POWER TRENDS 2016

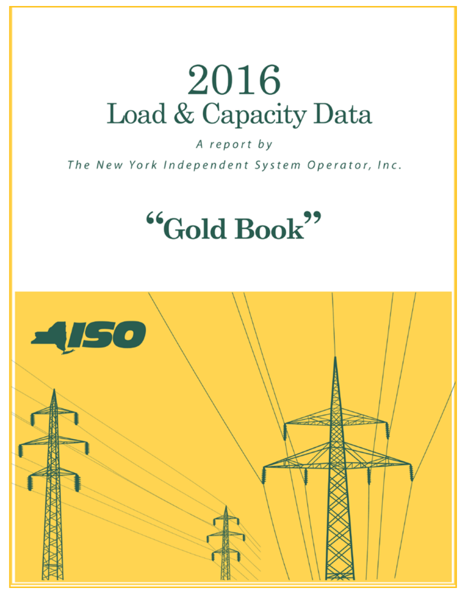
THE CHANGING ENERGY LANDSCAPE

New York Independent System Operator

Power Trends 2016 is printed on Mohawk Options 100% PC, which is made with 100% post-consumer recycled fiber, and manufactured entirely with Green-e certified wind-generated electricity.

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.

Data used in *Power Trends 2016*, unless otherwise noted, are from the *2016 Load and Capacity Data Report* (also known as the "Gold Book").



Published annually by the NYISO, the "Gold Book" presents New York Control Area system, transmission and generation data and NYISO load forecasts for the 2016 – 2026 period. It includes forecasts of peak demand, energy requirements, energy efficiency, and emergency demand response; existing and proposed resource capacity; and existing and proposed transmission facilities.

The "Gold Book" and other NYISO publications are available on the NYISO website, www.nyiso.com.

POWER TRENDS: BY THE NUMBERS

Renewable Resources

Summer 2016
Total Renewable
Resource Capability
6,174 Megawatts

2015
Percentage of
Electric Energy from
Renewables
23%

Summer 2016
Total Hydropower
Capability
4,315 Megawatts

2016
Total Existing Wind
Generating Capacity
(nameplate)
1,754 Megawatts

2016 Proposed Wind
Generating Capacity
(as of March 31)
3,737 Megawatts

Power Resources

2016
Total Generating
Capacity
38,576 Megawatts

Generating Capacity
Added Since 2000
11,655 Megawatts

2016
Total Circuit Miles of
Transmission
11,124 miles

Transmission
Capability
Added:
2000-2016
2,765 Megawatts

Demand Response
Summer 2016
Projected Special Case
Resources
1,248 Megawatts

Total Energy Generated in 2015 - **142,346 GWh**

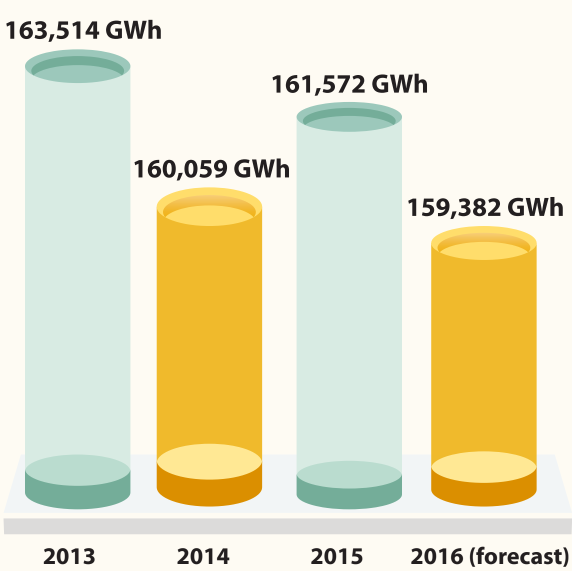
Reliability Requirements

Summer 2016 Reliabilty Requirement	39,198 MW
Summer 2016 Total Resources Available	41,552 MW

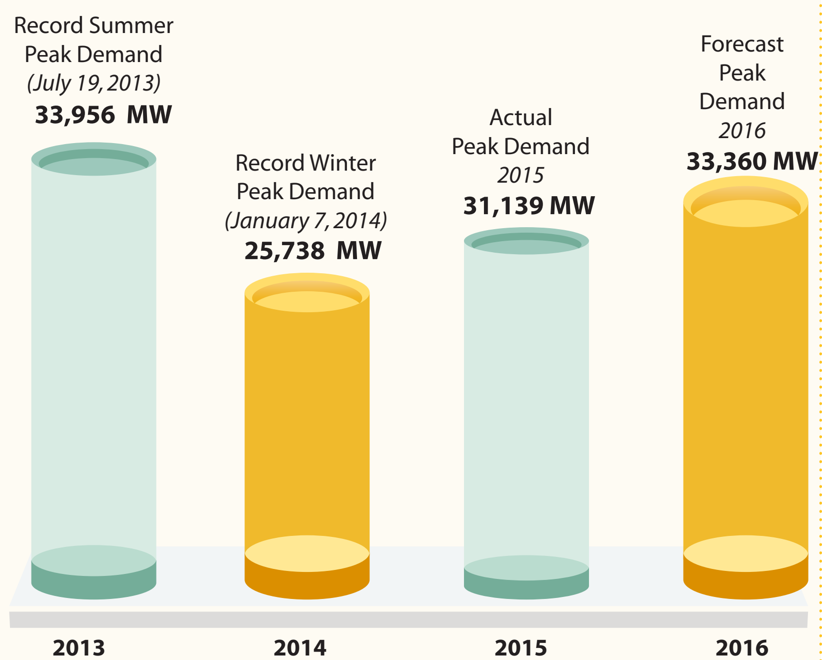
Power Demands

ENERGY USE

Total Annual



PEAK DEMAND



All data presented above refer to New York's bulk electric system and wholesale electricity markes

Table of Contents

List of Figures

EXECUTIVE SUMMARY

Transforming the Grid

A look across today's energy landscape reveals a period of exciting innovation. How people think about and use electricity is changing as quickly as the technology that generates and delivers it. Here in New York, the New York Independent System Operator (NYISO) is at the heart of those changes: meeting consumers' power needs, addressing public policy goals, and sustaining electricity's fundamental contributions to economic vitality.

As the electric system changes, new challenges and opportunities are coming into view. The NYISO's annual Power Trends report provides information and analysis on current and emerging trends that are working to transform the power grid and wholesale electricity markets. They include:

- *shifting patterns of demand for electricity affected by energy efficiency and distributed energy resources,*
- *aging infrastructure requiring replacement and upgrades,*
- *power economics influenced by low natural gas prices, and*
- *public policies aimed at reducing emissions, expanding renewable power resources, and providing customers more power choices.*

Changing Energy Usage & Moderating Peak Demand

Consumer use of electricity is changing. Energy efficiency is improving with new building codes and appliance standards, as well as government, utility, and community programs. The emergence of distributed energy resources is transforming historical patterns of consumption and affecting consumer reliance on electricity provided by the bulk electric system. [1]

- *Year-over-year growth in the overall usage of electric energy from New York's bulk electric system is expected to flatten or decline slightly over the next decade. While peak demand is projected to grow, it is expected to increase at a more moderate pace than previously forecast.*
- *Peak demand represents a small fraction of annual overall power use, but it is a significant metric because the electric system must be constantly prepared to supply those periods of highest use. 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.*
- *Improvements in energy efficiency are among the most prominent factors affecting electricity demand. Energy efficiency is expected to reduce peak demand on New York's bulk power system by 255 megawatts in 2016 and by more than 1,800 megawatts in 2026.*
- *Distributed solar photovoltaic 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 their electricity needs.*

Transmission as Enabler

The goal of building a cleaner, greener, integrated grid to serve New York requires the solid foundation of a modernized, upgraded, and expanded transmission system.

- *More than 80 percent of New York's high-voltage transmission lines went into service before 1980. Of the state's approximately 11,000 circuit-miles of transmission lines, nearly 4,700 circuit-miles will require replacement within the next 30 years, according to New York's transmission-owning utilities and power authorities.*
- *Upgraded transmission capability is vital to efficiently moving power to address regional power needs. The downstate region of New York (Long Island, New York City, and the Lower Hudson Valley) annually uses 58 percent of the state's electric energy. Yet, that region's power plants generate only 40 percent of the state's electricity.*
- *New York's major hydropower resources and all existing and proposed 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 make more effective use of current and future renewable resources.*

Enhancing Environmental Quality & Cultivating Green Power

At the federal and state level, policymakers are establishing environmental quality goals that significantly affect the electric system. Policies and programs such as the Federal Clean Power Plan, 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, such as those administered by the NYISO, have complemented environmental regulations and renewable power plans, integrating renewable resources and fostering efficiencies that reduce emissions.

- *From 2000 through 2015 New York's air quality improved as power plant emission rates dropped significantly. SO_2 emissions rates declined 97 percent. NOx emission rates declined 79 percent. CO_2 emission rates declined 42 percent.*
- *In 2015, 23 percent of New York's electricity was produced by renewable resources. Electricity produced from water, wind, solar and other renewable sources accounted for 32,943 gigawatt-hours of the 142,346 gigawatt-hours of electric energy generated in New York last year.*
- *New York's large base of hydropower resources produced 18 percent of New York's total generation in 2015, generating 25,879 gigawatt-hours of electric energy.*
- *Windpower resources provided three percent of New York's total generation in 2015, generating 3,984 gigawatt-hours of electric energy last year. Electric energy produced by windpower in New York has grown 3,000 percent since 2005.*
- *The generating capacity of wind-powered projects in New York grew from 48 megawatts in 2005 to 1,754 megawatts in 2016. More than 3,700 megawatts of windpower projects are currently proposed for interconnection with the New York bulk electric system.*

- *There is currently one grid-scale solar project in New York, a 32-megawatt facility located on Long Island. Another 233 megawatts of generating capacity from grid-scale solar photovoltaic projects are currently proposed for interconnection with the New York bulk electric system.*
- *New York's proposed Clean Energy Standard will mandate that 50 percent of all electricity consumed in New York by 2030 come from clean and renewable energy sources. According to the New York State Department of Public Service, the "50x30" goal requires 75,000 gigawatt-hours of total renewable energy by 2030, which means increasing energy from renewables by 33,700 gigawatt-hours from current levels. The NYISO estimates that the additional renewable energy would require carbon-free generating capacity additions approximately equivalent to:*
  - 25,000 megawatts of solar photovoltaics, or
  - 15,000 megawatts of wind turbines, or
  - 4,000 megawatts of hydro power.

