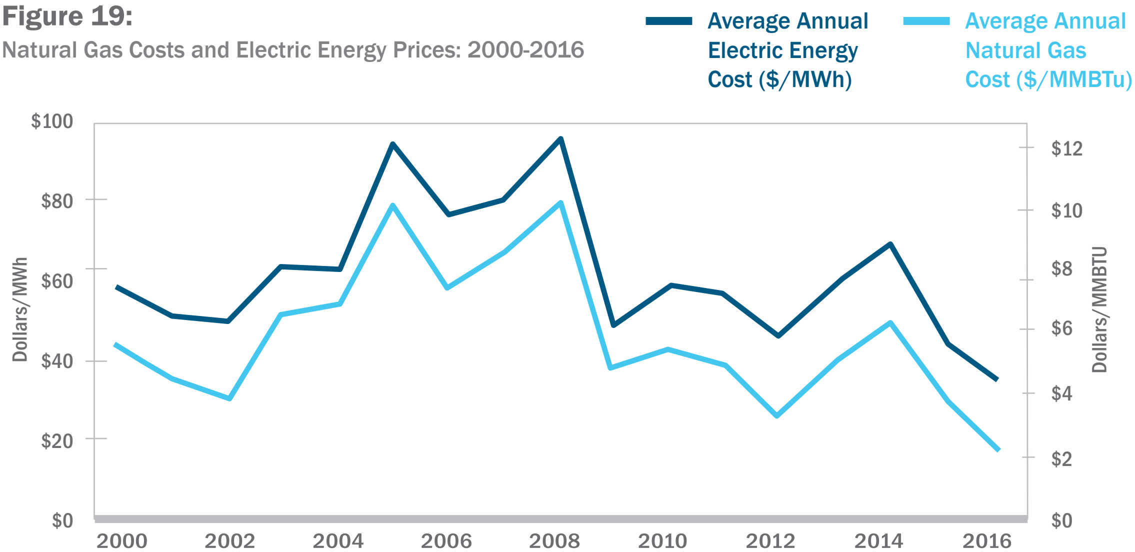
Electricity Prices & Fuel Costs

The average wholesale electric energy price in 2016 was $34.28 per megawatt-hour (MWh), the lowest in the history of the NYISO.

Wholesale electricity prices are directly influenced by the cost of the fuels used by power plants to meet the demand for electricity. Power plants fueled primarily by natural gas account for more than half of the electric generating capacity in New York State. Consequently, the price of natural gas and the cost of electricity are closely correlated.

▸ **$34.28 per MWh,** in 2016, was the lowest average wholesale electric energy price in NYISO history.

Figure 19:
Natural Gas Costs and Electric Energy Prices: 2000-2016



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 2016, the average demand in New York rose slightly from 2015, but it was "still noticeably lower than those [average demand levels] from 2010 to 2013," according to the 2016 State of the Markets Report.

Capacity Prices

Capacity prices during the Summer 2016 Capability Period were lower than those of the previous Summer Capability Period. The average Spot Market Auction prices in NYC were $12.24/kW-month compared to $15.38/kW-month, and were $4.63/kW-month compared to $5.72/kW-month in LI. The average Spot Market Auction prices over the Summer 2016 Capability Period were higher for NYCA and the lower Hudson Valley region, or the Zones G-J Locality, i.e., $4.09/kW-month, and $9.24/kW-month compared to $3.83/kW-month, and $9.10/kW-month respectively during the previous Summer Capability Period. These changes were driven primarily by changes in the respective Locational Minimum Installed Capacity Requirements (LCRs), as well as by the changes in available capacity.

Reliability & Markets

A Changing Mix of Supply Resources

As noted above, abundant domestic natural gas supplies and resulting low costs of natural gas are working to drive wholesale electric energy to record-low prices.

- While the trend toward lower-cost natural gas is benefiting New York consumers in the form of lower-cost energy supplies, New York's markets are reflecting a national trend where decreasing energy revenues is placing economic pressure on all generation resources to remain commercially viable.
- Combined with more stringent environmental regulations that have been put in place to reduce emissions from the power sector, both economic and public policy forces are producing a growing reliance on natural gas for electricity generation throughout North America.

According to the U.S. EIA, coal's share of the nation's electricity generation has decreased. In 2016, natural gas-fired generation exceeded coal's share of the U.S. electricity mix on an annual basis for the first time. In the U.S., natural gas accounted for an estimated 34% of the total annual utility-scale power generation in 2016, compared with a 30% share for coal-fired generation.[18]

"Coal's share of the nation's electricity generation has decreased. In 2016, natural gas accounted for 34% of total annual utility-scale power generation."

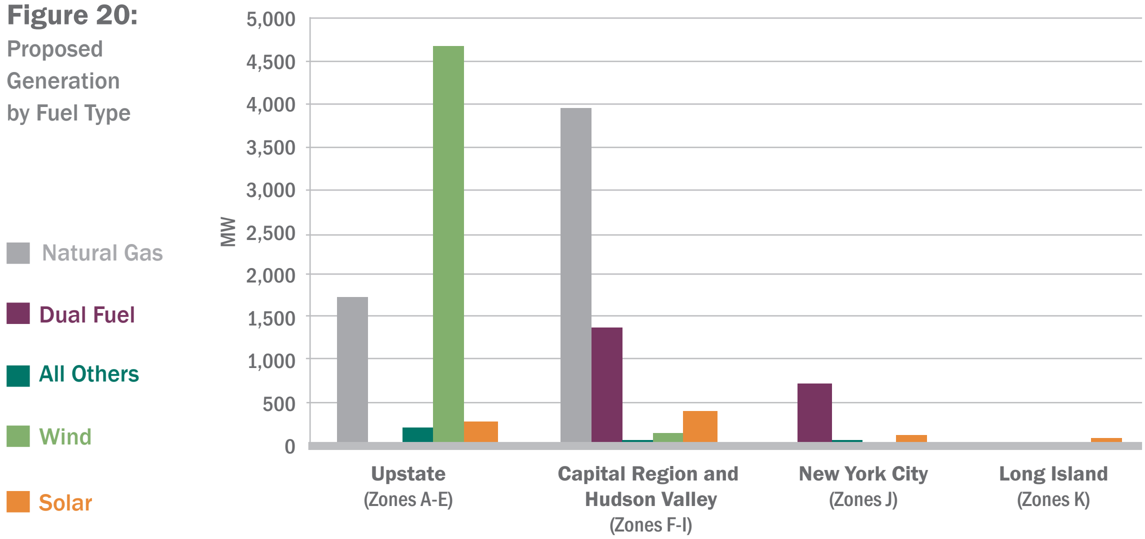
— U.S. Energy Information Administration

The trend toward greater reliance on natural gas in the power sector has brought the interaction between natural gas infrastructure and the power grid into sharper focus, as it appears that power grid reliability and economics will increasingly be linked to the performance and reliability of the gas pipeline infrastructure.

That interdependency between gas pipeline infrastructure and the bulk power system is heightened in New York State, where natural gas-fired power plants and dual-fuel power plants that rely primarily on natural gas produced 44% of the electricity. From a statewide perspective, New York continues to have a diverse mix of supply resources that includes wind, solar, hydro, and nuclear-powered generating facilities. However, there is less fuel mix diversity in the southeastern region of the state, where natural gas-fired power plants and power plants capable of burning both natural gas and oil are the predominant sources of power.

New York's reliance on natural gas-fired capacity is expected to grow as power projects using natural gas account for 56% of all proposed generating capacity.

Figure 20: Proposed Generation by Fuel Type



This heightened interdependency between natural gas and electricity has prompted numerous studies to identify what, if any, electric system reliability vulnerabilities might be exposed by growing reliance on natural gas infrastructure for power generation.

Here are three studies and what they found:

1. **A 2014 study commissioned by the Eastern Interconnection Planning Collaborative (EIPC)**
   a. Examined natural gas-electric system interfaces and identified risks for New York that include the threat of unplanned generator retirements combined with a growth in winter demand and/or the deactivation of nuclear units.
   b. Mitigating these risks, according to the report, are the robust dual-fuel capability already in operation, the diversity of existing natural gas pipelines that serve the generators, and the prospect of expanding pipeline capacity.
2. **In February 2016, the NYISO shared with stakeholders the results of a study** it undertook to determine whether the New York Control Area (NYCA) system can reliably serve its electric load during an extended cold snap, when access to gas supplies is more likely to be constrained. To assess this risk, the NYISO tested the system's ability to meet load under severe winter conditions with expected generator availability and with increasing attrition in New York's nuclear fleet.

a. The base-case scenario, which assumed the retirement of the Fitzpatrick nuclear unit in addition to retirements of the Dunkirk and Huntley coal-fired generating facilities, found that there would be no load curtailment provided that oil-fired facilities had access to refueling or if oil tanks were filled to capacity at the onset of the two-week event.

b. The study's nuclear retirement scenarios, which layered on the additional retirements of all nuclear generating resources; including Ginna, Nine Mile 1 and 2, and Indian Point 2 and 3 facilities, caused an increasing likelihood of load curtailments when oil units were limited to oil tank inventories and unable to refuel. In this most extreme scenario where all nuclear units were assumed retired, and assuming no ability to replenish oil tanks, it was predicted that load curtailments were likely to occur, beginning on the eighth day of the cold-weather event. The finding underscores the value of fuel diversity afforded to the system by dual-fuel units capable of switching to alternative fuel supplies during periods of gas pipeline constraints that might otherwise affect system reliability.

3. **In May 2016, the North American Electric Reliability Council (NERC) issued a report** focused on the operational risks to the power grid associated with high penetration of natural gas-fired generation.[19]

   a. The study noted that "regions with a growing reliance on natural gas are increasingly vulnerable to issues related to gas supply availability." The report suggests that the multiple pipelines supplying New York's generators will help to avoid tight operational margins in the near term.

   b. It also identified activities and characteristics of New York's system that support continued fuel assurance; including the NYISO's site visits and surveys of gas-fired units throughout the system, dual-fuel requirements on generators interconnecting to Local Distribution Company gas systems, and firm contracts for some gas-fired generators that cover all or a portion of those generators' capacity. NERC noted that planned gas pipeline expansions in New York would prove beneficial in maintaining fuel assurance going forward. Among NERC's suggestions is for regions with high levels of gas-fired generation to thoroughly examine reliability needs to determine if expanded use of firm fuel contracts or dual-fuel capabilities are needed.

New York's Gas Delivery Infrastructure

While the findings of the EIPC study and NERC report suggest that New York State is currently well positioned to address natural gas demand for generators as well as firm residential and commercial natural gas customers, future fuel assurance is less certain. Numerous pipeline projects have been proposed in the region. Nevertheless, the complex economics and financing arrangements of these efforts, combined with regulatory proceedings related to these projects raise questions about the likelihood of building new natural gas pipelines in the state.

In 2016, several proposed natural gas pipeline projects encountered economic and regulatory hurdles that called into question the future of those projects. In some cases, projects approved through federal regulatory proceedings were subsequently delayed or denied permits in state-level regulatory proceedings.[20] While pipeline siting is primarily the domain of FERC and federal regulations, the difficulties in securing long-term commercial commitments as well as challenges in securing state-level permits add layers of uncertainty. Ultimately, this uncertainty in gas pipeline development underscores the challenges the power generation sector faces with regard to natural gas infrastructure needed to support improved fuel assurance and more attractive pricing.

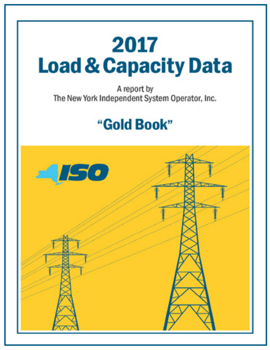
Natural Gas Power Generation in New York State

Today, power plants using natural gas total 57% of New York State's generating capability. Within that set of gas-fired capacity, 84% is dual fuel that can use either natural gas or an alternative fuel (typically oil).

1. **During periods of high usage,** reliability rules require many of these plants to be capable of switching over to burn oil within seconds.
2. **Outside of peak times, dual-fuel generators** may choose to run on whichever fuel is less expensive provided that they remain in compliance with state and federal emissions regulations.
3. **This operational flexibility provides** both fuel diversity and reliability benefits.

Future use of oil combustion for power generation will be restricted by New York City law.[21]

1. In 2015, New York City passed legislation that effectively bans the combustion of residual fuel (i.e.; Number 6 fuel oil) for any purpose beginning on January 1, 2020.
2. The law also bans the combustion of Number 4 fuel oil (a product produced from the blending of Number 6 and Number 2 oil grades) beginning on January 1, 2030.
3. The legislation was enacted as a measure to reduce negative health impacts associated with the emissions of particulate matter. Upon the phase-out of Number 4 fuel oil, only Number 2 fuel oil will be permissible for use in power generation, heating, and other applications within the borders of New York City.
4. In early 2017, local officials introduced legislation to accelerate the phase out of Number 4 fuel oil to 2025.[22]



2017 Gold Book, for more information visit www.nyiso.com.

The legislation poses potential fuel assurance issues. Power generators with dual-fuel capabilities currently using Number 6 fuel oil will face the need to retrofit their facilities to accommodate the storage and combustion of Number 4 or Number 2 fuel oil in order to retain functional dual-fuel capabilities beyond January 1, 2020. Based on 2017 Gold Book data, the rule will affect seven generation units in New York City with a combined total installed capacity of 2,800 MW.

The growing demand for natural gas by power generators, coupled with uncertainty over the likelihood of future natural gas infrastructure expansions and local restrictions on the use of fuel oil, is raising strategic concerns about the gas system. **Specifically, there is increasing concern over the gas system's ability to keep pace with the needs of gas utilities serving residential, commercial and industrial customers, while simultaneously meeting the expanding needs of gas-fired power plants, especially during peak demand conditions in winter and summer.**

Market Approaches to Addressing Fuel Supply & Performance Assurance

Recognizing the need to incentivize fuel assurance in the context of competitive power markets, ISO/RTOs are taking steps to ensure that economic incentives exist in those markets for generators to achieve fuel assurance. The approaches being undertaken vary from region to region, reflecting the acuteness of the issue within each region.

The NYISO in its stakeholder process has been developing and implementing market structure improvements to send the correct price signals and incentives for generators to maintain or procure adequate fuel supplies to operate in the event that their primary fuel becomes unavailable.

"Lower natural gas prices have effectively driven down wholesale power prices for all generators, regardless of whether they are using natural gas, coal, nuclear power or renewable resources to generate their electricity."