The relative size of the required capacity additions from renewable resources reflects the limited ability of intermittent resources (such as solar and wind) to generate electric energy compared to their installed power capacity. Providing a mix of resources at the least cost to consumers requires that policymakers be mindful of the impacts of the relative capability of intermittent resources to reliably supply power demands.

The Impacts of Natural Gas & the Future of Nuclear Power

According to the U.S. Energy Information Administration, natural gas is expected to surpass coal as the nation's primary fuel source for electricity in 2016. Natural gas already fuels the largest portion of New York's generating capacity. That share is growing as low natural gas prices affect the competiveness of nuclear energy and other power resources that rely on comparatively more expensive fuels.

- *Power plants fueled by natural gas (both gas-only & dual-fuel) provide 57 percent of New York's total generating capacity.*
- *47 percent of New York's generating capacity is composed of dual-fuel units. These facilities, predominantly located in downstate New York, offer the flexibility of operating on natural gas or an alternative fuel (typically oil), as determined by market signals or reliability requirements.*
- *Natural gas and dual-fuel projects account for more than 65 percent of the proposed generating capacity being studied by the NYISO for interconnection to the grid.*
- *Low natural gas costs drove record low wholesale electric energy prices in 2015. The average wholesale electric energy price ($44.09 per megawatt-hour) was the lowest in the 15-year history of New York's competitive markets for wholesale electricity.*
- *The effects of persistently low natural gas prices on wholesale electricity prices may be positive for consumers in the near-term, but it is contributing to emerging resource adequacy issues as power plants retire and the fuel mix becomes less diverse. From 2016 to 2018, approximately 2,300 megawatts of generation capacity is planned to retire or suspend operation.*

- *The emission-free attributes of nuclear generation and the fast-starting ability of gas-fired turbines to balance variable resources such as wind and solar mean that both types of generation provide essential support for the successful integration of cleaner, greener power resources.*

Integrating Distributed Energy Resources

Changing energy technologies are challenging the traditional model of centralized power generation. Consumers are taking advantage of an array of smaller scale power supplies, such as solar photovoltaics. These distributed energy resources offer challenges and opportunities. Effective integration is vital to avoiding reliability issues, and enhancing the resources' potential value to grid resilience.

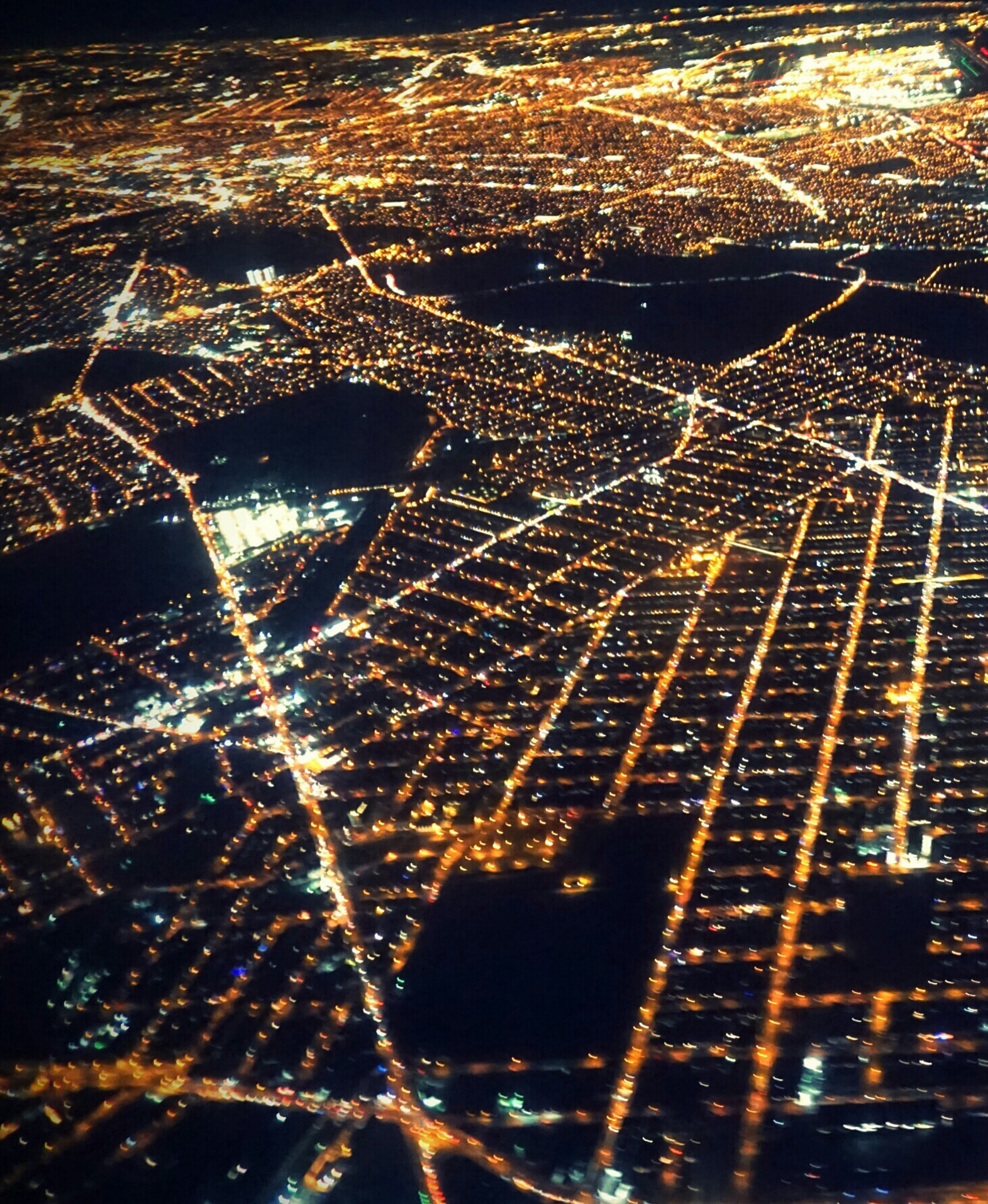
- *New York' State's Reforming the Energy Vision (REV) initiative is identifying regulatory changes and market developments to facilitate the role of distributed energy resources.*
- *Distribution-level solar photovoltaics, in 2016, have an estimated summer capability of more than 250 megawatts. That total is expected to triple by 2026.*
- *Recently adopted changes open NYISO markets to behind-the-meter generation that produces more power than consumed by its host facility. This is expected to introduce more than 100 megawatts of existing capacity that was previously unable to participate in New York's wholesale electricity markets.*
- *In collaboration with its stakeholders, the NYISO is developing a Distributed Energy Resource Roadmap to help guide changes in wholesale electricity market design that will enhance integration of distributed energy resources.*
- *The NYISO is studying the potential growth in solar power resources to determine their impact on grid operations and developing the operating procedures and forecasting tools needed to successfully integrate solar resources.*
- *New York's REV initiative envisions significant contributions from storage resources at the distribution level, and the NYISO Energy Storage Market Integration and Optimization initiative is examining how to improve market accessibility for storage resources.*

Markets Sustaining Reliability & Enhancing Efficiency

Open and competitive wholesale markets sustain reliability and enhance efficiency through transparent price signals that accurately reflect system needs. Supply resources rely on prices to determine how and when to enter or exit the market. Investors and developers rely on transparent market signals to determine whether to build new facilities, what type of facility to build, and where to build.

Market competition promotes operational decisions that provide the lowest cost power available to meet New York's rigorous reliability standards. NYISO markets have facilitated economically efficient investment in generation, transmission, and demand-side measures.

- *New York's competitive wholesale electric markets have provided significant benefits to the State and its electricity consumers. Since 2000, the markets have contributed to improved generation efficiency and lower reserve requirements that produced $7.7 billion in savings; reduced carbon emissions equivalent to taking approximately five million cars off the road, and increased renewable generation that provides enough wind-powered electricity to serve half-a-million New York homes.*
- *New generation – representing 30 percent of the current capacity of New York's power plants – has been added since the start of New York's wholesale electricity market. From 2000 to 2016, those additions totaled more than 11,600 megawatts.*
- *More than 80 percent of the new generation has been added in the Hudson Valley, New York City and Long Island, where demand for power is greatest.*
- *Since 2000, more than 2,700 megawatts of transmission capability have been added to serve the high-demand southeastern New York region.*
- *Demand response programs developed in competitive wholesale markets can provide more than 1,200 megawatts of resources to address peak demand.*
- *Markets have consistently responded to reliability needs in New York. The NYISO has conducted seven reliability assessments since it launched its reliability planning process in 2005. Five assessments identified emerging reliability needs. In each case, markets responded with resources to address those needs, avoiding the need to call upon regulatory solutions.*
- *Broader Regional Markets initiatives involving the Northeast, Mid-Atlantic, and Midwest U.S., and the Canadian provinces of Québec and Ontario are reducing the need to use more expensive local power when less costly power is available from a neighboring grid operator, and shortening the time commitment for moving power across control area borders, which allows faster responses to changing conditions.*



Demand Trends and Forecasts

ENERGY USE

Nationwide, the annual electricity usage growth rate has steadily declined in recent decades. During the 1950s, electricity use grew nearly 10 percent annually. Since 2000, the growth rate has been less than 1 percent per year. Electricity demand in the U.S. fell by 1.1 percent from 2014 to 2015. [2]

A May 2016 report from the North American Electric Reliability Corporation (NERC) suggests that the energy efficiency provisions of the federal Clean Power Plan could further reduce electricity demand, perhaps cutting the rate of growth from 0.61 percent to 0.31 percent nationwide. [3]

In New York, annual electric energy usage since 2000 has been relatively flat, growing at an average annual rate of 0.2 percent.