— As reported by Moody's rating agency in March 2016

Through the NYISO Electric and Gas Coordination Working Group, stakeholders are addressing joint operational, planning and market design issues. The working group has engaged in extensive study and analysis of electric-gas issues. This includes research that assessed the cost of providing fuel assurance through dual-fuel capability and oil supply provisions, and compared the cost of dual-fuel capability to firm pipeline transportation under a range of scenarios.[23]

Working with stakeholders, the NYISO adopted several energy market design enhancements to provide price signals for generators to maintain fuel assurance.

1. In November 2015, the NYISO implemented enhancements to its Shortage Pricing market design that strengthen incentives for generators to secure sufficient fuel to meet their Day-Ahead schedules.
2. The design allows energy prices to rise at times when the Real-Time energy market is unable to procure sufficient reserves or regulation to meet requirements.
3. The Shortage Pricing enhancements incent generator performance on critical days.

In addition to the Shortage Pricing enhancements, the NYISO is strengthening its Scarcity Pricing system, which works to sustain appropriate price levels throughout Demand Response events, when prices might otherwise fall once the resources are activated to suppress demand. Through the Comprehensive Scarcity Pricing design the NYISO incorporates the value of demand response resources into its pricing software to more appropriately reflect resource lost opportunity costs in the energy, reserve, and regulation prices.

The NYISO and its stakeholders have generally focused their fuel assurance initiatives on energy market design changes that seek to improve generator performance. However, as the prospect of natural gas infrastructure expansions becomes less certain, there are potential capacity market changes that could be implemented to supplement energy market fuel assurance signals.

The already significant impact of natural gas costs on electric energy prices will continue to grow with increased reliance on gas-fueled power generation. This trend reinforces the need to bolster gas-electric coordination and address fuel assurance concerns.

As the rating agency Moody's reported in March 2016, "Lower natural gas prices have effectively driven down wholesale power prices for all generators, regardless of whether they are using natural gas, coal, nuclear power or renewable resources to generate their electricity." [24]

Performance assurance concerns in the generation sector vary based on regional differences in terms of the fuel diversity of each region's generator fleet and the availability of natural gas pipeline infrastructure serving those regions. While ISO-NE and PJM have both recognized fuel assurance as a concern in their efforts to sustain reliability, both are pursuing different approaches reflecting the near-term acuteness of the concern.

ISO-NE, where fuel assurance concerns are perhaps the greatest given that region's reliance on natural gas and its limited gas infrastructure, has already implemented "Performance Incentive" capacity market design changes to improve the availability of capacity resources during stressed system conditions. PJM, on the other hand, is planning to transition from its Base Capacity Resource product to a Capacity Performance Resource product similar to ISO-NE's over a four-year period.

Nuclear Energy Trends

There are currently 100 nuclear power plants operating in the U.S.[25] In 2015, nuclear facilities produced 19% of the nation's power.[26] New York's six nuclear power projects generated 30% of the electricity generated in the state last year.

In recent years, however, owners of several nuclear-powered generating projects have deactivated their units or announced plans

▶ **100 nuclear power plants** operate in the U.S, 19% of the nation's power was produced from nuclear facilities in 2015. 30% of the electricity generated last year came from New York's six nuclear power projects.

to retire their facilities. Competition from lower-cost natural gas power plants, increased safety and security requirements, the moderation of demand for electricity, and increasing cost of nuclear fuel and plant operations are negatively influencing the economics of nuclear power projects.

According to the Nuclear Energy Institute, between 2002 and 2015, nuclear fuel costs increased 21%, capital expenditures by 103%, and operating costs by 11% (in 2015 dollars per MWh).[27]

On January 9, 2017 Governor Cuomo and Entergy Corporation, owner of the generating facility, announced an agreement to close the Indian Point Energy Center by April 2021. The Indian Point Energy Center, located in Westchester County, includes two nuclear power generating units capable of producing a total of 2,060 MW. Under the agreement, plant operations could continue until 2025 should New York State determine that an emergency condition warrants such an extension. Also as part of the agreement, Entergy is to amend its NRC relicensing request, which previously sought a 20-year extension, to comport with the agreement timeline. New York State has agreed, in turn, to discontinue its legal opposition to the license extension. In its announcement, Entergy cites increased operating costs, low current and projected wholesale energy prices and declining revenues due to competition from low-cost natural gas resources as reasons for retiring the facility.

“Between 2002 and 2015, nuclear fuel costs increased 21%, capital expenditures by 103%, and operating costs by 11% (in 2015 dollars per MWh).”

— The Nuclear Energy Institute

Prior to the announcement of the closure of Indian Point, other nuclear power plant operators in New York State indicated they were facing economic pressure to retire, including the FitzPatrick Nuclear Power Plant, located on Lake Ontario near Oswego as well as the Ginna Nuclear Power Plant, located on Lake Ontario near Rochester. With the Public Service Commission’s approval of a ZEC policy for upstate nuclear facilities in 2016, both plants have continued to operate. New York’s Clean Energy Standard will offer out-of-market payments to eligible nuclear facilities in the state in the form of ZEC payments. The ZECs are designed to reflect the value these facilities offer to consumers by generating energy without emissions, which the PSC determined was not adequately reflected in wholesale market pricing for energy.[28]

Elsewhere in the northeastern U.S., the Vermont Yankee Nuclear Power Station in southern Vermont retired at the end of 2014, while Entergy announced plans to retire its Pilgrim Nuclear Power Station in Plymouth, Massachusetts in May 2019, due to market conditions and increased costs.[29] Additional units in New England and the Midwest have indicated they are facing similar economic pressures to retire absent intervention in the markets, as is being done in New York.

Public Policy & Markets

Transmission Infrastructure as Enabler

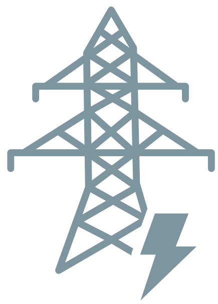
Nationwide, electric companies are continuing to build stronger and smarter energy infrastructure to provide consumers with economic and reliable electric service and to integrate new renewable resources to meet public policy objectives. According to the Edison Electric Institute, in 2015 total transmission investment reached $20.1 billion, a 97% increase from the 2014 total investment of $10.2 billion. Transmission investment is expected to increase by another $2 billion to reach $22.5 billion in 2017.[30]

In 2013 The Brattle Group, an international economic consulting firm, conducted a comprehensive study of the value of transmission investments. It identified benefits that included enhanced system reliability, more effective market competition, capacity cost savings, environmental benefits resulting from expanded use of cleaner resources, and reduced costs of meeting public policy goals.[31] A 2015 update of that study stated, "Ultimately, our transmission grid is the backbone that supports all future policy changes in the electricity sector."[32] Even in the context of expanding DER deployment, an integrated grid with a resilient transmission system is necessary to capture the full value DERs can offer to all of New York's electricity consumers.

The value of transmission investments is being confirmed by experience. The Southwest Power Pool (SPP) has determined that its $5 billion investment in transmission will have a multiplier effect of benefits to consumers. The SPP reports that "[o]verall, the NPV [net present value] of all quantified benefits for the evaluated projects, including production cost savings, are expected to exceed $16.6 billion over the 40-year period, which results in a Benefit-to-Cost ratio of 3.5."[33]

Over the past several years, the NYISO, New York Transmission Owners, and New York State government have identified the need for new transmission investments in New York.

New and upgraded transmission capacity will help to address concerns about maintaining or replacing aging infrastructure; provide greater operational flexibility for dispatching resources; enhance access to operating reserves and ancillary services; and facilitate the ability to remove transmission and generation resources for maintenance when needed.



"Ultimately, our transmission grid is the backbone that supports all future policy changes in the electricity sector."

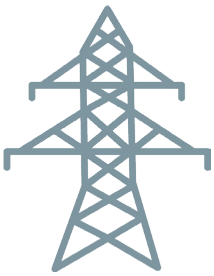
— Toward More Efficient Transmission Planning, The Brattle Group, April 2015

▸**The Southwest Power Pool (SPP)** has determined that its $5 billion investment in transmission will have a multiplier effect of benefits to consumers.

In 2016, Governor Andrew M. Cuomo and the New York State Public Service Commission announced an ambitious clean energy mandate to address climate change, reduce air pollution and support fuel diversity in New York State's resource mix.

1. The Clean Energy Standard (CES) will require 50% of New York's electricity come from renewable energy sources like wind and solar by 2030.
2. The PSC has concluded that this mandate will require the delivery of approximately 70,500 GWh of renewable energy from existing and new resources by 2030.[34]

Achieving public policy objectives will require additional transmission capacity in New York State to deliver renewable resources from upstate New York and northern regions to consumers in downstate New York. Here again, the tale of two grids in New York is important to understand. Much of New York's renewable energy capability is in upstate New York. The resource mix and geographic distribution of expected new renewable resources are expected to dramatically change power flows in New York State. To maximize the load served by renewable generation, cross-state energy transfers will increase — even as statewide load is decreasing — due to the fact that more renewable generation is available to serve the downstate load.



“Additional transmission capability will be required to transfer energy from renewable resources to New York's load centers.”

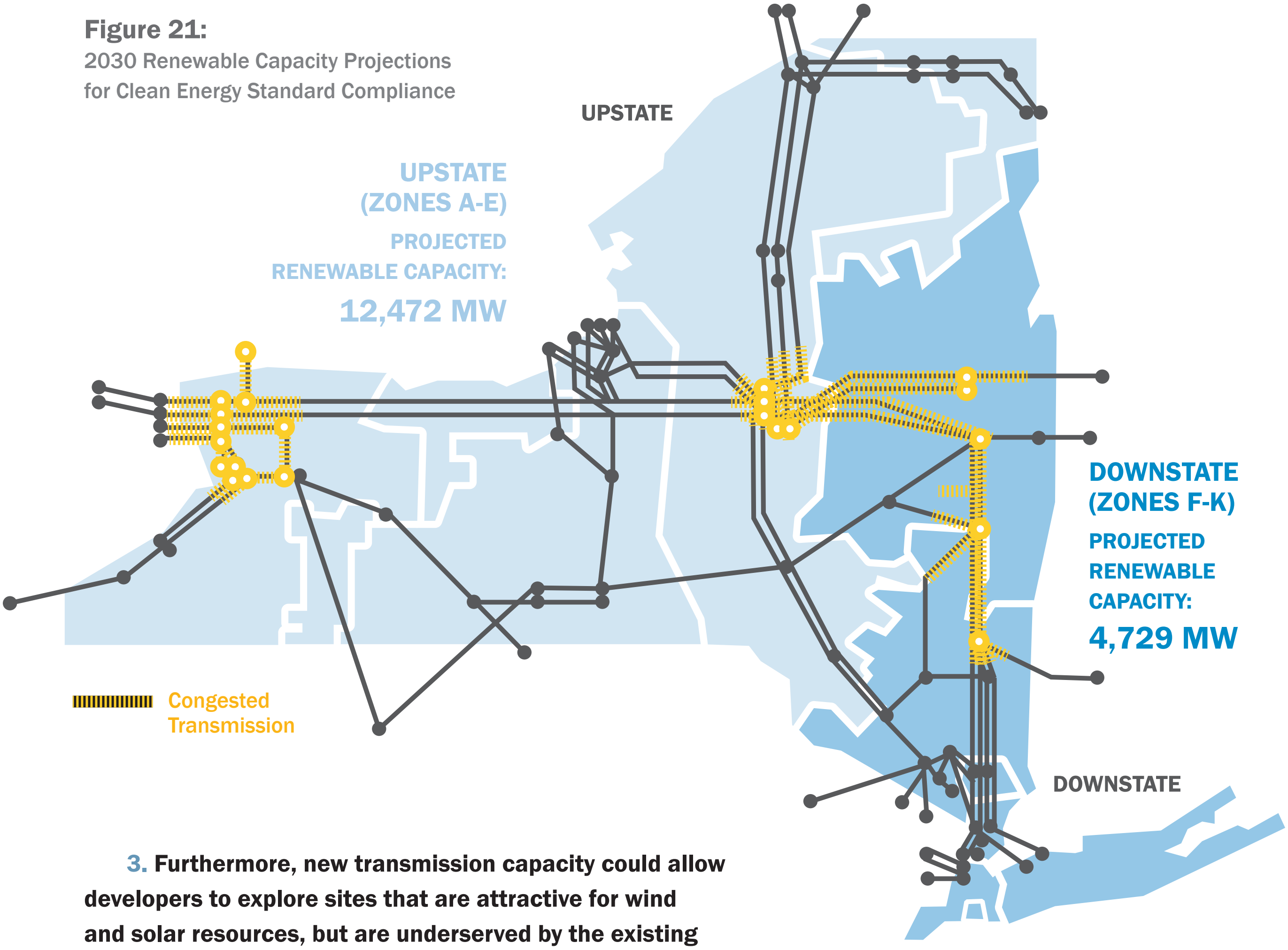
— NYISO comments to the PSC on Clean Energy Standard

Key considerations:

1. **As renewable penetration in the upstate regions exceeds the load in those same regions, additional energy transfers from upstate renewable resources to downstate load centers are necessary, subject to transmission system capability.** Failure to expand transmission capabilities from upstate to downstate will induce market inefficiencies, including increased curtailment of renewable generation to maintain transmission system reliability or generator deactivations notice 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 goal of achieving 50% renewable energy generation by 2030 is jeopardized because energy will not be deliverable from renewable resources to downstate load centers.

2. **Specifically, expansion of the New York transmission system in the St. Lawrence to Marcy corridor would allow developers of renewable resources to provide additional output onto the high-voltage system for delivery to consumers in downstate New York.** Based upon the NYISO's experience, high-voltage transmission in the northern corridor would unbottle the hydroelectric generating capacity in that region, allowing that existing capacity to operate at its full output while simultaneously allowing for the delivery of other renewable resources to consumers in the eastern and southern load centers of New York State.

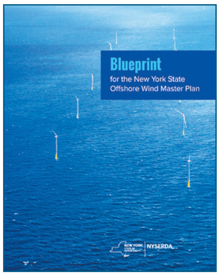
Figure 21:
2030 Renewable Capacity Projections for Clean Energy Standard Compliance



3. **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 transmission system have already been taken or are under development. Conceptually, expanding the transmission system in certain key locations could facilitate the interconnection of new wind and solar resources that are not in proximity to the high-voltage transmission system, as well as unbottle energy from existing wind resources. Further analysis will be required to identify the areas of the State that have high potential for renewable resource development that could be facilitated through the expansion of the transmission lines that connect to the backbone of the high-voltage transmission system.