From 2014 to 2015, New York electric energy usage increased by 0.9 percent. However, that increase followed a 2.1 percent decrease between 2013 and 2014. The 161,572 gigawatt-hours of electricity used in 2015 was the second lowest total since 2009, when mild weather and reduced economic activity resulted in a 4.1 percent decrease in electricity use from 2008 levels.

The overall trend for the past several years has been flat. The NYISO forecasts energy usage in New York to decline at an annual average rate of -0.16 percent from 2016 through 2026. As recently as 2014, long-term forecasts of energy usage projected 10-year average growth at 0.16. Last year's forecast projected no (0.00 percent) growth.

Figure 1 – Change in Long-Term Forecasts of Energy & Peak Demand: 2014-2016

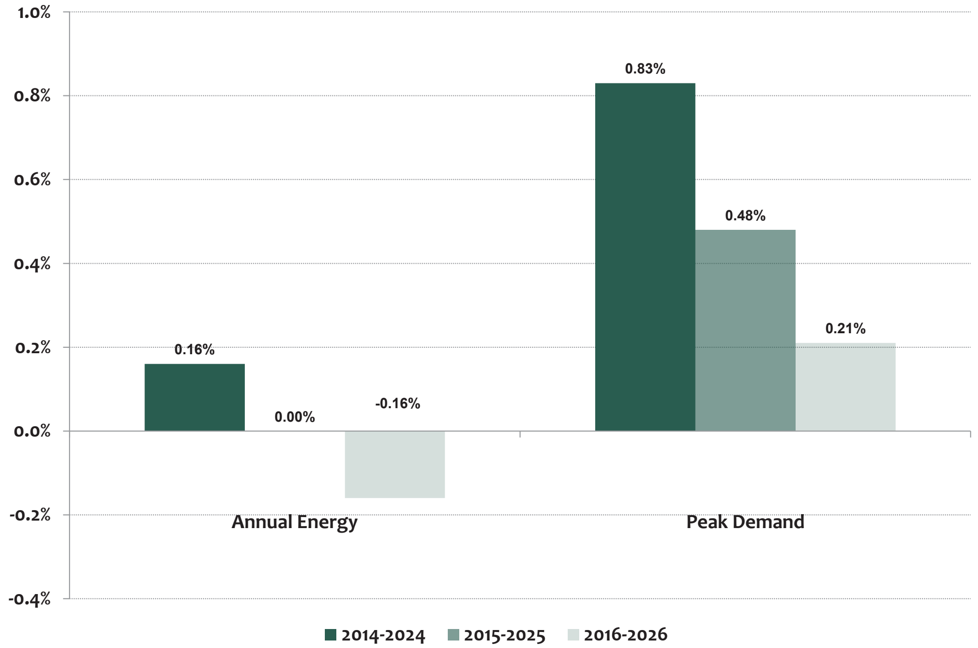


Figure 2 – Annual Electric Energy Usage Trends in New York State: 2000-2015

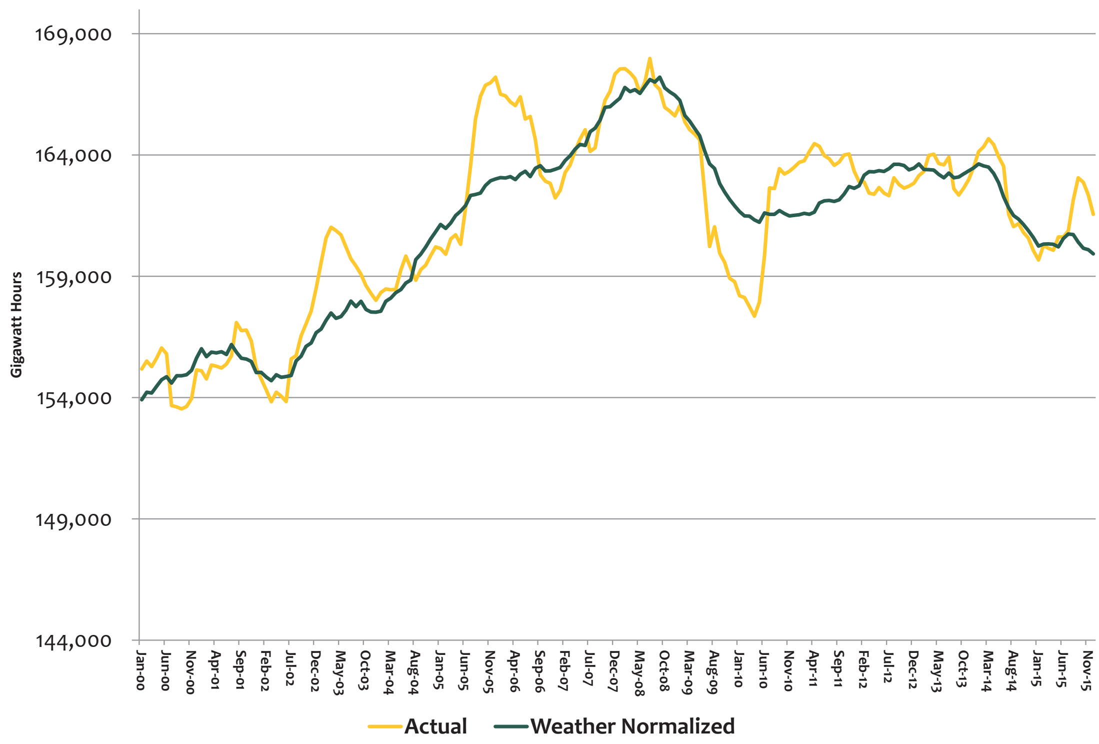


Figure 3 - Annual Electric Energy Usage by Region: 2014-2015

ANNUAL ELECTRIC ENERGY USAGE BY REGION 2014-2015			
	2014 GWh	**2015 GWh**	**Percent Change**
New York State	160,059	161,572	0.9%
Long Island	21,568	21,906	1.6%
New York City	52,541	53,485	1.8%
Lower Hudson Valley	18,808	19,211	2.1%
Upstate	67,142	66,970	-0.3%

Figure 4 - Electric Energy Usage Trends in New York State: 2000-2026

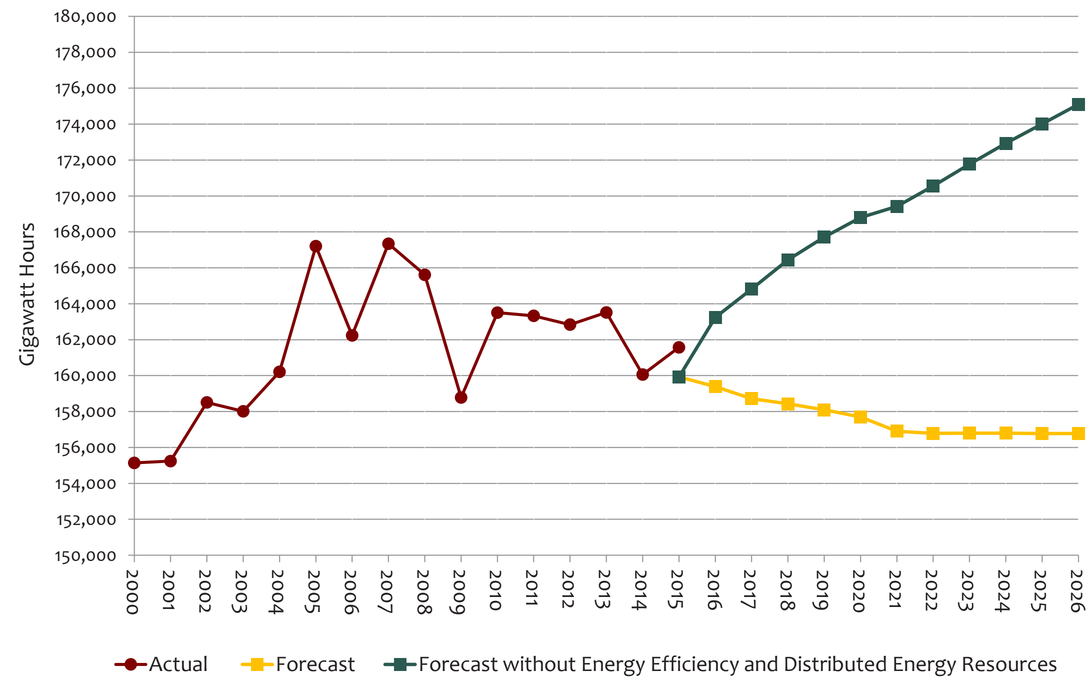
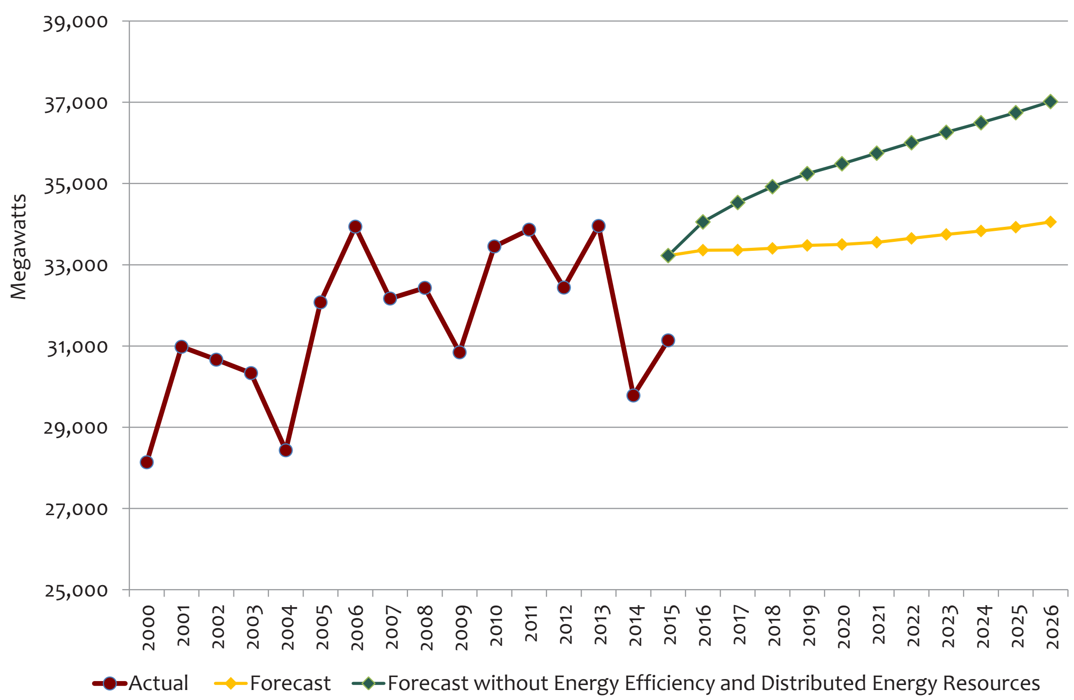


Figure 5 - Electric Peak Demand Trends in New York State – Actual & Forecast: 2000-2026



PEAK DEMAND

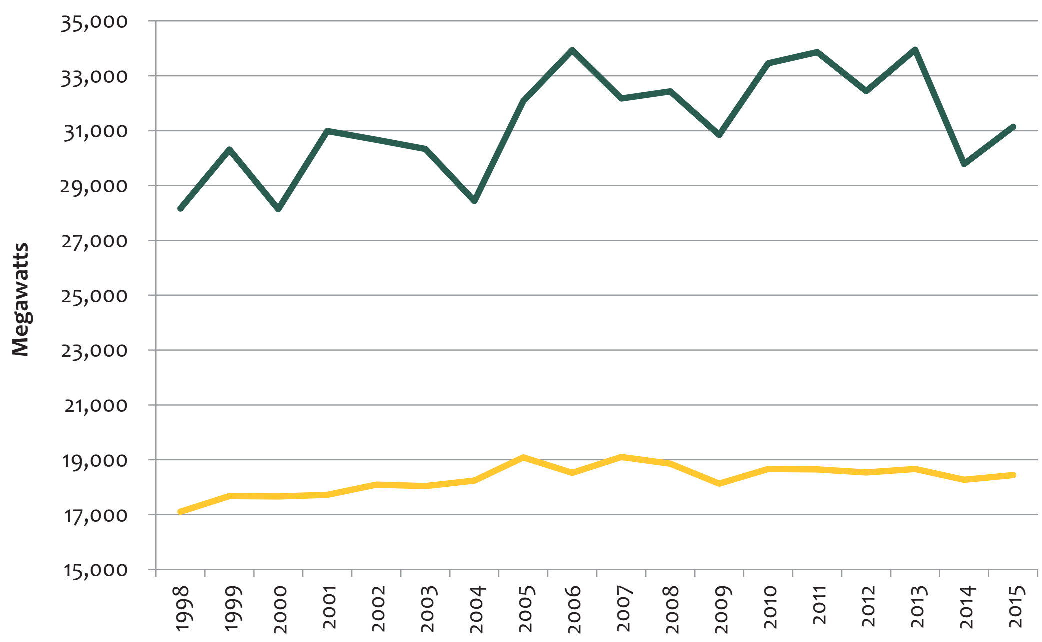
Peak demand represents a small fraction of annual overall power usage. However, it is a significant metric, because the electric system must be constantly prepared to supply those periods of highest use. Reliability standards, such as resource adequacy and reserve requirements, are based on projected peak demand. These reserve requirements determine the total amount of power capacity that must be purchased to meet the system's reliability needs.

New York's all-time record peak is 33,956 megawatts, reached in July 2013 at the end of a week-long heat wave. In 2015, the annual peak reached 31,138 megawatts, 8.3 percent below the record, but 4.6 percent above the 2014 peak.

Peak demand in New York is forecast to grow at an annual average rate of 0.21 percent from 2016 through 2026. The NYISO's long-term forecasts of peak demand have decreased from a projected 0.83 percent annual growth in 2014 and 0.48 percent in 2015.

While the growth of peak demand is slowing, it continues to outpace the rate of change in energy usage. This pattern of peak demand growing faster than average electricity use is not unique to New York. [4]

Figure 6 - Peak vs. Average Load in New York State: 1998-2015



ELECTRICITY TRENDS, ENERGY EFFICIENCY AND DISTRIBUTED RESOURCES

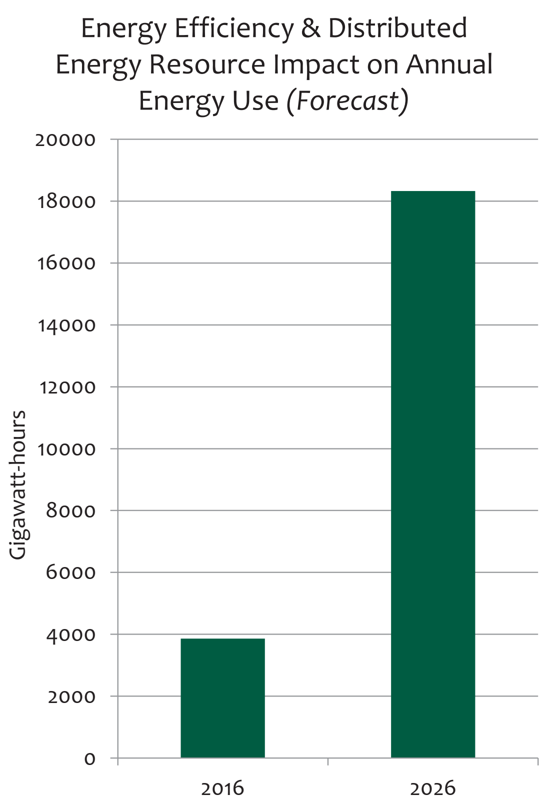
Energy efficiency programs, distributed solar photovoltaics, and non-solar distributed resources are combining to moderate the growth of energy usage and peak demand demand on the bulk power system..

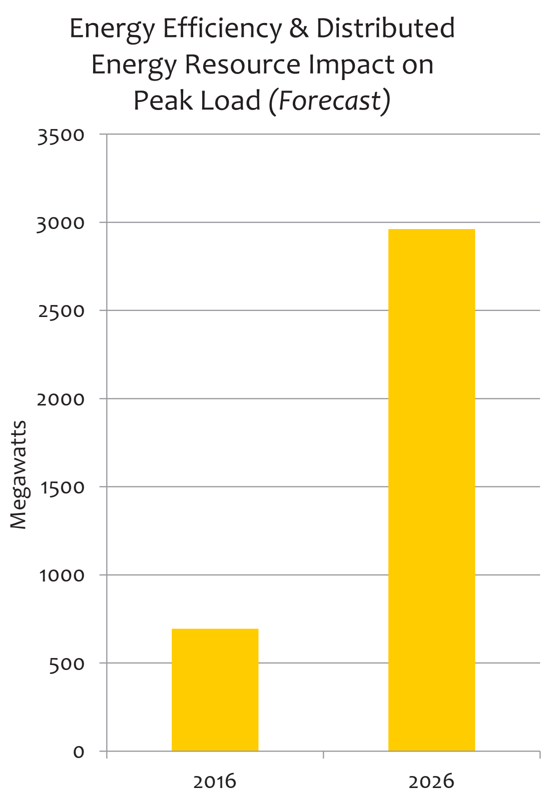
Energy efficiency is improving with new building codes and appliance standards, as well as government, utility, and community programs. These energy efficiency gains are expected to reduce peak demand on New York's bulk power system by 255 megawatts in 2016 and by more than 1,800 megawatts in 2026. They are also expected to lower annual energy usage served by the bulk power system by 1,752 gigawatt-hours in 2016 and by nearly 13,000 gigawatt-hours in 2026.

Distributed solar photovoltaic resources in New York are expected to reduce peak demand on the bulk power system by 258 megawatts in 2016 and by nearly 750 megawatts in 2026. They are also expected to lower annual energy usage served by the bulk power system by 1,053 megawatts in 2016 and by more than 3,600 gigawatt-hours in 2026.

In addition to distributed solar, other behind-the-meter resources are expected to reduce peak demand on the bulk power system by 182 megawatts in 2016 and by more than 350 megawatts in 2026. They are also expected to lower annual energy usage served by the bulk power system by 1,056 gigawatt-hours in 2016 and by more than 1,700 gigawatt-hours in 2026. (See the "Integrating Distributed Resources" section for more discussion.)