Governor Cuomo has called for developing up to 2,400 MW of offshore wind power by 2030 to support the overall CES mandate.[35] To develop the offshore wind resource, the New York State Energy Research and Development Authority (NYSERDA) has outlined an offshore wind master plan for New York State.[36] Fulfilling this level of offshore wind development will require significant expansion of transmission capability into Long Island and New York City.

Planning Transmission Infrastructure for Public Policy Requirements



▸**Blueprint for the New York State Offshore Wind Master Plan, NYSERDA**

Among the components of Order No. 1000, the FERC required that planning processes consider transmission needs driven by public policy requirements.

Transmission projects that fulfill such public policy requirements will be eligible for cost recovery through the NYISO's tariff — if they are selected by the NYISO as the more efficient or cost-effective transmission solution to the need identified by the New York State PSC. Under provisions of the NYISO tariff, the New York State PSC reviews and identifies the public policies (including existing federal, state or local law or regulation, or a new legal requirement that the PSC establishes after public notice and comment under the state law). Once the New York State PSC determines the Public Policy Transmission Needs, the NYISO solicits transmission and other types of projects, performs planning studies, and selects the transmission projects that will meet those needs in a more efficient or cost-effective manner.

Western New York Public Policy Need

In July 2015, the New York State PSC issued an order that identified relieving congestion in the state's western region as a Public Policy Transmission Need.[37] The Commission determined that reducing transmission congestion in the region could achieve significant environmental, economic and reliability benefits throughout the state.

These include optimizing output from:

- The Niagara Power Project.
- Greater imports of renewable energy from Ontario.
- Increased operational flexibility and efficiency.

The NYISO solicited proposals to resolve the Western New York transmission need. Of the proposed solutions submitted by developers, the NYISO determined that 10 proposals were viable and sufficient.[38] On October 13, 2016, following consideration of public comments, the PSC issued an order confirming the Western NY Need and determining that the NYISO should evaluate and select a transmission solution.[39]

AC Transmission Upgrade Public Policy Need

In December 2015, the New York State PSC advanced its AC transmission proceeding to a competitive process managed by the NYISO by identifying a Public Policy Transmission Need to relieve congestion on the UPNY-SENY and Central East interfaces, which run from central New York, through the Capital Region to the Lower Hudson Valley.[40] The Commission action limited the new transmission lines to replacing and upgrading existing lines within existing rights-of-way, which is intended to reduce or eliminate adverse environmental, landowner, and economic impacts.

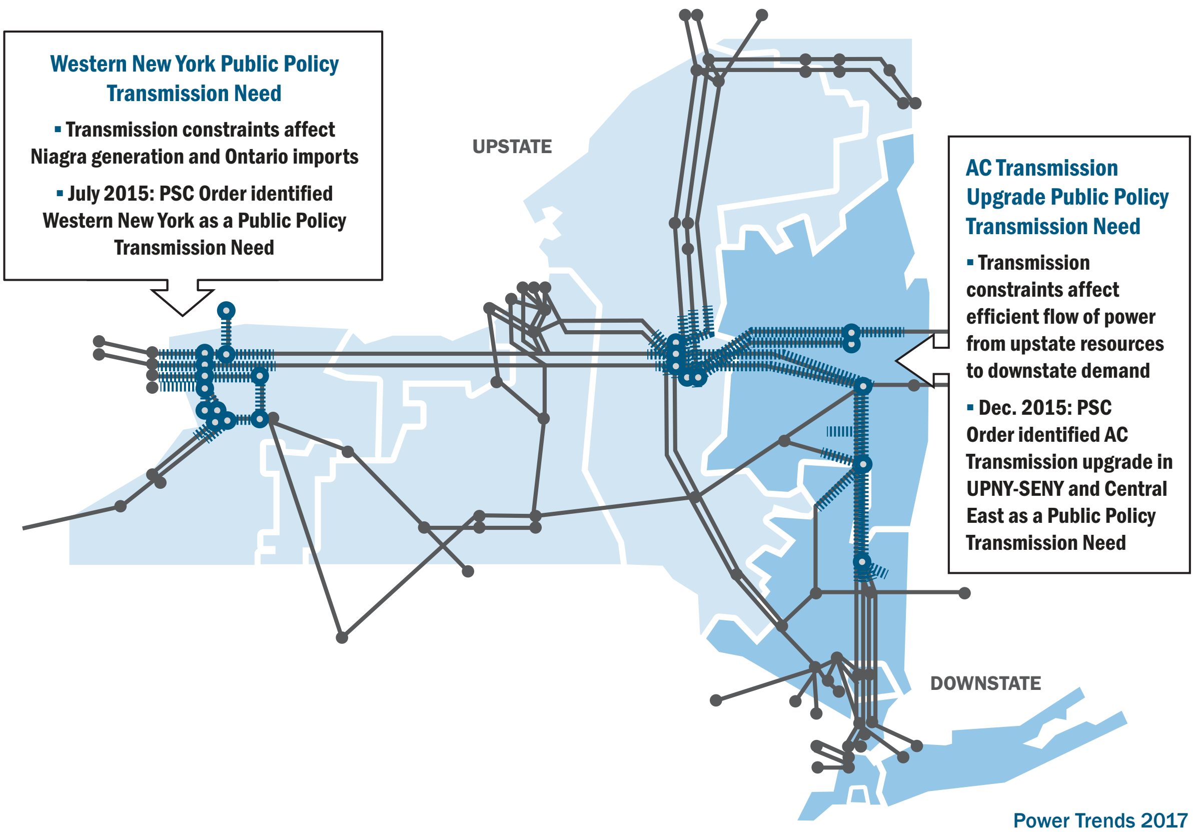
In April 2016, developers submitted 15 transmission projects and one non-transmission project in response to NYISO's solicitation of proposed solutions. Following a stakeholder review and comment period, the NYISO issued the *AC Transmission Public Policy Transmission Need Viability and Sufficiency Assessment.*[41] 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.[42]

For both the Western New York and the AC Transmission Needs efforts, the NYISO is engaged in a detailed evaluation of the transmission proposals with respect to their benefits to the transmission system, including their operability, expandability, performance and cost. Following input from its stakeholders, the NYISO may select the more efficient or cost effective transmission project that, pending siting approval, could be built and recover its costs under the NYISO's tariffs. NYISO expects to complete its evaluation process for Western New York in 2017 and for the AC Transmission Need in early 2018.

Current Cycle of the Public Policy Transmission Planning Process

The NYISO commenced a new Public Policy Transmission Planning Process on August 1, 2016 by providing a 60-day period to allow stakeholders or interested parties to submit proposed transmission needs driven by Public Policy Requirements.

Figure 22: Public Policy Transmission Needs in New York State



The NYISO received, and subsequently submitted to the PSC, proposed transmission needs driven by Public Policy Requirements from 12 entities. Respondents stated that the Clean Energy Standard, in combination with other public policies including New York State's Reforming the Energy Vision (REV) and Offshore Wind Master Plan Blueprint, drives the need for transmission in three common categories:

1. Deliverability of renewable resources from constrained regions within upstate New York and Long Island.
2. Increased transfer capability from Northern New York and Quebec.
3. Increased cross-state transfer capability from west to east and from upstate to downstate.

Successful implementation of the Clean Energy Standard will require significant transmission infrastructure upgrades. In comments filed with the Public Service Commission, the NYISO voiced support for a PSC finding of a need for new transmission in support of offshore wind and renewable resource development in northern New York.[43]

Aging Infrastructure

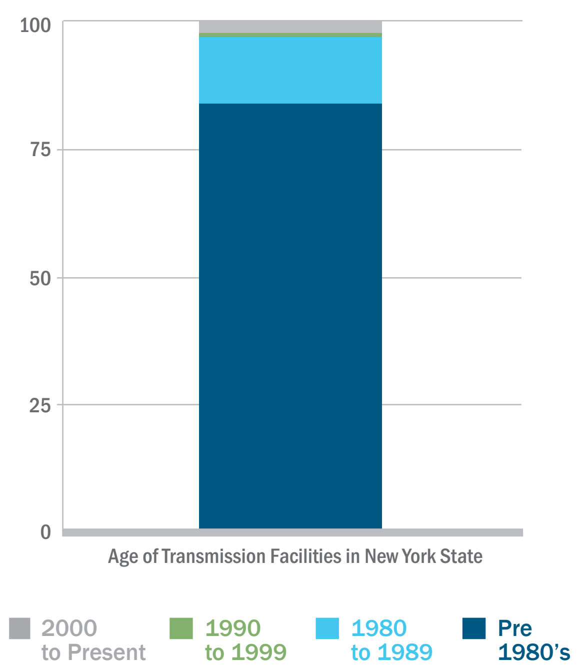
Over 80% of New York's high-voltage transmission lines went into service before 1980. Of the state's more than 11,000 circuit-miles of transmission lines, nearly 4,700 circuit-miles will require replacement within the next 30 years, at an estimated cost of $25 billion.[44]

The New York State PSC previously approved a set of projects collectively named the Transmission Owner Transmission Solutions (TOTS). They are expected to increase transfer capability into southeastern New York by 450 MW.

The transmission projects include:

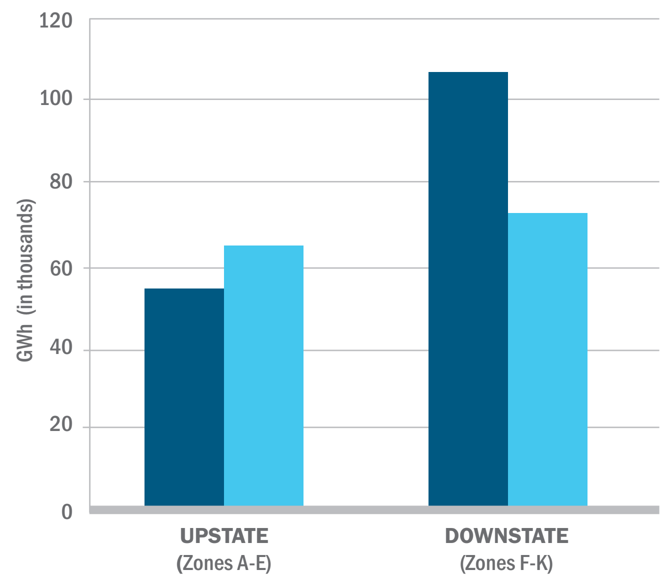
- Marcy-South Series Compensation and Fraser—Coopers Corners 345 kV line reconductoring.
- Construction of a second Rock Tavern—Ramapo 345 kV line.
- Upgrading underground transmission circuits from Staten Island to the rest of New York City.

Figure 23:
Age of New York Transmission Facilities by Percentage of Circuit Mile



These projects were placed into service in June 2016. In 2012, the New York State PSC initiated proceedings to expand the transmission capacity of the AC transmission system that links upstate to downstate.[45] To encourage transmission development within existing rights-of-way while limiting potential impacts to communities, the New York State PSC adopted an expedited siting process for transmission facilities built within the current right-of-way "envelope" (height and width).

Figure 24:
Regional Usage and Production in New York State: 2016



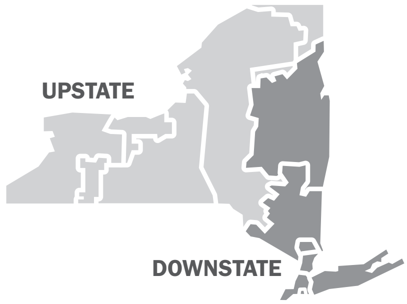
Transmission Congestion

On a statewide basis, New York has a surplus of power resources needed to sustain system reliability. However, the reliability of the region's power grid is made more complex by physical limitations on the transmission system's ability to freely move electricity from more efficient generation resources where and when it is needed.

The downstate region (New York City, Long Island, and the Hudson Valley — Zones F-K) annually uses 66% of the state's electric energy. Yet, that region's power plants generate only 53% of the electricity produced in the state.

With regard to the regional variations in periods of highest demand for electricity, 72% of New York's peak power demand occurs downstate (Zones F-K). Power plants in this region, however, which typically use higher-cost fuel supplies because of more stringent environmental requirements, are capable of supplying only 63% of New York's electricity needs during peak periods.

NYISO's markets are designed to use the lowest-cost power available to reliably serve demand. However, physical transmission constraints limit the economically-efficient dispatch of electricity and can



▸ **The downstate region** (New York City, Long Island, and the Hudson Valley — Zones F-K) annually uses 66% of the state's electric energy. Yet, that region's power plants generate only 53% of the electricity produced in the state.

cause “congestion” on the system. The physical limitations of the transmission system, such as thermal line ratings, can cause delivery constraints that may require the scheduling of higher-cost electricity supply resources to serve areas unable to receive lower-cost energy from other parts of the grid. More expensive, local generation must then be operated to meet customers’ needs.