Figure 7 – Projected Impact of Energy Efficiency Programs and Distributed Energy Resources on Peak Loads & Energy Usage: 2016 & 2026



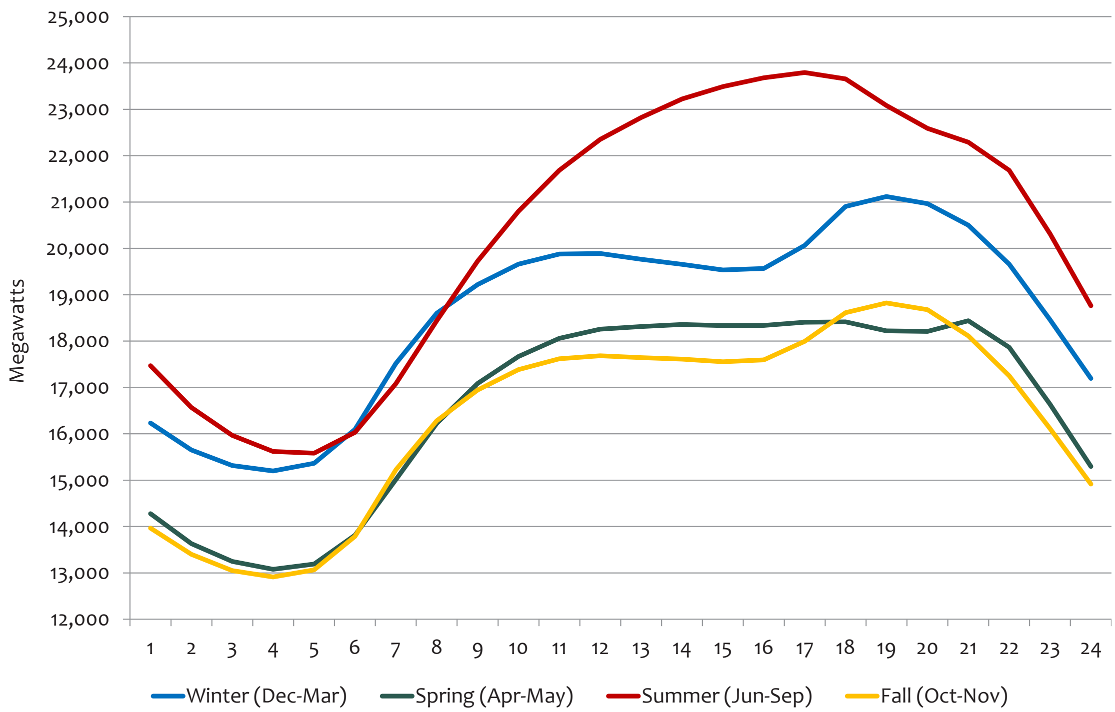


DAILY AND SEASONAL DEMAND PATTERNS

In addition to year-over-year changes, 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.

In New York, the periods of highest demand occur during the summer when heat waves prompt greater use of air conditioning and other climate controls. Annual record peaks are typically recorded in summer months. The all-time record peak demand in New York (33,956 megawatts) was recorded on July 19, 2013. In comparison, New York's all-time record for demand during the winter is 25,738 megawatts, which was recorded on January 7, 2014.

Figure 8 – Seasonal Demand



Resource Trends

Significant additions of generation, transmission and demand-side resources have developed since New York's competitive marketplace for wholesale electricity began operating in 2000. A changing array of resources is expected to be available to meet forecasted demand over the next decade.

Resources Added Since 2000

11,000 + MW generating capacity

2,700 + MW transmission capability

1,200 + MW demand response

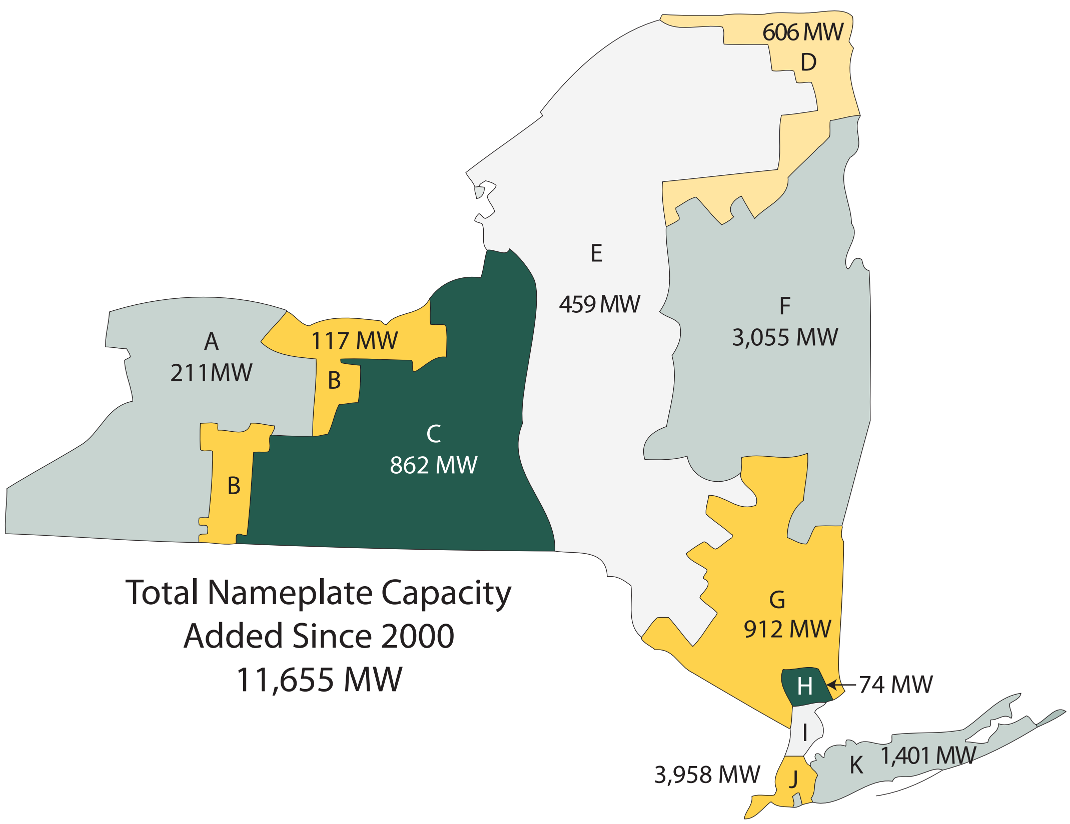
Generation

Since 2000, private power producers and public power authorities have added more than 11,655 megawatts of new generating capacity in New York State. This additional generation represents approximately 30 percent of New York's current generating capacity.

Over 80 percent of that new generation is located in the eastern and southern regions of New York (Zones F-K) -- where power demand is greatest. New York's wholesale electricity market design, which includes locational based pricing and regional capacity requirements, encourages investment in areas where the demand for electricity is the highest.

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.

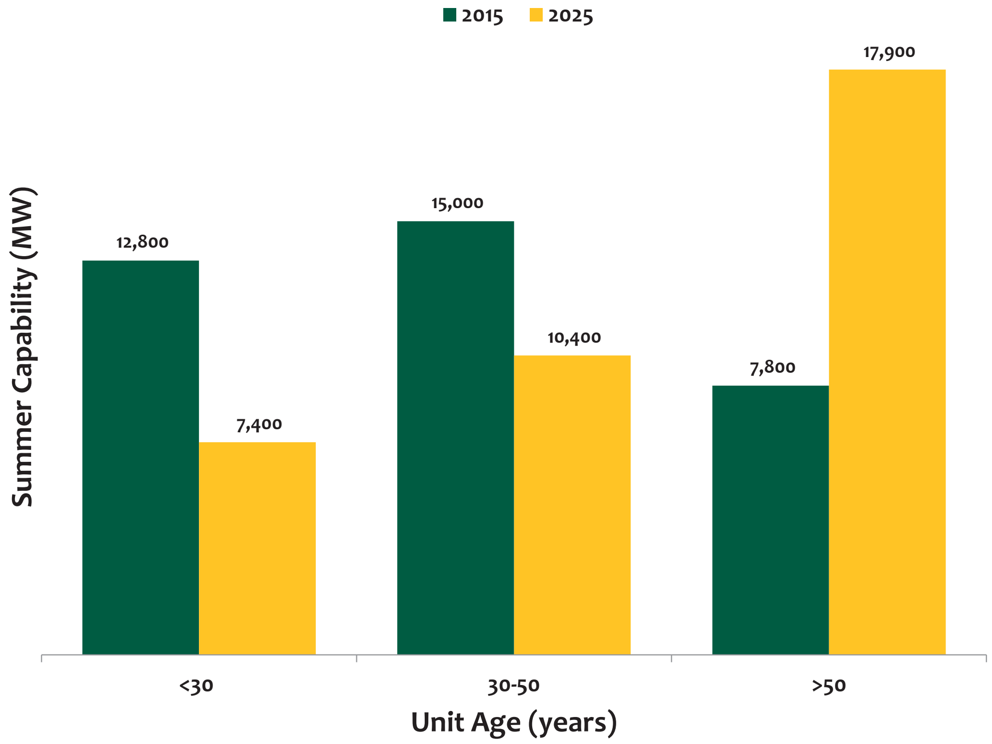
Figure 9 – New Generation in New York State: 2000-2016



While there have been significant additions to generating capacity since 2000, the issue of aging power plant infrastructure persists. While 7,800 megawatts of New York's generating capability were more than 50 years old in 2015, that segment will grow to 17,900 by 2025 in the absence of new generation to replace aging assets.

Renewable power projects such as wind and solar units are among New York's newest generating facilities. In addition, combined cycle units fueled by natural gas have an average age of little more than a decade. The average age of New York's hydropower facilities is over 50 years, although the major hydropower projects have undergone life extension and modernization within the past decade and a half.

Figure 10 – Age of New York State Generation Fleet: 2015 & 2025



EXPANSION AND 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 (so-called "mothballing") in response to competitive forces.

Since 2000, more than 10,000 megawatts of new generation have been added to the system (and existing facilities have improved their generating capacity), while more than 7,000 megawatts have retired or suspended operation. The pattern of expansion and contraction has ranged from the addition of more than 2,400 megawatts between 2005 and 2006 to a reduction of 1,900 megawatts between 2012 and 2013. [5]

Generation additions were primarily natural gas-fueled or wind-powered facilities. Since 2000, approximately 2,000 megawatts of generation fueled by coal have retired or suspended operation. In addition, a former coal-burning power project with more than 500 megawatts of summer capability *(the Danskammer project in the Lower Hudson Valley)* converted to natural gas in late 2014.

Figure 11 – Generation Additions & Retirements: 2000-2016

The pattern of expansion and contraction has continued in recent years. In 2012, statewide power resources exceeded peak demand and reserve requirements by more than 5,000 megawatts. In 2013, the margin declined to approximately 2,500 megawatts, dropping to roughly 1,900 megawatts in 2014. In 2015, the surplus of power resources in excess of reliability requirements rebounded to total more than 2,300 megawatts.

Competitive wholesale electricity markets are designed to facilitate investment in more efficient resources to meet demand. As more efficient and lower cost competitors enter the market, less efficient, higher cost resources may retire or suspend operation. However, power plant retirements can present challenges to electric system reliability. *(See "The Impacts of Natural Gas and the Future of Nuclear" for more discussion.)*

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-range planning process or alternate means.