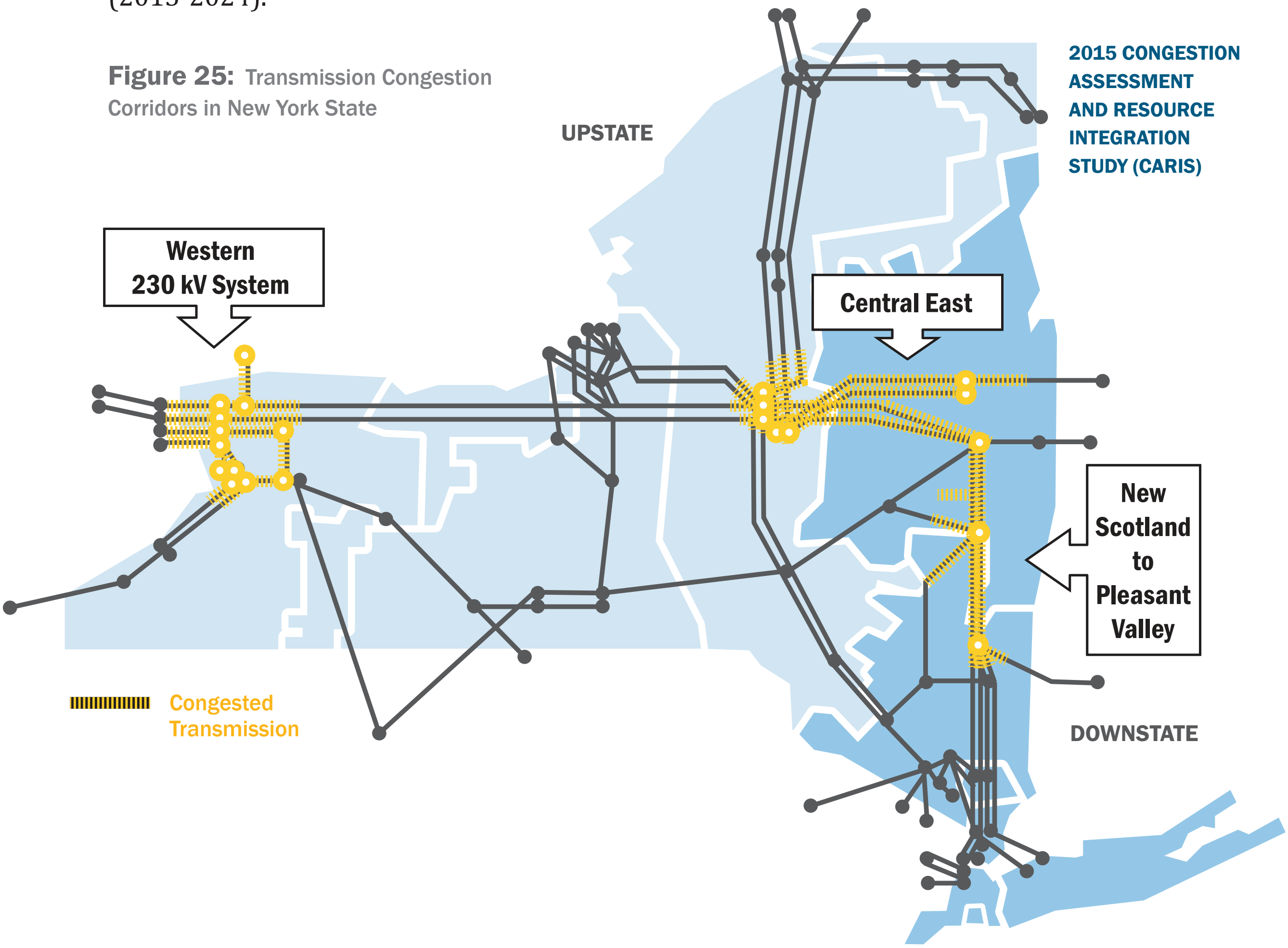
The NYISO evaluates congestion as part of its planning processes with its biennial *Congestion Assessment and Resource Integration Study (CARIS)*. The study is an economic analysis of transmission congestion on the New York bulk power system and the potential costs and benefits of relieving transmission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

Solutions to congestion may include:

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

The 2015 CARIS identified the most congested parts of the New York State bulk power system based upon historic data (2010-2014) as well as estimates of future congestion (2015-2024).

Figure 25: Transmission Congestion Corridors in New York State



Those areas include:

- All or parts of the high-voltage transmission path from Oneida County through the Capital Region (Central East).
- South to the Lower Hudson Valley (New Scotland — Pleasant Valley).
- The 230-kilovolt system in Western New York (Western 230kV).

The CARIS process analyzed generic transmission, generation, and demand response solutions in these regions that could ultimately yield savings for power consumers.[46]

Merchant Transmission Proposals

In addition to the transmission projects noted above, several merchant plans for transmission have also emerged and are in various stages of development. High-Voltage Direct Current (HVDC) projects primarily designed to enhance transmission of power within New York State include the 1,000-megawatt Empire State Connector, announced by transmission developer OneGRID, which is a 260-mile project which would run between Utica and New York City [47]; and the West Point Transmission project, which aims to add a 1,000 MW facility from the Capital Region to a substation in Buchanan, NY. HVDC projects primarily designed to bolster New York's electrical ties with neighboring areas include the Champlain-Hudson Power Express, proposed by Transmission Developers Inc., which is a 300-plus mile transmission project designed to deliver up to 1,000 MW from Québec to New York City; [48] the Poseidon Transmission project, which is a 500 MW facility proposed to connect Long Island with New Jersey; the Empire Interconnection and Glenwood projects on Long Island connecting with South Brunswick, NJ , each of which aims to add a 275 MW facility; the Alps project, which proposes to construct a 600 MW inter-tie between Rensselaer County and Berkshire, Massachusetts; and the Grand Isle Intertie project, which aims to export a 400 MW from Plattsburgh, NY to New Haven, VT. In addition, two projects, the Compass project in Rockland County and the Cedar Rapids project in St. Lawrence County each aim to add AC capability to New York's grid.

► **The NYISO** was a leader in the formation of the Eastern Interconnection Planning Collaborative (EIPC), which now involves 19 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.

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 Northeast Coordinated Planning Protocol that had been in place for more than a decade. In April 2016, the three ISO/RTOs issued the *2015 Northeast Coordinated System Plan.*[49] No new needs for interregional transmission projects were identified by the plan.

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 Eastern Interconnection Planning Collaborative (EIPC), which now involves 19 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.[50]

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 March 2016, the EIPC issued its *Report for 2025 Summer and Winter Roll-Up Integration Cases.* The "roll-up" cases combine the electric system plans of the EIPC members in a comprehensive interconnection-wide model. The report evaluated summer and winter peak periods for the year 2025. Examining the amount of power that can be reliably moved between regions, based on current system plans, the report identified potential additional transfer capability that may be available in various parts of the Eastern Interconnect.

Environmental Quality & Renewable Power

The environmental impact of power production was among the considerations deliberated by policymakers during the restructuring of the electric industry in the 1990s. The Clinton Administration included electricity restructuring in the 1997 White House Climate Change Initiative, saying, "With appropriate market-based provisions, electricity restructuring legislation could reduce carbon emissions by creating incentives to produce and use electricity more efficiently and with less pollution."[51]

Since their inception, wholesale electricity markets have:

- Worked in concert with energy and environmental policies to foster more efficient generation.
- Expanded renewable resources.
- Developed demand reduction programs — all of which contribute to significant reduced emissions.

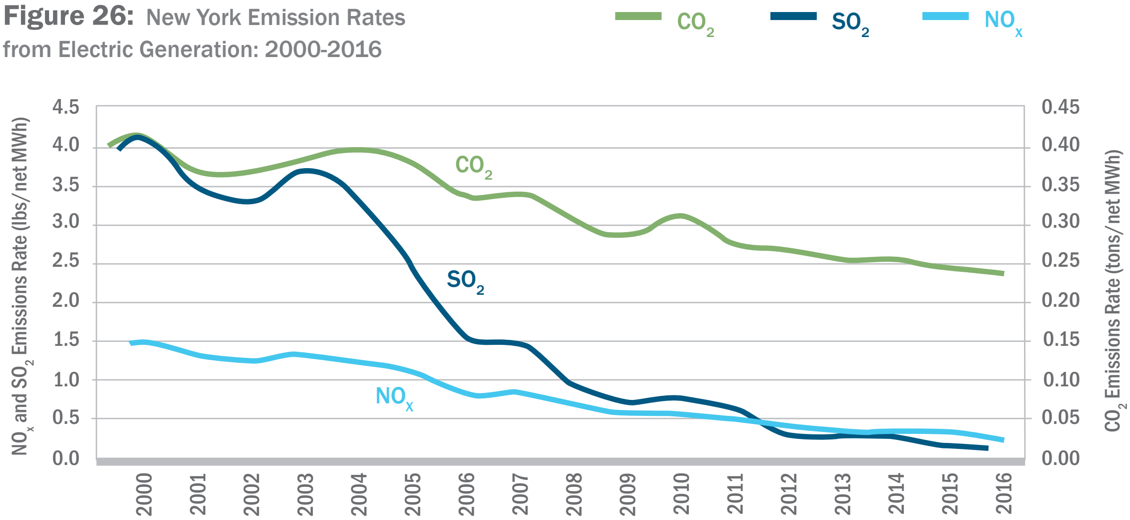
Power Plant Emission Trends

Based on available emissions data from the U.S. Environmental Protection Agency, power plant emission rates (pounds/megawatt-hour) in New York have significantly improved since the NYISO began administering competitive wholesale markets for power in 2000. From 2000 through 2016, sulfur dioxide (SO_2) emissions rates dropped 98%. The emission rates for nitrogen oxides (NO_X) and carbon dioxide (CO_2) declined by 87% and 43%, respectively, during that period.

- New York is part of the Regional Greenhouse Gas Initiative (RGGI), which is built around an agreement among nine eastern states (Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont) to restrict carbon emissions from power plants through a mandatory, market-based CO2 allowance cap-and-trade program.

- Through RGGI, electric power generators located in each participating state are required to obtain a number of CO_2 allowances equal to the number of tons of CO_2 they emit.
- RGGI distributes the allowances to the market primarily through open auctions, though generators may also obtain allowances through secondary trading markets.
- Generators required to obtain RGGI allowances can then factor the cost of these allowances into their price offers in the NYISO market, effectively internalizing the cost of CO_2 emissions allowances into the price of energy sold in the NYISO's wholesale markets.

Figure 26: New York Emission Rates from Electric Generation: 2000-2016



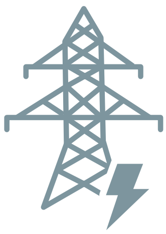
Through this structure, RGGI creates incentives for generators to reduce their allowance requirements. Nuclear or wind energy generators, for example, require no CO_2 allowances and thus, RGGI works in harmony with the NYISO's competitive market structure to create market-based incentives for investments in, and the operation of these types of zero-emission resources. In the same manner, operators of more conventional fossil-fuel based generation have incentives to improve the efficiency of their facilities to limit their exposure to costs associated with RGGI allowances. In fact, a February 2017 report by energy consulting firm MJ Bradley & Associates notes that many industry stakeholders "have come to see the auction approach as the most efficient method of releasing allowances into the market without picking winners and losers."[52] The study notes that as RGGI was being developed, researchers evaluating various compliance options ranked the auction process ultimately used by RGGI highly in terms of economic efficiency.

In 2014, the RGGI states agreed to set the cap at 91 million tons of emissions, declining by 2.5% year on year through 2020. In addition to sustaining the CO_2 reductions that have already occurred, the cap was designed to yield an estimated 80-90 million tons of cumulative emission reductions by 2020. Through RGGI's 2016 Program Review, there is ongoing discussion among the RGGI states to address continued emissions reductions beyond 2020, though caps have not yet been established for this timeframe.

In the 2017 State-of-the-State message,[53] New York Governor Andrew M. Cuomo called on states participating in RGGI to agree to lower the emissions cap by at least an additional 30% below 2020 levels by 2030.[54] He noted that, "as federal climate policy remains uncertain, this bold action will renew the RGGI states' commitment to lead the fight against climate change and drive the transition to a new clean energy economy."[55] The Governor noted that CO_2 emissions from the power sector have been five to eight percent below RGGI cap levels by over the past three years and that further reductions in the cap will complement state-level policies to promote clean energy resources.

Federal Clean Power Plan

When the EPA issued the final rule on its Clean Power Plan in August 2015, the NYISO's analysis of it suggested that New York should be able to meet the plan's obligations while maintaining a reliable electric system.



"March 28, 2017 Executive Order, directs the EPA to review and reconsider a number of final rules, including the Clean Power Plan."

— Executive Order, Promoting Energy Independence and Economic Growth

In cooperation with the New York State Department of Environmental Conservation, the NYISO prepared a study of the Clean Power Plan to assess how New York's compliance approaches might interact with existing market rules and system reliability criteria under various scenarios.[56]

Among the conclusions of the study were:

- Compliance with the Clean Power Plan is attainable in New York, but when analyzed in the context of other emissions regulations such as RGGI and the Cross-State Air Pollution Rule (CSAPR) Update Rule, compliance may require additional capacity resources and transmission reinforcements to maintain bulk power system reliability.
- Trading between states is an essential element for complying with the Clean Power Plan, and other environmental regulation, when considered among other air quality requirements aimed at the power sector.
- Increasing deployment of renewable resources in New York increases the state's compliance margin with the Clean Power Plan.

Legal challenges resulted in a February 2016 U.S. Supreme Court ruling to stay the implementation of the plan pending review in the D.C. Circuit Court of Appeals. President Trump's March 28, 2017 Executive Order, "Promoting Energy Independence and Economic Growth" directs federal agencies to review existing policies and practices that potentially burden the development or use of domestically produced energy resources, with emphasis on coal, oil, and natural gas. The Order directs the EPA to review and, if appropriate begin the process to reconsider a number of final rules, including the Clean Power Plan. Further, the EPA filed motions in the D.C. Circuit Court of Appeals to hold Clean Power Plan appeals in abeyance as it reconsiders the initiative, a process that is likely to unfold over the course of the next few years.[57]

While recent federal actions and ongoing legal proceedings have made the future of the Clean Power Plan unclear, New York's trajectory of pursuing state public policy initiatives to achieve CO_2 emissions reductions and the advancement of clean energy resources likely will continue. New York State policies and regulations have historically driven much of the investment in clean energy technologies and Governor Cuomo has sent clear signals that he expects New York State to continue to be a national leader in this area.

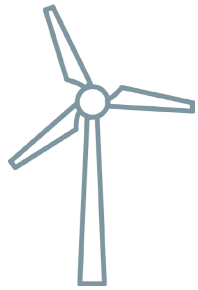
The 2015 New York State Energy Plan set the stage for aggressive action on the part of the state to reduce greenhouse gas emissions and promote the expansion of renewable energy resources.[58]

Among the stated goals of the 2015 State Energy Plan are to:

- Reduce economy-wide greenhouse gas emissions by 40% in 2030 relative to 1990 emissions levels.
- Growing renewable energy resources to account for 50% of the electricity consumed in the state by 2030. Through the establishment of the Clean Energy Standard, the Public Service Commission codified the renewable energy goals in the State Energy Plan by mandating that all load-serving entities procure Renewable Energy Credits to facilitate investments in new renewable resources.
- Advancing energy efficiency.

Cumulative Impact of Environmental Regulations

To varying degrees, environmental regulations impact how generation is provided to the bulk power transmission system. These local, state, regional, and federal regulatory initiatives cumulatively may require owners of New York's existing thermal power plants to make investments to achieve compliance. If the plant owners must make considerable investments, those costs could impact whether they remain in the NYISO's markets and potentially affect system reliability. The NYISO has estimated that as much as 32,400 MW in the existing fleet (72% of 2015 Summer Capacity) will have some level of exposure to the environmental regulations identified below, with many facilities exposed to multiple regulations.



▸ New York State policies and regulations have historically driven much of the investment in clean energy technologies and Governor Cuomo has sent clear signals that he expects New York State to continue to be a national leader in this area.

Figure 27: Summary of Environmental Regulations and Estimated Impact on New York Generation

PROGRAM	DESCRIPTION	GOAL	STATUS	ESTIMATED CAPACITY AFFECTED (MW)
MATS Mercury and Air Toxics Standards	Establishes Limits for Emissions of Hazardous Air Pollutants (HAP) from Coal and Oil Fired Boilers	Sets Technology Based Emission Limits Required by the Clean Air Act.	In effect Compliance Deadlines April 2015 and 2017.	1,000
CSAPR Cross State Air Pollution Rule	Limits emissions of SO_2 and NO_x from power plants in 28 states through the use of emission allowances with limited trading.	Achieve and maintain air quality consistent with National Ambient Air Quality Standards.	In effect Compliance Deadlines 2015 and May 2017.	27,600
RGGI Regional Greenhouse Gas Initiative	Nine State Compact to Cap CO_2 Emissions from Power Plants.	RGGI Cap established in 2014: 91 million tons CO2 decreasing 2.5% yr./yr. through 2020.	In effect with Program Review underway to review and revise Cap.	27,600
CPP Clean Power Plan	Federal Plan to limit CO2 emissions from steam and combined cycle plants.	Reduce CO2 emissions by 32% below 2005 emission levels.	Currently under stay by U.S. Supreme Court.	24,000
BTA Best Technology	Available for cooling water intake structures Implements Clean Water Act requirements to protect aquatic biota.	Limits damages to aquatic biota from cooling water intakes on public waters.	Reviewed when water permits are renewed.	18,400
NYC RFO Phase Out	Phases out use of residual fuel oil in utility boilers.	Reduce emissions of Volatile Organic Compounds and particulates.	2020 Phase-out of #6 oil. 2030 Phase-out of #4 oil.	2,800

Markets Designed for Renewable Integration

Wholesale electricity markets and open access to the transmission system provided by independent system operators facilitate development of renewable resources.

- Open access enables resources to interconnect to the grid and transmit power with upgrades necessary to maintain system reliability.
- The NYISO shared governance system, which guides market evolution, provides a forum for market participants and stakeholders to collaborate on market changes that facilitate and integrate new technologies.

Participation in the wholesale electricity market is open to all resource types including:

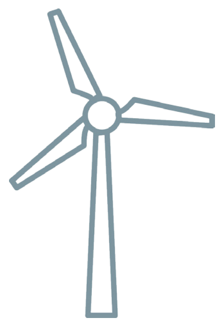
- Conventional generation
- Renewable resources, storage resources, imports from other regions
- Demand response

Much of the investment since the creation of New York's competitive marketplace for wholesale electricity has been in clean, efficient combined cycle units and renewable resources, as more than 6,800 MW of older, and generally higher emitting, generation has retired or ceased operation.

Wind Power

Over the past decade, the design of New York's wholesale electricity markets has been revised to address the unique characteristic of wind power by:

- Recognizing wind in 2006 as a "variable energy resource" and revising market rules to exempt it from under-generation penalties that apply to conventional generation.
- Establishing a centralized wind forecasting system in 2008 to better utilize and accommodate wind energy by forecasting the availability and timing of wind-powered generation.
- Pioneering the economic dispatch of wind power in 2009 to adjust operating practices and enable more efficient use of wind resources.



Wind-Powered generating capacity in NY grew from 48 MW in 2005 to 1,827 MW in 2017. Electricity generated by wind power increased from 101 GWh in 2005 to 3,943 GWh in 2016.

These and other market initiatives have supported the growth of New York's wind power resources. The generating capacity of wind-powered projects in New York grew from 48 MW in 2005 to 1,827 MW in 2017. Electricity generated by wind power increased from 101 GWh in 2005 to 3,943 GWh in 2016.

On March 2, 2017 wind power output in New York marked a new record of 1,574 MW. At the time of record production, wind provided 9% of New York's total generation.

Projects capable of supplying another 4,807 MW of wind power currently are proposed for future interconnection with the New York bulk electricity grid. Nearly all of the currently proposed projects are planned for sites in western and northern New York. However, federal officials in March 2016 dedicated a 127-square-mile area off the coast of Long Island for wind power development.[59] Following a December 2016 auction to lease this area for development, Statoil Wind US LLC, a Norwegian-based company with experience developing offshore wind resources in Europe, secured the development rights with an offer of $42.5 million. Statoil has indicated its intentions to develop as much as 1,000 MW of wind capacity. Additionally, the Long Island Power Authority (LIPA) approved a Power Purchase Agreement (PPA) with Deepwater Wind LLC for the output of its proposed $1 billion wind farm to be sited approximately 30 miles east of Long Island. LIPA awarded the PPA in January 2017 in support of its efforts to meet expected load requirements for Long Island's South Fork.

Governor Andrew Cuomo indicated the Statoil and Deepwater Wind projects are to be only the start of a much grander expansion of offshore wind capacity to support the state's goals for CO_2 emissions reduction and renewable energy expansion. His State-of-the-State message calls for upwards of 2,400 MW of offshore wind development off the coast of Long Island by 2030, the year in which the state has planned to achieve the Clean Energy Standard goal of 50% renewable energy generation. At the same time, Governor Cuomo directed NYSERDA and the Department of Environmental Conservation to undertake a comprehensive study to determine the timing, costs, and feasibility of reaching 100% renewable generation on a statewide basis.

Figure 28: Wind Generation in New York - Installed Capacity: 2003-2017

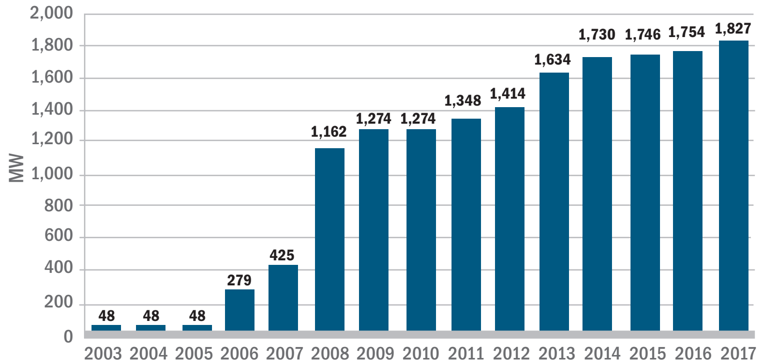
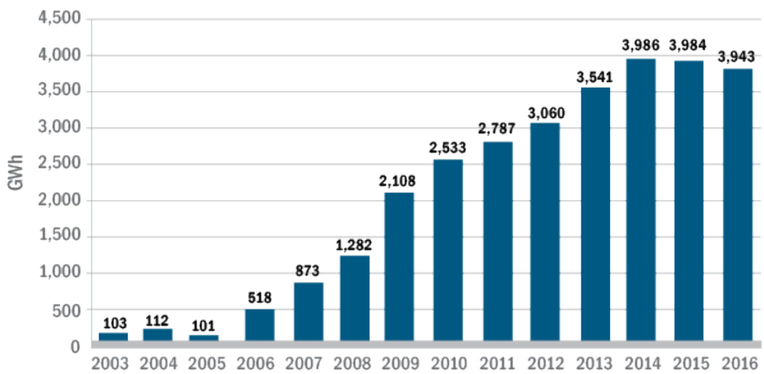


Figure 29: Wind Generation in New York State - Energy Produced: 2003-2016



Energy Storage

Electricity is unique among energy sources because it typically must be produced, delivered, and consumed instantly.

Other energy commodities, such as natural gas, oil, or coal, can be produced and stored in bulk, to be delivered and consumed as demand requires. Electricity storage, in contrast, has historically been limited, costly, and complex.

The most widely used means of storing electricity for use by the power system has been pumped storage hydroelectric projects that store water as potential energy during off-peak hours for later use when demand for electricity is higher. Pumped storage accounts for 4% of New York's generating capacity. While a proven and effective resource in supporting grid reliability, sites conducive to the development of pumped storage are expected to be limited.

Additionally, New York has access to "storage" in the form of conventional hydroelectric power projects with large reservoirs, both within the state and across the border in Quebec. The water that flows into the reservoirs is captured and released to produce electricity when needed. Again, the potential for expansion of such resources within New York is limited by the availability of appropriate sites.

The variable nature of the power output from renewable resources has highlighted the value of energy storage and its potential to balance renewable energy output. At the same time, energy storage offers the potential to:

- Reinforce grid resilience during extreme weather events.
- Reduce transmission.
- Distribute costs by providing alternate means to address system needs.
- Shift demand away from higher-cost peak demand periods.

The combination of emerging applications for storage on the grid and technological advancements that are reducing its costs and expanding its capabilities suggest that the historical paradigm for grid-scale storage may be changing. As the technology continues to advance, it may be increasingly practical to store electricity in bulk for delivery at a time when the energy is most needed. Addressing these emerging trends requires a re-examination of market rules to provide that markets are capable of integrating storage.

The NYISO has been a pioneer in refining its markets to facilitate the integration of storage resources. **In 2009, the NYISO became the first grid operator in the nation to establish market rules for a new category of energy storage resources, which provide frequency regulation service to balance supply and demand on the grid.** In addition to the development of the Limited Energy Storage Resource category, NYISO markets also accommodate participation of storage in the wholesale markets, including:

- Energy Limited Resources
- Demand Side Ancillary Services
- Special Case Resources

In 2016, the NYISO launched an Energy Storage Integration and Optimization[60] initiative to examine the options available for storage to participate in the NYISO markets and begin discussions with stakeholders on ways to enhance market accessibility for storage resources.

Through this storage integration initiative:

- The NYISO is working closely with its Market Participants and grid operators to develop a comprehensive model for electricity storage resources to participate in wholesale Energy, Ancillary Service, and Capacity Markets.
- The effort will help to harness the potential strengths of storage resources in support of the state's existing generation fleet as well as its increasing portfolio of renewable resources.
- The NYISO sees particular value in storage resources' capability to ramp up and down rapidly, to both withdraw energy from and inject energy into the system, and to interconnect storage devices in locations that are advantageous to power grid needs and economic efficiency.

▸**Hydro Pumped Storage** is the most widely used means of storing electricity for use by the power system. Stored water has the potential to be used during off-peak hours or when demand is higher. Pumped storage accounts for 4% of New York's generating capacity. While a proven and effective resource in supporting grid reliability, sites conducive to the development of pumped storage are expected to be limited.

The NYISO is beginning this market design effort by identifying the physical and operational characteristics of storage that will shape its participation in the wholesale market. Given the complexity of the issues involved, the NYISO expects its market design effort to be completed by the end of 2018, after which it plans to develop appropriate tariff revisions and software to implement the new market design by 2021.

Recognizing the growing potential of storage to support wholesale power markets and grid reliability, FERC issued a Notice of Proposed Rulemaking (NOPR) in November 2016 to "remove barriers to the participation of electric storage resources and distributed energy resource aggregations in the capacity, energy, and ancillary service markets operated by regional transmission organizations (RTO) and independent system operators (ISO)."[61] In addition, FERC issued a Notice of Inquiry exploring the potential of storage to perform as a transmission asset.

- FERC noted that wholesale markets are governed by participation models and rules that reflect the types of resources and technical requirements for market services that those resources are eligible to provide.
- As such, the emergence of new technologies with different capabilities necessitates that ISO/RTOs continue to evolve their markets to efficiently integrate the new capabilities such

technologies offer. The NYISO's historical efforts to integrate storage into its markets exemplify FERC's notion of the need for markets to reflect technological developments and capabilities.

- In its initial comments to FERC, the NYISO noted that, "Integration of ESRs (electricity storage resources) and DER will improve the Commission-regulated wholesale markets by providing system resiliency, energy security and fuel diversity, while at the same time having the potential to lower consumer prices and improve market efficiency."[62] The NYISO acknowledged that it continues to work with stakeholders to develop a more comprehensive participation model that fully integrates energy storage into wholesale markets, which is the objective that lies at the heart of both the FERC NOPR as well as the NYISO's Storage Integration Initiative.[63]

Solar Power

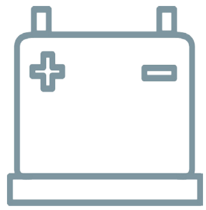
Much of the power produced by solar is generated either behind the retail meter on a customer's premises, or at the distribution level of interconnection. According to a May 2016 report from National Renewable Energy Laboratory and Sandia National Laboratories, solar at the distribution level represented 61% of the nation's total solar capacity.[64] (See page 65 the 'Integrating Distributed Energy Resources' section for more discussion.) In New York State, the percentage experienced to date is much greater. According to the NYISO's analysis to support development of the *2017 Load & Capacity Data Report* (the Gold Book), of the roughly 785 MW of installed solar operating in the state, approximately 753 MW are installed at the distribution level and not participating directly in the NYISO's markets.

However, interest in grid-scale solar is growing and the NYISO is working to enhance its markets accordingly. To integrate grid-scale solar, New York's wholesale electricity markets have begun to adopt design changes similar to wind integration efforts. In 2012, provisions of NYISO market rules were adapted to address solar power as a variable energy resource.

There is currently one grid-scale solar project operating in New York:

- **The Long Island Solar Farm,** a 32 MW facility located at the Brookhaven National Laboratory, is the largest solar power plant in the Eastern United States.