In 2015, a FERC order concluded that reliability agreements 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."[6] FERC directed the NYISO to make 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.[7]

Pursuant to that order the NYISO filed tariff revisions establishing rates, terms and conditions for "reliability must run" agreements as part of its tariff. "Reliability must run" agreements provide for the retention of generation units that had planned to deactivate, but have been determined to be needed for electric system reliability. Based on an April 2016 order, the NYISO will file further refinements to its "reliability must run" process this September.

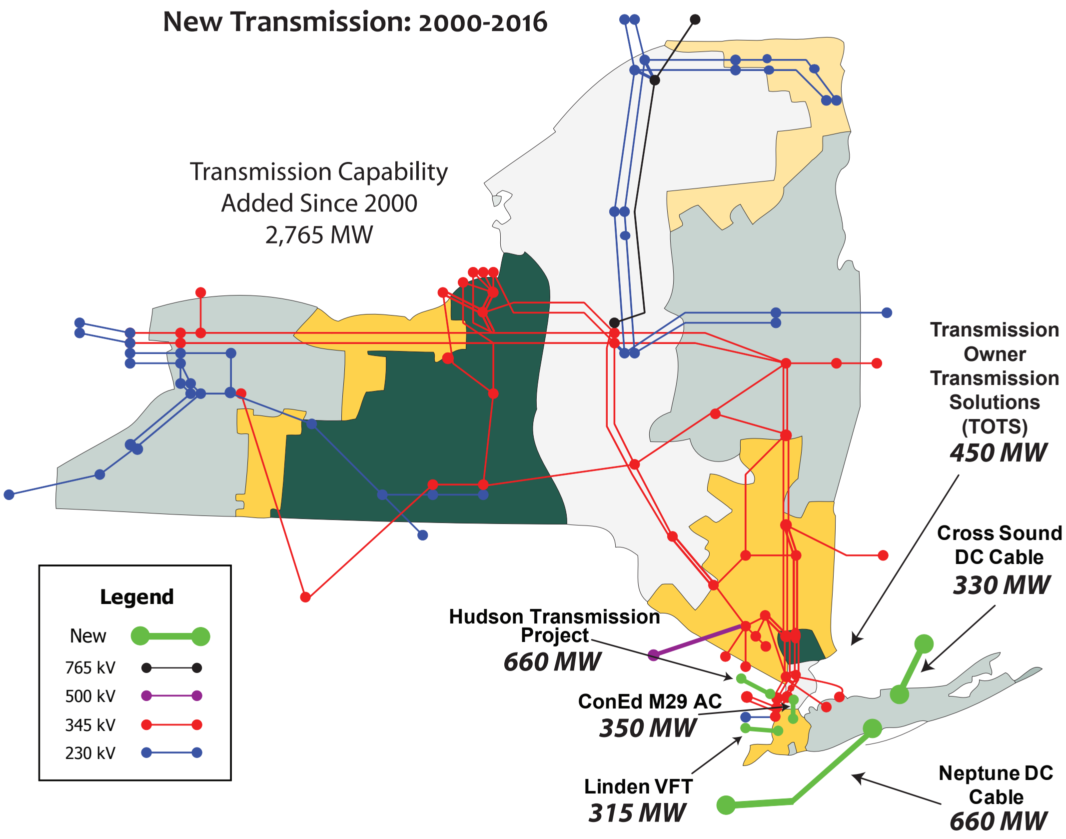
Transmission

Since 2000, more than 2,300 megawatts of transmission capability have been added to serve New York's electric system. The power demands of the downstate metropolitan New York region have attracted the development of various transmission projects, primarily interregional transmission bringing power to the southeastern New York region from neighboring electricity markets.

These investments include the Cross Sound Cable – connecting Long Island with ISO-NE – and the Neptune Regional Transmission System, connecting Long Island with PJM. Also connecting New York with PJM are the Hudson Transmission Partners project and the Linden Variable Frequency Transformer project.

Very recently, a set of three intrastate projects collectively named the Transmission Owner Transmission Solutions (TOTS) was placed in service in June 2016. Approved by the New York State PSC as part of New York's Energy Highway initiative, the projects are expected to increase transfer capability into southeastern New York by 450 megawatts.

Figure 12 - New Transmission in New York State: 2000-2016



In addition to these investments, there is a need to further upgrade and enhance transmission infrastructure in New York State. Modernized and expanded transmission can serve 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. *(See "Transmission as Enabler" section for further discussion.)*

Demand Response

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

Prior to the establishment of wholesale electricity markets, the electric system generally addressed growth in peak demand with comparable increases in generating capacity. Demand response programs have helped alleviate the need for more generation by focusing on consumers to assist in reducing their use of electricity.

According to the Federal Energy Regulatory Commission, demand response resources in the nation's seven ISO/RTO regions totaled nearly 28,934 megawatts in 2014, representing 6.2 percent of peak load.[9]

Large power customers and aggregated groups of smaller consumers participate in several demand response programs developed in the NYISO markets. In summer 2015, the programs involved 3,896 end-use locations providing a total of 1,325 megawatts of load reduction capacity, representing 4.3 percent of the 2015 summer peak demand. The 2015 enrollment level represented a 9.5 percent increase in demand response capacity over the 2014 level.[10]

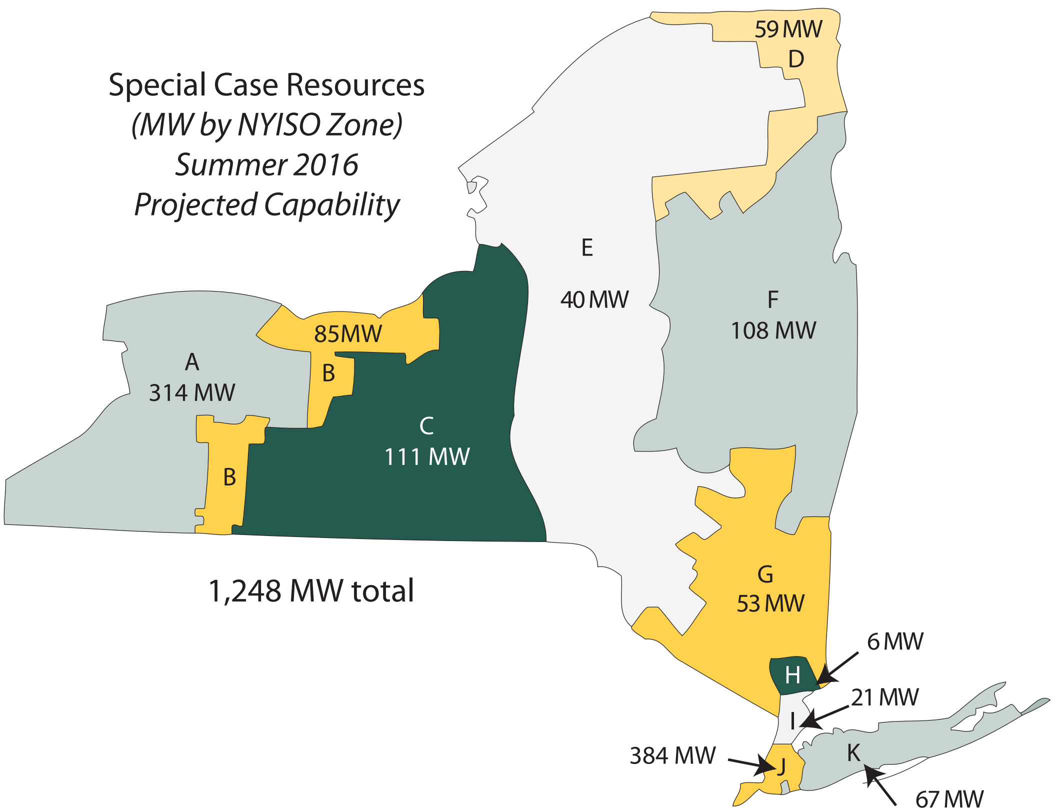
For the summer of 2016, the capability of projected enrollment is comparable to last year's levels. The NYISO's largest demand response program, Special Case Resources, is projected to be capable of offering up to 1,248 megawatts. In addition, the Emergency Demand Response Program is expected to provide 77 megawatts.

For the past several years, participation in demand response programs had been affected by legal challenges to FERC Order 745, which required that demand response resources be compensated at wholesale market prices for energy. In May 2014, the U.S. Court of Appeals for the District of Columbia invalidated the order as an infringement on state powers to regulate retail electricity sales.[11] However, the U.S. Supreme Court reversed the lower court's decision in January 2016 and determined that FERC has authority to regulate demand response under the Federal Power Act through wholesale electricity markets.[12]

With the clarity provided by the Supreme Court ruling, the NYISO is continuing to operate its demand response markets as prescribed by federal tariffs. This includes implementation of tariff changes to the scarcity pricing[13] mechanism, which were conditionally accepted by FERC in March 2016. These changes will enable real-time pricing of demand response and potentially yield more than $46 million in annual cost savings to consumers.[14]

In the *Summer 2016 Energy Market and Reliability Assessment,* FERC staff reported, "There are two new market developments that could have a bearing on demand response this summer. The first is the NYISO's revisions to its scarcity pricing mechanism, which affect the real-time markets and incorporates scarcity pricing into the real-time optimization by establishing a 30-minute reserve requirement in real-time when NYISO calls upon demand resources. This change should improve real-time price formation, reduce the potential for uplift payments and increase price transparency."[15]

Figure 13 – Demand Response – Summer 2016 Capability



Resource Outlook

Reliability Assessment

The NYISO's Comprehensive Reliability Planning Process biennially examines emerging reliability needs over a 10-year planning horizon. The findings of the most recent review were detailed in the *2014 Comprehensive Reliability Plan*, which was approved in July 2015. It concluded that sufficient resource additions and interim operating procedures are available to meet reliability needs that had previously been identified in the 2015-2024 study period.[16]