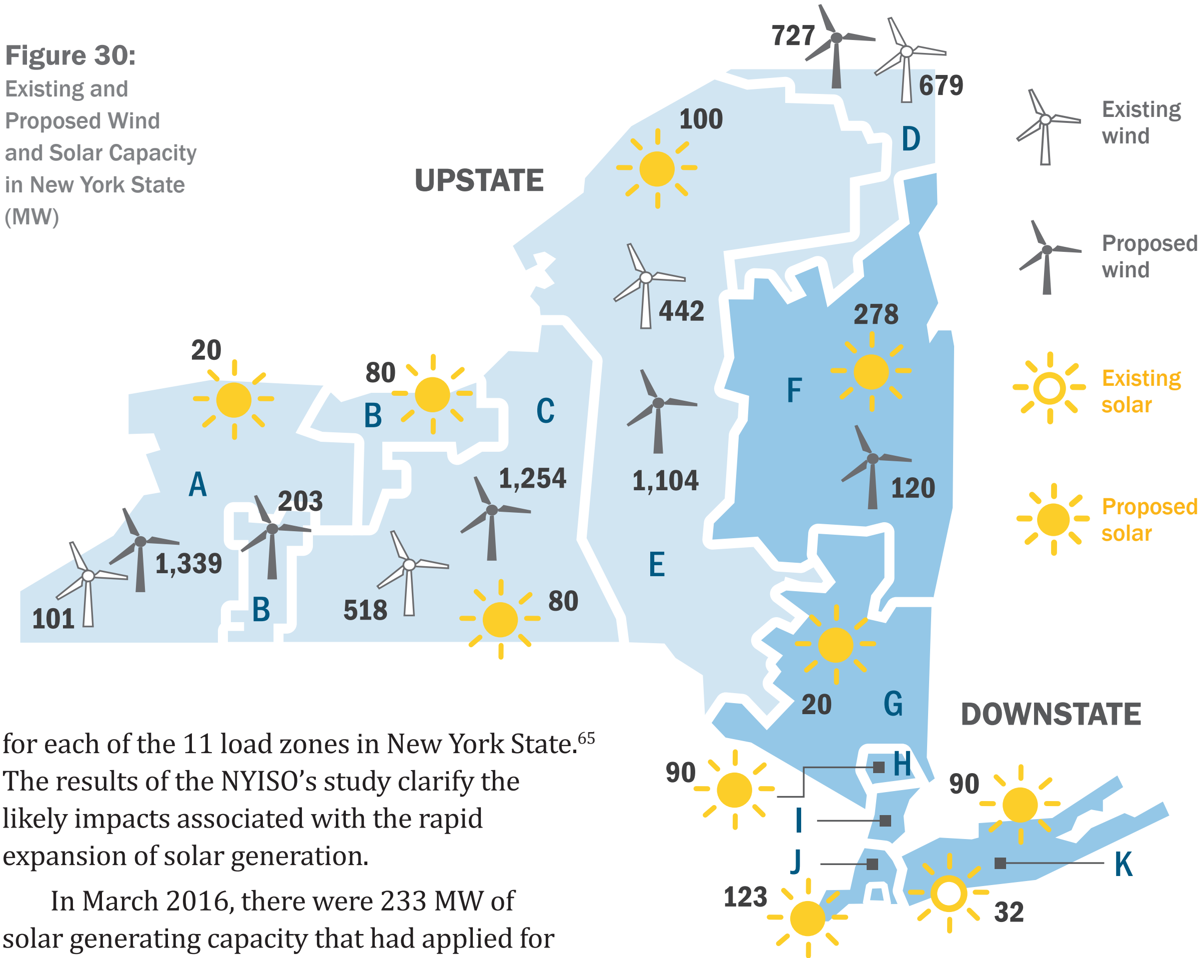
In 2015, the NYISO initiated a study to evaluate the potential for growth in solar power resources to determine their impact on grid operations. The effort developed and tested solar forecasting tools and prepared 15-year forecasts of solar capacity



"Integration of ESRs (electricity storage resources) and DER will improve the Commission-regulated wholesale markets by providing system resiliency, energy security and fuel diversity, while at the same time having the potential to lower consumer prices and improve market efficiency."

— The NYISO's comments to FERC on the Notice Of Proposed Rulemaking (NOPR)

Figure 30: Existing and Proposed Wind and Solar Capacity in New York State (MW)



for each of the 11 load zones in New York State.[65] The results of the NYISO's study clarify the likely impacts associated with the rapid expansion of solar generation.

In March 2016, there were 233 MW of solar generating capacity that had applied for interconnection to the bulk power system via the NYISO's interconnection study process. The number and capacity of proposed grid-connected solar projects has more than tripled since then. As of March 2017, 35 solar projects representing 881 MW of generating capacity were proposed for interconnection with the New York bulk electric system.[66] Individual projects range in size from 7.5 MW to 98 MW of generating capacity.

▸**881 MW** of generating capacity, spanning 35 projects, were proposed for interconnection with the New York bulk electric system as of March 2017. Individual projects range in size from 7.5 MW to 98 MW of generating capacity.

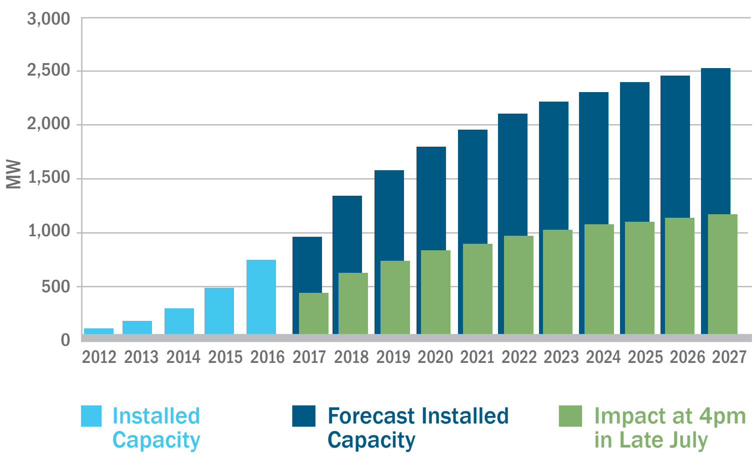
The NYISO will need to understand the performance of solar installations regardless of whether they are interconnected directly to the bulk power system or to the distribution system. Those tied to the bulk power system will be integrated in a manner similar to utility-scale wind installations, where forecasting tools are used to assess the anticipated output of installed projects so that the NYISO can efficiently dispatch more conventional generation to meet demand on the system.

At the same time, the NYISO will have to accurately account for the impact of behind-the-meter solar resources on system demand. Beginning in the summer of 2017 the NYISO plans to integrate behind-the-meter and grid-connected solar forecasts into its real-time generator dispatch and commitment processes.

- Whereas grid-connected solar sites provide the NYISO with a direct stream of solar power production, there is no direct stream of data from the approximately 80,000 locations of behind-the-meter solar installations across the state.
- In order to obtain real-time data on these sites, the NYISO has contracted with a firm that directly monitors the power production for a portion of these sites, and provides it to the NYISO in real-time.
- With this additional information, the NYISO will be able to develop forecasts of both behind-the-meter and grid-connected solar and continue to efficiently dispatch conventional generation to fulfill system needs.
- As distributed solar resources proliferate, their impact on peak demand and annual energy usage in New York is expected to nearly triple by 2027. (See page 15 discussion of Daily & Seasonal Demand Patterns.)

Clean Energy Policy

Figure 31: Distributed Solar in New York - Historical and Forecast



State renewable portfolio standards contributed to more than half of all renewable electricity growth in the United States since 2000, according to an April 2016 report from the Lawrence Berkeley National Laboratory.[67]

Expanding the supply of electricity from renewable resources and enhancing energy efficiency are among the longstanding goals of New York State's energy policy. **To date, the NYISO's cooperative efforts with the State have enabled wholesale market signals to provide a platform for renewable generation to flourish in New York.**

The New York State PSC established a Renewable Portfolio Standard (RPS) in 2004, aimed at expanding the portion of renewable power consumed by New Yorkers. In 2016, 33,192 GWh of New York's electricity was produced by renewable resources (hydropower, wind, solar and other) representing approximately 24% of New York's electric generation. New York's large base of hydropower resources generated 26,314 GWh of electric energy, representing 79% of the renewable power produced in New York in 2016. New York's wind power resources generated 3,943 GWh, approximately 12% of the renewable power produced in the state in 2016.

The New York State PSC also established an Energy Efficiency Portfolio Standard (EEPS) in 2008 with a goal of reducing statewide annual electricity consumption by 26,885 GWh by 2015. This equated to reducing statewide electricity consumption to a level of 152,352 GWh in 2015, a reduction of 15% from the forecast for 2015 of 179,238 GWh. Electricity usage in New York totaled 161,572 GWh in 2015, a reduction of 10% from the EEPS forecast for 2015, but falling short of the EEPS goal.

The Cuomo Administration advanced a series of renewable energy and energy efficiency measures consistent with goals outlined by the 2015 State Energy Plan.[68]

The goals to be achieved by 2030 include:

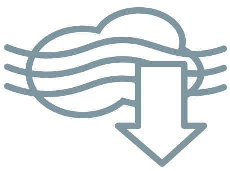
- 40% reduction in economy-wide greenhouse gas emissions from 1990 levels.
- 50% of energy generation from renewable energy sources (the “50-by-30” goal).
- 600 TBtu in annual energy savings, which is estimated to be equivalent to a 23% decrease in energy consumption levels.

In January 2016, the PSC issued an order authorizing a 10-year, $5 billion Clean Energy Fund, administered by the New York State Energy Research and Development Authority,

- To replace expiring clean energy programs and provide continuity of support for clean energy goals of the 2015 New York State Energy Plan.
- The PSC also stated that the fund is a critical component of the REV plan.[69]

As previously noted, New York is part of the Regional Greenhouse Gas Initiative (RGGI). The initiative, which took effect in 2009, uses a market-based emission allowance trading to achieve the emission reductions. RGGI states agreed to set the cap at 91 million tons of emissions in 2014, declining by 2.5% year on year through 2020. The cap was planned to yield an estimated 80-90 million tons of cumulative emission reductions by 2020.[70] RGGI represents a market-based emissions program that can support emissions reductions in a cost-effective manner that works in harmony with the NYISO’s wholesale power markets.

The NYISO’s markets are designed for economic efficiency, driving least-cost solutions to providing reliable grid operations under varying conditions and levels of demand for energy. That drive for efficiency has produced significant environmental benefits in the form of reduced emissions rates of CO_2, SO_2, and NO_X because generators supplying the market have incentives to optimize the efficiency of their facilities and minimize fuel costs. This market design has also ensured that renewable resources like wind and solar are dispatched when they are available because they have no fuel costs and can offer into the market below the costs of more traditional generators.



▸**The NYISO’s Markets** provide incentives for generators to reduce their environmental impact and facilitate the dispatch of renewable resources like wind and solar.

Clean Energy Standard

To convert the State Energy Plan goals into mandated requirements, the PSC issued an order on August 1, 2016 adopting the Clean Energy Standard and thus charting a course for the state to achieve the 50-by-30 goal.

The CES will play a significant role in shaping New York's bulk power system over the next 15 years, and the NYISO supports the public policy objectives associated with the 50-by-30 goal. Specifically, the Order codifies the state's commitment to promoting increases in renewable generation to achieve the 50-by-30 goal; supporting construction and continued operation of renewable generation in New York; protecting upstate nuclear facilities from premature closure; and promoting of the market objectives of REV.[71]

Under the CES, electric utilities and others serving load in New York State 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.

The credits would include:

- **Renewable Energy Credits (RECs).** Generators of eligible renewable energy resources will earn one REC for each MWh of renewable energy generated. Generators will have the option of selling such RECs directly to load serving entities or through a centralized procurement process administered by NYSERDA, which will then allocate the RECs proportionally to load serving entities in accordance with their prescribed percentages.
- **Zero Emission Credits (ZECs).** In addition to the renewable energy mandate, the CES requires load serving entities to obtain a certain amount of ZECs from eligible nuclear power facilities. These ZECs represent incentive payments the state deems necessary to forestall the premature closure of upstate nuclear facilities, the loss of which would "undoubtedly result in significantly increased air emissions due to heavier reliance on existing fossil-fueled plants or the construction of new gas plants to replace the supplanted energy."[72] The Order establishes two-year tranches in which the price of ZECs is administratively determined and adjusted as necessary to ensure eligible nuclear units remain economically viable while minimizing added costs to consumers.

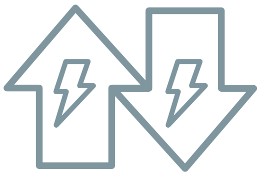
▸ 70,500 GWh

of total renewable energy will need to be generated by 2030 in order to acheive the 50-by-30 goal, as determined by the PSC Order on August 1, 2016. The increment of new renewable energy generation needed for compliance by 2030 will be approximately 29,200 GWh.

In order to achieve the 50-by-30 goal, the PSC Order determined that approximately 70,500 GWh of total renewable energy will need to be generated by 2030.[73] A portion of this obligation will be met with resources already in operation, meaning the increment of new renewable energy generation needed for compliance by 2030 will be approximately 29,200 GWh on top of current levels of renewable energy production and contracted production that has yet to be built.[74]

The Order establishes:

- A triennial review process to reevaluate fixed targets on a going-forward basis.
- Examines the balance between mandated demand and anticipated supply.
- Assess the progress of any voluntary activities in the market that may affect target levels, possible changes to eligibility rules, and the effect of the CES on fuel diversity.
- Any interactions among the CES and RGGI or any federal policies related to greenhouse gas emissions.[75]



"Resources with the ability to follow dispatch signals to ramp up, ramp down or turn off are critical to the reliable operation of the bulk power transmission system. New resources that exhibit these characteristics will strengthen the operation of the bulk power transmission system…"

— NYISO comments on Clean Energy Standard Order, January 2017

Separate compliance tiers were adopted to address the wide range of potentially eligible resources under the CES.

The tiers include:

- New Incremental Renewable Generation
- Existing Renewable Generation
- Existing, Eligible Nuclear Facilities

NYSERDA will continue to offer long-term (20 year) contracts for RECs associated with eligible renewable resources, with revenues collected from obligated load serving entities and RECs allocated to each load serving entity according to its obligation.

While the PSC's adoption of the REC-only procurement mechanism reflects the value of competitive wholesale markets in driving efficient market outcomes, the pending influx of new renewable resources necessary to achieve compliance with the state's goals will still pose challenges in terms of system operations, maintaining market efficiency, and planning for future system needs.

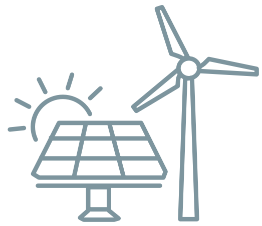
Issues that the NYISO will need to address include:

- **Maintaining Resource Adequacy:** Reliably integrating 50% renewable energy production to the grid by 2030 will affect the dynamics of NYISO's competitive energy and capacity markets. With relatively little load growth anticipated on the system, conventional generation needed for reliability will likely see declining energy revenues with the entrance of new renewable resources.
- **Market Design & Grid Operations:** A key task in managing the expansion of renewable resources on the grid will be "to redesign power markets to reflect the new need for flexible supply and

demand."[76] The NYISO will need to enhance its energy, ancillary, and capacity markets in response to the CES in order to send appropriate market signals needed to sustain the level of conventional generation necessary to reliably operate the grid. Further, the NYISO may need to modify or enhance its operational practices and market products to address new needs that may be triggered by expanded renewable resources, such as needs for fast-acting resources capable of balancing large variations in renewable energy production. Developing specific operational and market enhancements, as may be necessary, will be further informed through ongoing and pending planning activities.

- **Role of Transmission:** As previously discussed, the magnitude of incremental renewable resources likely to enter the NYISO's markets will also put pressure on the existing backbone and underlying transmission system in New York. The PSC has issued orders confirming the Public Policy Need for the Western Transmission and the AC Public Policy Transmission Projects based on the rationale that expanding transmission capabilities in these regions will unbottle NYPA's hydro resources and increase diversity in supply, including renewable resources. The NYISO recognizes the need for additional studies to evaluate the adequacy of the transmission system to integrate the desired levels of renewable resources. Ensuring adequate transmission is in operation where and when it is needed will require continued coordination with, and support from, the PSC through the Public Policy Transmission Planning Process.