The report also indicated a number of potential risks, including:

- *the operational procedures utilities will rely on before the 2017 completion of their local transmission upgrades include the potential for limited load shedding in Rochester and Syracuse during periods of peak demand;*

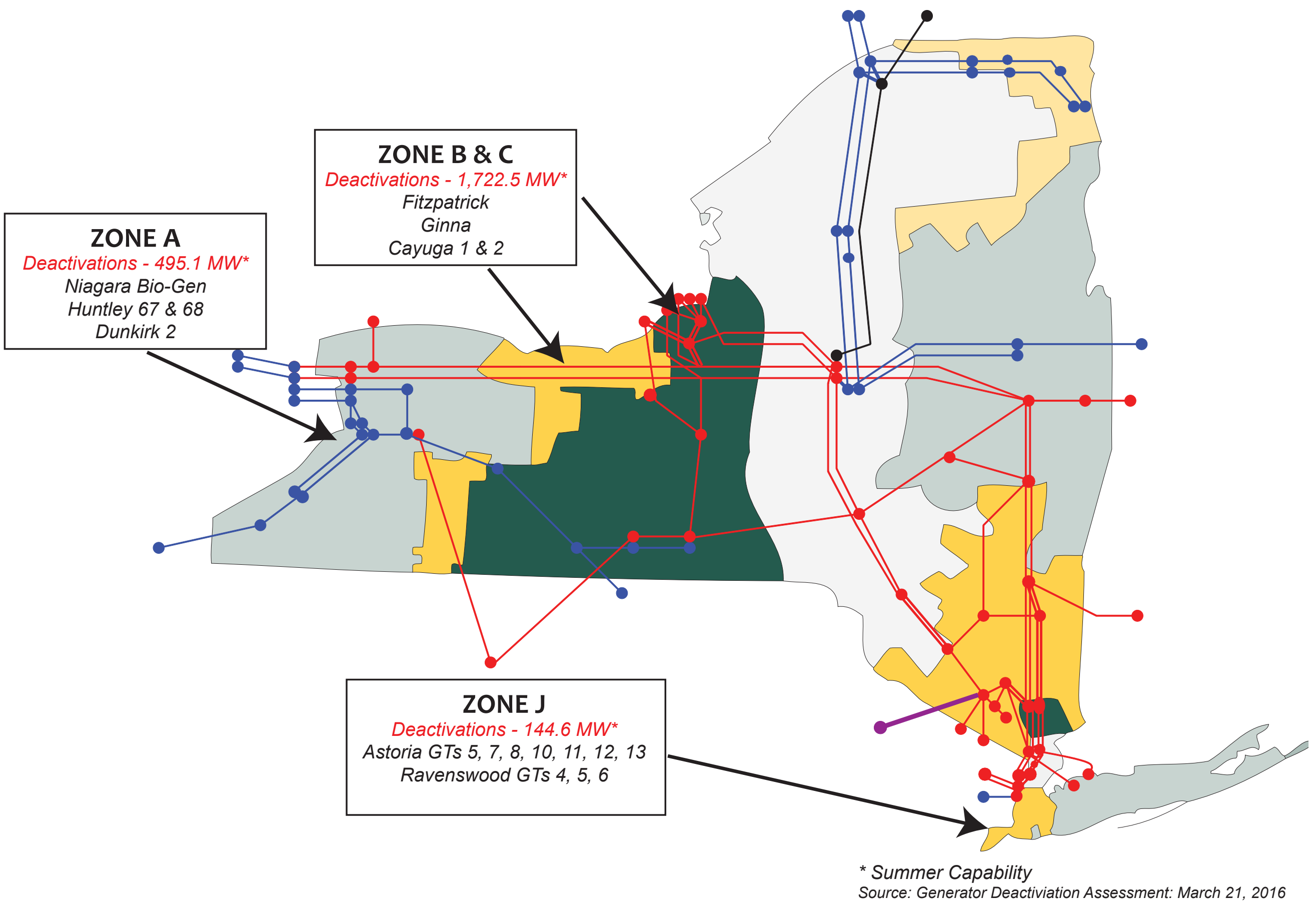
- *aging generation and transmission infrastructure;*
- *the potential for higher system loads than forecasted under the 50-50 probability level;*
- *failure of resources to return to service as planned or unplanned loss of resources due to emerging environmental requirements or other factors; and*
- *the potential retirement of the Ginna Nuclear Power facility near Rochester.*

The NYISO has begun developing the *2016 Reliability Needs Assessment*. Scheduled for completion in the Fall of 2016, it will evaluate the 2016-2026 planning horizon and set the stage for the solicitation of solutions to any indentified reliability needs.

The NYISO continually monitors the implementation of local transmission plans and maintains a close watch on risk factors. The NYISO also conducts a project-specific reliability assessment when an existing generating facility announces deactivation plans.

The most recent deactivation assessment notes capacity resource deactivations totaling more than 2,300 megawatts in summer capability during the 2016-2018 period.

Figure 14 – Capacity Resources – Deactivations: 2016-2018

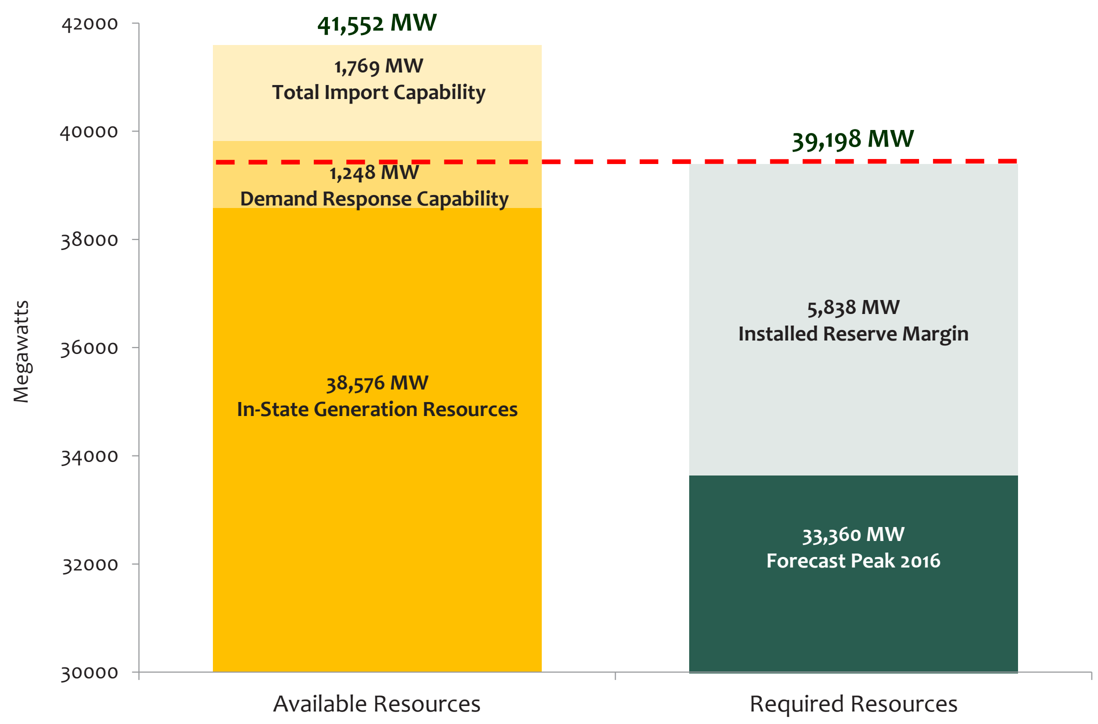


2016 Summer Outlook

For the summer of 2016, power resources available to serve New York State total 41,552 megawatts. These resources include the installed generating capacity of in-state power projects (38,576 megawatts), projected levels of demand response participation (1,248 megawatts of Special Case Resources), and power available for imports from neighboring electric systems (1,769 megawatts of net long-term purchases and sales), minus 41 megawatts of generating capacity retirements expected during the summer of 2016.

While the 2016 total is 58 megawatts below last year's level, available power resources remain well above the projected peak demand of 33,360 megawatts plus the reserve requirement, a combined total of 39,198 megawatts.

Figure 15 - Statewide Resource Availability: Summer 2016



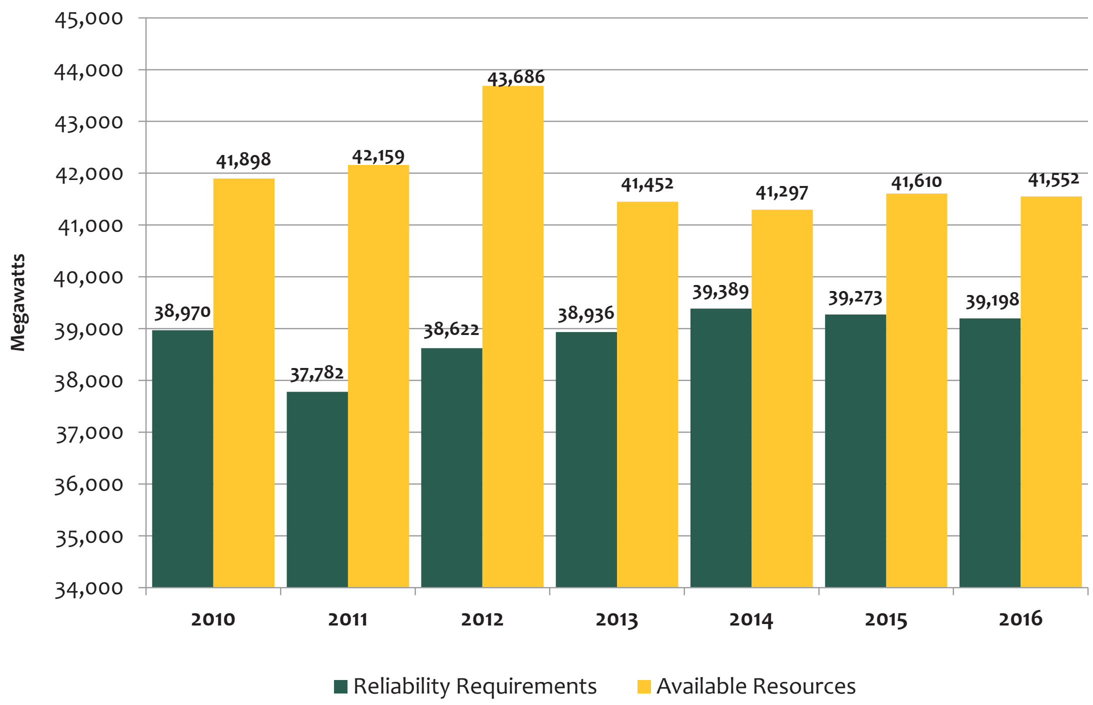
This estimate of total resources measures the maximum potential of resources. However, outages of generating and transmission facilities or lower-than-expected participation in demand response can reduce the availability of resources. Similarly, the forecasted peak represents a baseline estimate. Weather extremes could produce peak demand ranging from 30,250 to nearly 35,700 megawatts in 2016.