Together, the NYISO, the PSC and Department of Public Service staff are diligently planning for the system transformation necessary to facilitate the growth of clean energy resources in New York. By leveraging competitive markets, the NYISO believes the state can pursue its goals in an economically efficient manner, while maintaining the reliability New Yorkers have come to expect.



▸2,500 MW
of installed wind capacity growth and 1,500 MW of installed solar capacity will be sufficiently balanced by the existing Regulation Service requirements according to NYISO's solar integration study.

NYISO Solar Study

The addition of solar resources alone can alter the load shape for which the **NYISO must dispatch generation resources to meet consumer demand. At increasing levels of behind-the-meter solar installations, the net load that must be met with centrally dispatched generation during a typical winter day begins to feature sharper peaks that would require generators to move up or down more quickly than currently experienced on the system.** Notably, at 9,000 MW of solar installation, the solar resource production begins to decline long before system demand peaks for the typical winter day, exacerbating the ramping effect. For a typical summer day, solar represents a better match between the timing of the solar resources' output and system peaking conditions, but not a perfect match.

Based on results from the NYISO's solar preliminary integration study, [77] the NYISO estimates that existing Regulation Service requirements will be sufficient to balance the variability of new wind and solar resources up to the point where solar penetration breeches 1,500 MW of installed capacity or installed wind capacity grows to exceed 2,500 MW. Beyond these penetration thresholds the study suggests that "minor upward revisions of the regulation requirements could be warranted," notably in the spring, fall, and winter periods. During the summer, system load and solar production generally track each other more closely than during the other seasons, lessening the need to increase Regulation Service requirements. At the highest penetration levels examined by the study (9,000 MW solar, 4,500 MW wind), there will be additional upward pressure on Regulation Service requirements, but grid operators should be able to manage such increases within existing market rules and existing system resources. However, the study notes that it will be important to monitor the system's capability to serve its regulation and ramping needs as wind and solar penetration increases and displaces conventional thermal generation. In particular, the study recommends that the NYISO periodically assess the potential for storage technologies to mitigate the need for higher levels of regulation.

Figure 32: Solar Penetration Implications for Net Load - Typical Winter Day

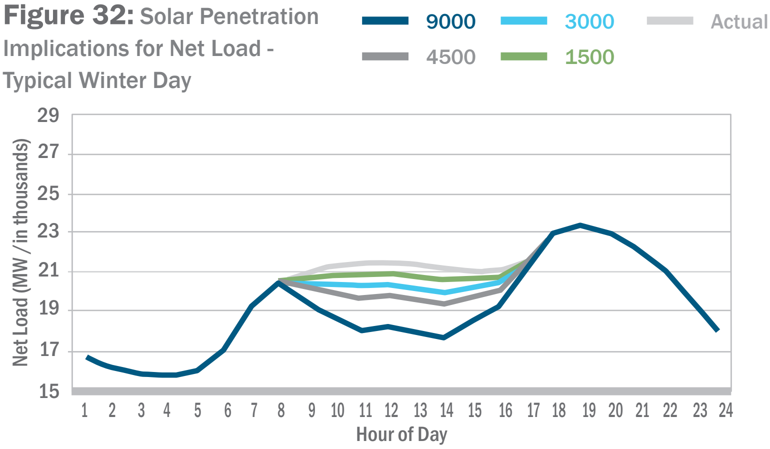
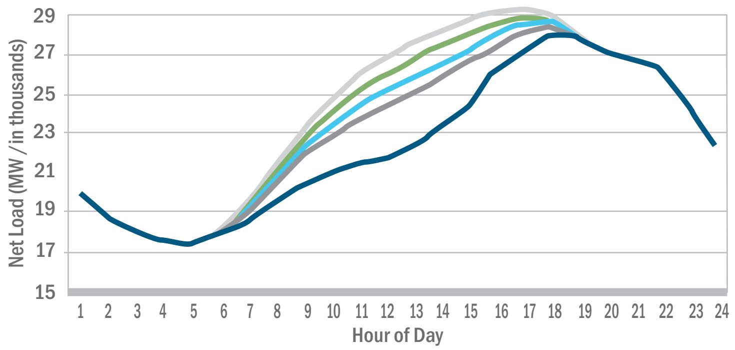


Figure 33: Solar Penetration Implications for Net Load - Typical Summer Day



Market Design Options for Encouraging Investments in Clean Energy Resources

The effect of historically low natural gas prices on wholesale electricity prices has caused financial distress for nuclear units and, in many instances, threatened their viability. **To address this, New York State implemented a ZEC program to retain certain nuclear generators within the state. The NYISO believes the ZEC program is a necessary bridge to retain nuclear generation until a market-based mechanism for pricing CO_2 emissions can be explored.**

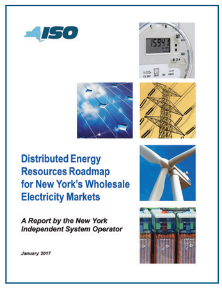
It is important to understand that a generating unit that may appear uneconomic based on its electricity market revenues alone may nevertheless be viable if it could capture the economic value of its environmental attributes. Current wholesale market designs function well to send economically efficient market signals needed to maintain reliability, but they do not value externalities such as the environmental attributes at the heart of the state's clean energy policies.

Ideally, public policy should clearly:

- Identify the attribute that is valuable or necessary to achieve that policy but not being priced in the existing electricity markets (e.g., reduced carbon emissions).
- This attribute should then be systematically valued and procured through a market mechanism across the entire generating fleet.
- Pricing or procurement that is specific to a unit type or fuel type creates the potential for harmful distortions in the competitive wholesale electricity market.
- At the request of its stakeholders, the NYISO commissioned the Brattle Group (Brattle) to explore whether New York State environmental policies may be pursued within the existing wholesale market structure at a reasonable cost to consumers. The NYISO is in the initial stages of exploring that potential with the Brattle Group, our market participants, and New York State.

Integrating Distributed Energy Resources

Technological advancements and public policies, particularly REV, are encouraging greater adoption of DER to meet consumer energy needs as well as electric system needs. DER offer the potential to make load more dynamic and responsive to wholesale market price signals, potentially improving overall system efficiencies. The NYISO generally considers DER to be behind-the-meter resources, although small aggregations such as Community Solar may also be considered DER. Some DER may be net-generators and others net-loads. The NYISO defines DER as a resource, or a set of resources, typically located on an end-use customer's premises that can provide wholesale market services but are usually operated for the purpose of supplying the customer's electric load. DER can consist of curtailable load (demand response), generation, storage, or various combinations of these resources aggregated into a single entity.



► **Distributed Energy Resources (DER Roadmap)** for more information, visit www.nyiso.com.

DER are poised to transform New York's wholesale electricity system by:

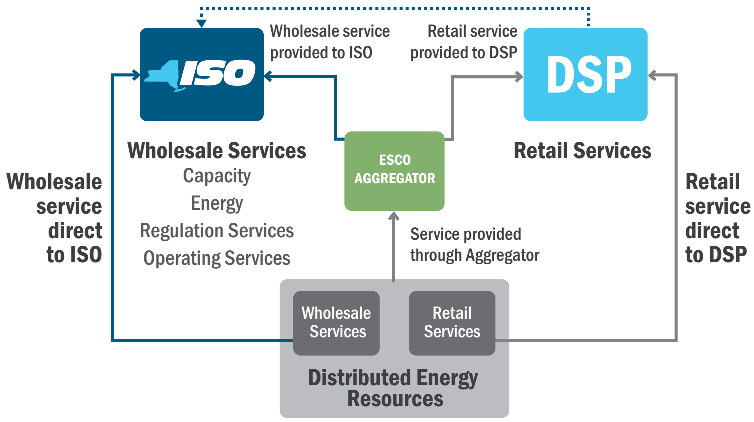
- **Potentially improving system resiliency,** energy security, and fuel diversity.
- **DER can lower consumer prices,** improve market efficiency, and allow consumers to take greater control of their electricity use and costs through a variety of new technologies.

- **DER can also support environmental goals** through the development of new renewable generation and energy storage technologies, helping the State of New York achieve its goals under the REV initiative and Clean Energy Standard. The NYISO stands ready to harness these benefits and build the grid of the future.

In support of its efforts to harness the benefits of DER, the NYISO released a *Distributed Energy Resource Roadmap.* The *Roadmap* offers routes to a future where consumers and emerging technologies support more optimized grid utilization. It offers the NYISO's vision of seamlessly transitioning from a primarily central station-based grid to a diverse bi-directional grid. However, the *Roadmap* represents just the first step toward building that grid of the future.

The transition will require careful and extensive planning by the NYISO and its stakeholders and the NYISO will continue to provide its stakeholders and the public with independent and impartial information it can trust to guide the evolution of the grid. This evolution will fundamentally alter the composition of New York's infrastructure and energy markets but, throughout this transformation the NYISO will continue to ensure reliable and economic electricity to meet the needs of New York's consumers.

Figure 34: Integrating DER in Wholesale Markets



Roadmap to New Opportunities

DER currently have limited opportunities to participate in the NYISO's Energy, Ancillary Services, and Capacity markets. Through the Roadmap, the NYISO's goal is to develop a series of market enhancements to more fully integrate DER into these markets in support of five key objectives that, once achieved, will improve market animation, increase system-wide efficiency, and improve system reliability and resiliency.

Key objectives:

- Integrate DER into Energy, Ancillary Services, and Capacity markets.
- Align with the goals of New York State's REV.
- Enhance measurement and verification methodologies.
- Align compensation with wholesale service performance.
- Focus on wholesale market transactions.

Figure 34, above, depicts how DER may provide services in the wholesale and retail markets in the future, and the dark blue lines are intended to show the scope of NYISO's DER initiative.

Figure 35: Today's Electric Grid

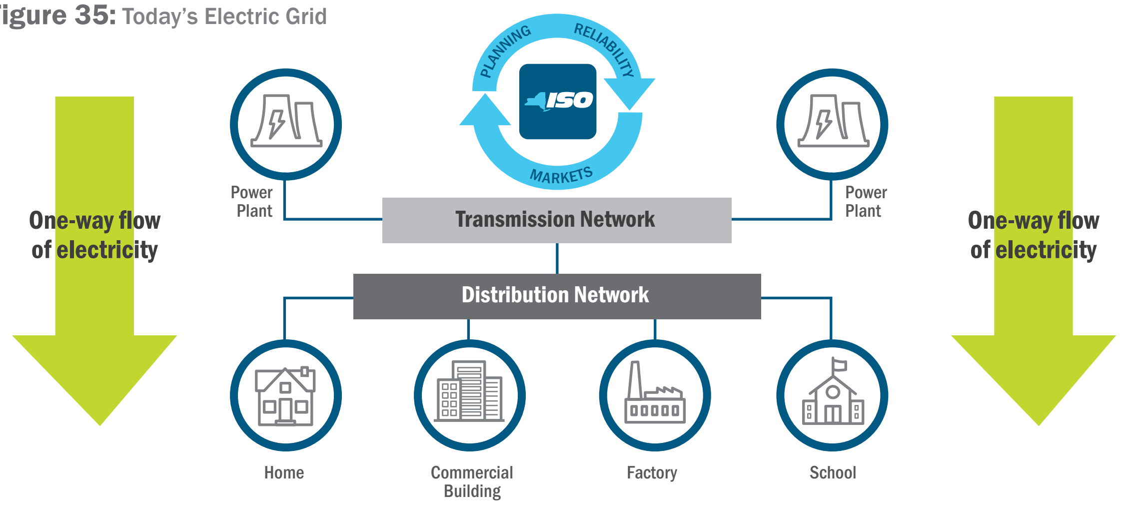
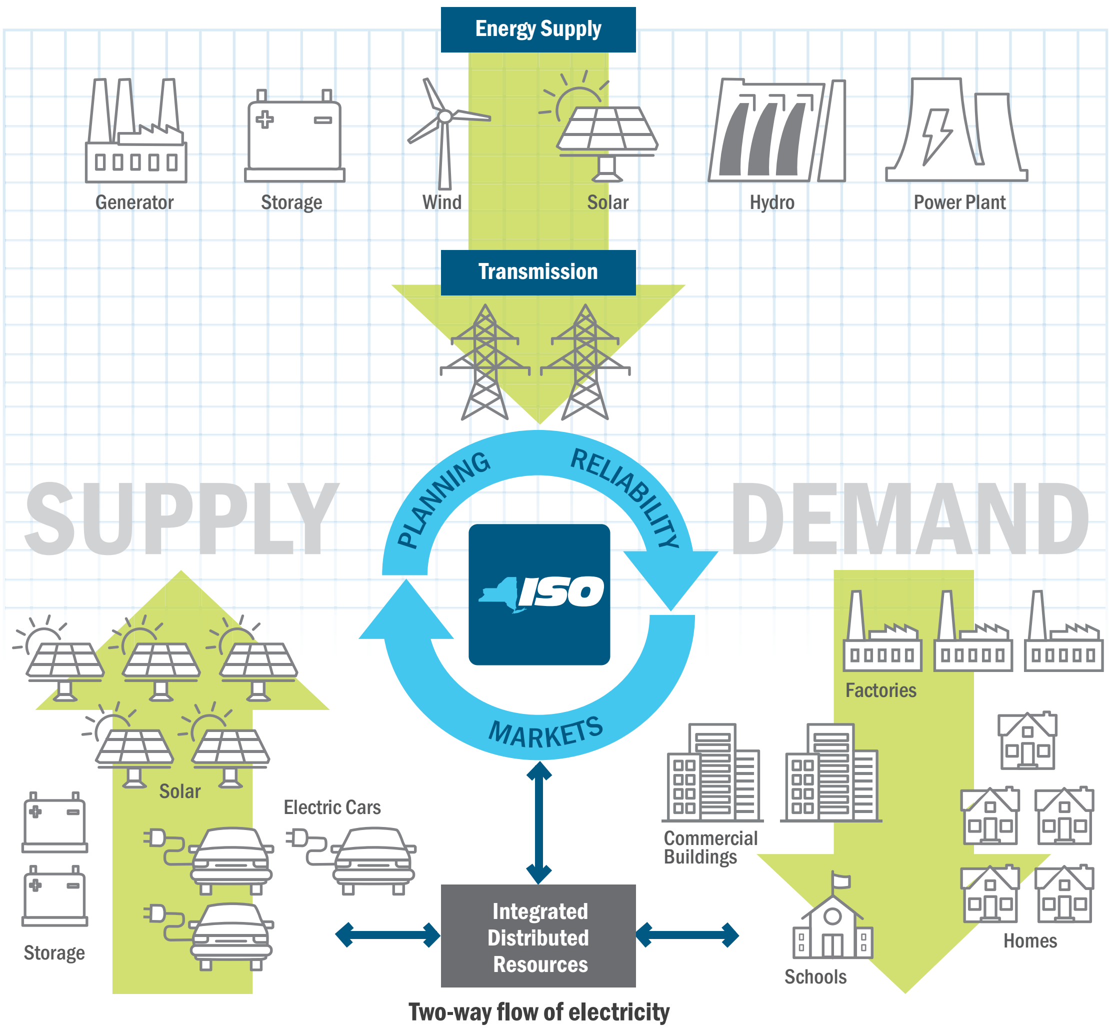


Figure 36: Tomorrow's Electric Grid



Although DER can currently participate in limited ways, the NYISO recognizes that market enhancements to further integrate DER will benefit the system as a whole. **Therefore, the main objective of the DER Roadmap is to identify the key, high-level concepts for the NYISO to address in integrating existing and emerging DER technologies. These concepts will be further developed, refined, and implemented, with stakeholder input through the NYISO's shared governance process.**[78]

The *Roadmap*, though focused on wholesale markets, aligns with the Public Service Commission's (PSC) REV objectives to complement the retail market enhancements undertaken by the PSC and utilities. The NYISO intends to treat dispatchable DER comparably with traditional generators, but recognizes that the capabilities of DER may be different from traditional generators. For instance, the NYISO recognizes that DER are likely to participate in the NYISO's wholesale markets on an aggregated basis due to individual resource size and capability. The market enhancements developed over the next three to five years will permit DER participation in the NYISO's Energy, Ancillary Services, and Capacity markets with the option of being either dispatchable for economics or non-dispatchable for economics.

"The Roadmap offers routes to a future where consumers and emerging technologies support more optimized grid utilization. It offers the NYISO's vision of seamlessly transitioning from a primarily central station-based grid to a diverse bi-directional grid."

— NYISO DER Roadmap release, January 2017

The fundamental premise behind the NYISO's DER Roadmap is straightforward:

- Competitive markets and system operations will benefit from access to emerging technologies that can adjust demand on an economic basis in response to price signals from the market.
- However, developing and implementing the market enhancements necessary to realize this premise will entail a considerable amount of time, effort, and stakeholder engagement.
- The NYISO will use its Roadmap over the next three to five years as a framework to develop the market design elements, functional requirements, and tariff language necessary to implement its vision to integrate dispatchable DER.

Technology & Infrastructure

Emerging Technologies

The emergence of DER and the transformation of the historically centralized electric grid to a more decentralized system cannot take place without advanced technology.

An electricity system that is more distributed places a greater emphasis on data needs and situational awareness so ISOs and RTOs can continue to meet reliability requirements. As mass adoption of DER continues, regional information sharing becomes a significant component of the smarter grid.[78]

Efforts to integrate emerging technology build on a foundation of upgrading and modernizing key elements of the grid to enhance the precision with which grid operators manage the flow of electricity. ISOs have matured beyond the technological framework that existed at the time of market deregulation in the 1990s. For example, supervisory control and data acquisition (SCADA) systems have been supplemented with phasor measurement unit (PMU) data, an advanced tool for grid operations to use to relay system electric conditions at a rate of up to 60 times per second — 360 times faster than previously available.

By using data from PMUs, grid operators have a more comprehensive understanding of what is happening across the system and can more quickly detect potential problems or help avoid major electric system disturbances like the 2003 blackout, which was triggered by events on the transmission system in the Midwest that went undetected in New York until it was too late to take preventative actions. The NYISO, in collaboration with regional partners, also is working on ways to apply PMU data in real-time situations and continues to assess how information can improve reliability and performance.

There are more than 2,000 synchrophasors installed throughout the U.S. as part of the U.S. Department of Energy's 2013 Smart Grid Investment Grant Project.[79] The NYISO's control center employs the capabilities of these devices and connects with PMU networks in New England, the mid-Atlantic, and the Midwest to provide faster and wider situational awareness of grid conditions throughout the eastern United States.

The concept of "Smart Grid" encompasses technological solutions intended to enhance the operation of the transmission and distribution systems, and ultimately improve the ability of electricity consumers to manage their use of power. Efforts to expand smart grid technology build on a foundation of upgrading and modernizing key elements of the grid to enhance the precision with which grid operators manage the flow of electricity.

Collaboration with other ISOs and RTOs on emerging technology issues is a significant component of the smarter grid. In March 2017, the ISO/RTO Council, which includes the NYISO, issued a white paper on emerging technology integration entitled *Emerging Technologies: How ISOs and RTOs Can Create a More Nimble Robust Bulk Electricity System.*[80] The white paper focuses on renewable supply integration, improving situational awareness to better understand the potential of new technologies, and the challenges associated with reliably operating a grid with increased participation of DER.

"There are more than 2,000 synchrophasors installed throughout the U.S. The NYISO's control center employs the capabilities of these devices and connects with other PMU networks."

— From the U.S. Department of Energy's 2013 Smart Grid Investment Grant Project

Grid Security

As the systems that control and monitor the power grid become more advanced and interconnected, the scope of physical and cyber security concerns expands. Increased awareness of man-made threats to critical infrastructure and the potential for physical damage from natural disasters keep security issues in the spotlight.

Mandatory federal reliability standards for owners and operators of the bulk electric system include Critical Infrastructure Protection (CIP) standards. These standards are developed by NERC and approved by FERC.

These standards cover a wide range of risk areas:

- Identification and classification of cyber assets to physical security
- Personnel and training
- Event monitoring and communication
- Incident response
- Protection and isolation of network architecture
- Access and change control
- System recovery

“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

Though the CIP standards are continuing to mature to cover various operations, they serve as robust, base-level requirements for securing our critical infrastructure. [81] CIP standards undergo continuous updates as the nature and scope of threats change.

NERC’s physical security standard requires users, owners and operators of bulk power system facilities to conduct a risk assessment to identify critical facilities and then develop and implement security plans to protect against and recover from attacks on those facilities.

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.

The latest version of CIP standards took effect in July 2016 and uses a layered approach to identify and classify bulk electric system cyber assets according to their potential impact on electric system reliability.[82] The NYISO successfully met requirements and passed a federal CIP standards audit in 2016.

The NYISO actively participates in the development of standards and remains engaged in enhancing cyber and physical security practices to address evolving risks by collaborating with various state and federal government agencies, other ISOs and RTOs, and other industry entities, to maintain rigorous cyber security protections.

For instance, on February 1, 2017, the ISO-RTO Council, which includes the NYISO, participated in a hearing of the U.S. House of Representative’s Committee on Energy and Commerce’s Subcommittee on Energy. The hearing, titled *“The Electricity Sector’s Efforts to Respond to Cybersecurity Threats”* focused in part on steps Independent System

Operators and Regional Transmission Organizations are taking to address cyber and physical security. Comments noted that the IRC's members, including the NYISO, "routinely practice cyber incident response and system recovery to ensure resilience in the wake of a cyberattack. Drills are routinely conducted on local, state, regional and federal levels, in coordination with government agencies and industry associations to provide opportunities to improve our ability to respond and recover with the goal of maintaining the highest possible level of resilience."

In November 2016, the NYISO participated in the New York State Cybersecurity Exercise event to test communications and preparations in the face of an attack. Primary participants included energy sector organizations that operate within New York State, in addition to federal, state and local governments, and the Electricity Information Sharing Analysis Center (E-ISAC).

In 2017, the NYISO will join participants from organizations across the country in GridEx IV, as NERC conducts a simulated attack on the U.S. power grid. The GridEx exercise is designed to enhance the coordination of cyber and physical security resources and practices within the industry, as well as improve communication with government partners and other stakeholders.

Concluding Comments

Great Expectations

In New York, the NYISO's competitive wholesale markets have played a vital role in adapting the power grid to changes in technology, demand, fuel supply economics, and public policy — while meeting the most stringent reliability standards — to provide proven value to New York consumers and the economy of the Empire State.

The NYISO was founded on the belief that active collaboration among power system stakeholders is essential to the development of effective and equitable solutions. The NYISO's system of shared governance, which guides the ongoing transformation of New York's bulk power grid operation and wholesale electricity markets, provides a valuable forum to identify and address the challenges and opportunities facing New York's energy future.

In our evolving energy landscape, the value of this collaboration has never been more important. Collaborating with stakeholders, New York State energy policymakers, and federal policymakers, the NYISO serves as an independent, authoritative source of information. At the heart of this collaboration remain core values: the power system exists to serve customers; and an open, competitive marketplace for wholesale electricity plays a vital role in the efficient allocation of resources and sustained economic growth.

New York is on the cutting edge of this new energy future. Together, we are transforming the power grid as it strives to achieve the goals of cleaner energy, improved efficiency, and robust economic growth. New York's tale of two grids is an unfolding story. The NYISO is working to accommodate change while ensuring continuity. We have great expectations that we can integrate the emerging power trends in a manner that benefits consumers and supports public policy goals.

Glossary of Terms

The following glossary offers definitions and explanations of phrases used in Power Trends 2017, as well as terms generally used in discussions of electric power systems and energy policy.

"50/50 and "90/10": Load forecast scenarios used in transmission planning analyses to help account for increases in system peak demand that can occur in extreme weather. A 50/50 scenario means there is an equal probability of the actual peak load being higher or lower than the forecast value. A 90/10 scenario means there is a 90% chance the actual peak load will below the forecast and a 10% chance it will be above the forecast.

Behind-the-Meter Generation: A generation unit that supplies electric energy to an end user on-site without connecting to the bulk electric 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.)

Broader Regional Markets (BRM): A set of coordinated changes to the region's bulk electricity markets that will reduce the inefficiencies of moving power between markets. In addition to the NYISO, the regional initiative involves Ontario's Independent Electricity System Operator, the Midwest Independent Transmission System Operator, PJM Interconnection, ISO New England, and Hydro Québec.

Bulk Electric System: The transmission network over which electricity flows from suppliers to local distribution systems that serve end users. New York's bulk electricity 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.

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%.

Clean Energy Standard: 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 electricity grid 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. The CARIS is based on the most recently approved CRP.

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.

Day-Ahead Demand Response Program (DADRP): A NYISO demand response program to allow energy users to offer their load reductions into the day-ahead energy market. The resources are paid the same market clearing price per megawatt as generators.

Demand Response (DR) Programs: A series of programs designed by the NYISO to maintain the reliability of the bulk electricity grid by calling on electricity users to reduce consumption, usually in capacity shortage situations. 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).

Demand Side Ancillary Services Program (DSASP): A NYISO demand response program to allow energy users to offer their load reductions into the ancillary services market to provide operating reserves and regulation service. These resources are paid the same ancillary service market clearing price as generators.

Distributed Generation: A small 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 ("behind-the-meter") to serve the customer's power needs, but may in some instances sell excess energy production back 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 demand response program designed to reduce power usage through voluntary electricity consumption reduction by businesses and large power users. The companies are paid by the NYISO for reducing energy consumption upon NYISO request.

Energy: Energy is the amount of electricity a generator produces over a specific period of time. It is measured in megawatt-hours. 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 Independence and Security Act of 2007: A federal energy statute approved in December 2007. The stated purposes of the act are "to move the United States toward greater energy independence and security, to increase the production of clean renewable fuels, to protect consumers, to increase the efficiency of products, buildings, and vehicles, to promote research on and deploy greenhouse gas capture and storage options, and to improve the energy performance of the Federal Government, and other purposes."

Energy Policy Act of 2005 (EPAct): An extensive energy statute approved in August 2005 that requires the adoption of mandatory electricity reliability standards and gave the Federal Energy Regulatory Commission (FERC) the authority to site major transmission lines under certain circumstances in National Interest Electric Transmission Corridors (NIETC) identified by the U.S. Department of Energy. The EPAct also made major changes to federal energy law concerning wholesale electricity markets, fuels, renewable resources, electricity reliability, and the energy infrastructure needs of the nation.

Federal Energy Policy: A policy established by the Federal government which addresses issues of energy production, distribution, and consumption.

Energy policy may include legislation, international treaties, subsidies and incentives for investment, guidelines for energy conservation, taxation, or other public policy techniques.

Federal Energy Regulatory Commission (FERC): The federal regulatory agency that approves the NYISO's tariffs and regulates its operation of the bulk electricity grid, wholesale power markets, and planning and interconnection processes.

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

Gigawatt-Hour (GWh): A gigawatt-hour is equal to one gigawatt of energy used 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) and Northeast Power Coordinating Council (NPCC) 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. All projects must undergo three studies — a Feasibility Study (unless parties agree to forgo it), a System Reliability Impact Study (SRIS), and a Facilities Study — before interconnecting to the grid.

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

Load Serving Entity: An entity, such as an investor-owned utility, public power authority, municipal electric system or electric cooperative that supplies energy, capacity and/or ancillary services to retail electricity customers.

Locational Installed Capacity Requirement: 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 (NYISO Zone J), Long Island (NYISO Zone K), and lower Hudson Valley (NYISO 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 electricity grid. The state's bulk electricity grid 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 electricity grid 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 used 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 electricity grid, 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.

Peak Load: The maximum instantaneous power demand averaged over an interval of time and measured in megawatt hours (MWh). Peak load, also known as peak demand, is usually measured hourly.

Phasor Measurement Units (PMUs): These devices provide near instantaneous measurement and observation of bulk power system phase angles at strategic locations across the system. PMUs are enhancing the NYISO's (and transmission owners') awareness of the system's status and its vulnerabilities in real time.

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.

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 energy modernization initiative proposed by New York Governor Andrew M. Cuomo. 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 tax credit offered by a local or federal taxation authority as an incentive for the installation and operation of renewable energy systems. One REC equates to one MWh of energy generated from eligible renewable energy resources. RECs are used to measure compliance with the renewable energy goals of the state's Clean Energy Standard.

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 of 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 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. Companies that sign up as SCRs are paid in advance for agreeing to cut power upon NYISO request during periods of system stress.

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: A tax credit offered by a local or federal taxation authority as an incentive for the operation of an eligible zero-emission facility. In New York, one ZEC equates to one MWh of energy generated from eligible nuclear generator. ZECs are used to measure compliance with the obligations under the State's Clean Energy Standard.

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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.

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