Surplus Dynamics

New York's wholesale electricity markets are designed to achieve an economically efficient balance between supply and demand. When surplus generation is abundant, market prices discourage the entrance of new resources. As supplies grow scarcer, markets incent the development of new power resources.

Recent history illustrates the year-over-year changes in surplus resources. In 2012, power resources totaled 43,686 megawatts, more than 5,000 megawatts above 2012 reliability requirements (peak forecast plus installed reserve margin). By 2014, the surplus had declined to 1,900 megawatts. In 2016, the surplus remains comparable to 2015, more than 2,300 megawatts above reliability requirements.

Figure 16 – Power Resources & Reliability Requirements: 2010-2016



Resource Diversity and 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 the 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.

Policy goals and environmental regulations 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.[17]

Fuel Mix in New York State

From a statewide perspective, New York has a relatively diverse mix of generation resources. However, the supply mix is less diverse within the various regions of the state. For example, the combination of stringent air quality regulations, transmission limitations, and reliability standards that require local generation in the downstate region has 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.

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 megawatts.*
- **Energy** *is the amount of electricity a generator produces over a specific period of time. It is measured in megawatt-hours. (A generating unit with a 1 megawatt capacity operating at full capacity for one hour will produce 1 megawatt-hour of electricity.)*
- **Capacity Factor** *measures actual generation as a percentage of potential maximum generation. (A generator with a 1-megawatt capacity operating at full capacity for full year, or 8,760 hours, would produce 8,760 megawatt-hours of electricity and have an annual capacity factor of 100 percent.)*

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.

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.

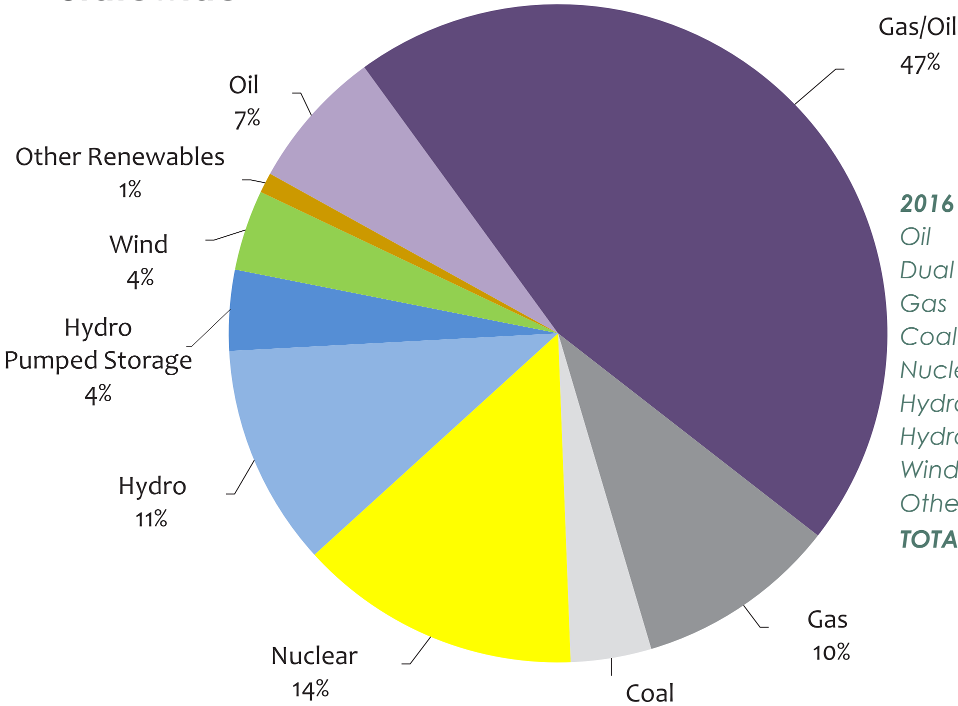
For example, power plants that run on fossil fuels (natural gas, oil and coal) account for 67 percent of New York's generating capacity. However, generation powered by fossil fuels amounted to only 45 percent of the total electric energy produced in New York during 2015.

Nuclear and hydropower generation facilities maximize their output compared to their relative share of capacity. Nuclear, with 14 percent of statewide capacity, produced 31 percent of the total electric energy in New York last year. Hydropower, with 11 percent of statewide capacity, produced 18 percent of New York's electric energy in 2015.

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.

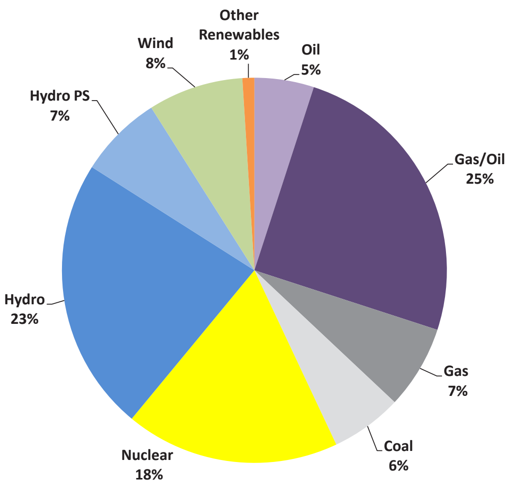
Figure 17 - Generating Capacity in New York State by Fuel Source – Statewide, Upstate New York and Downstate New York: 2016

Statewide



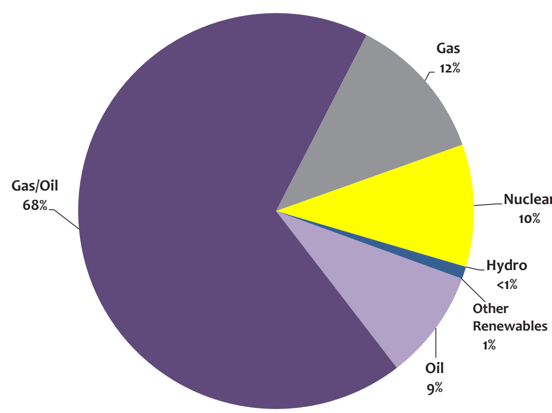
2016 Capacity	MW
Oil	2,578
Dual Fuel (Gas/Oil)	18,211
Gas	3,788
Coal	1,017
Nuclear	5,402
Hydro	4,315
Hydro PS	1,406
Wind	1,446
Other Renewable	413
TOTAL	**38,576**

Upstate (Zones A-F): 2016



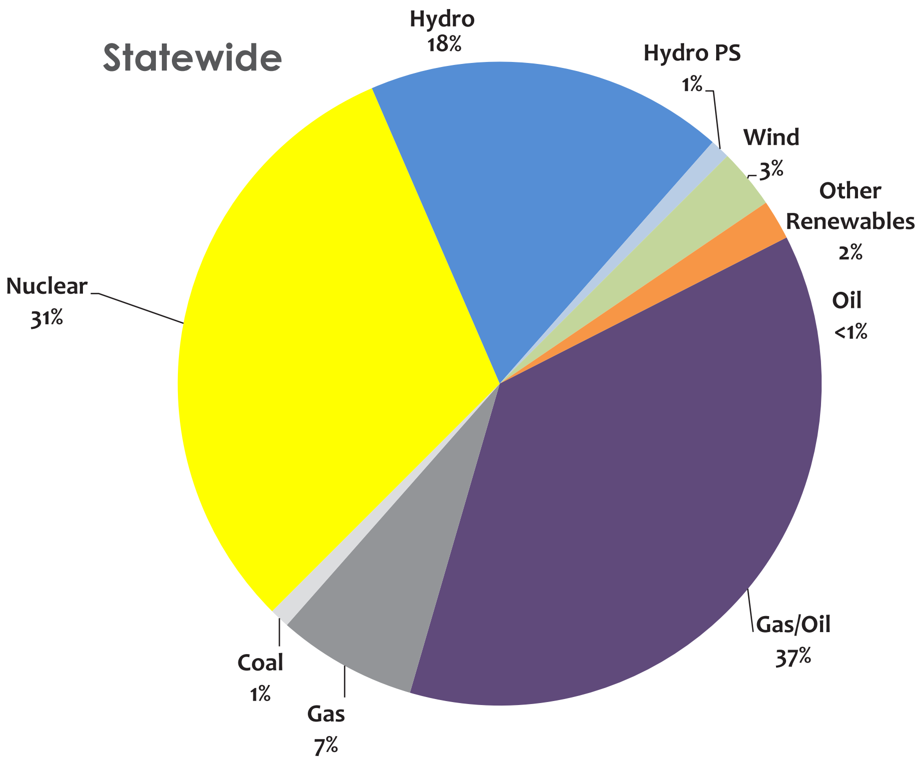
2016 Capacity	MW
Oil	825
Dual Fuel (Gas/Oil)	4,675
Gas	1,371
Coal	1,017
Nuclear	3,350
Hydro	4,237
Hydro PS	1,406
Wind	1,446
Other Renewables	203
TOTAL	**18,531**

Downstate (Zones G-K): 2016



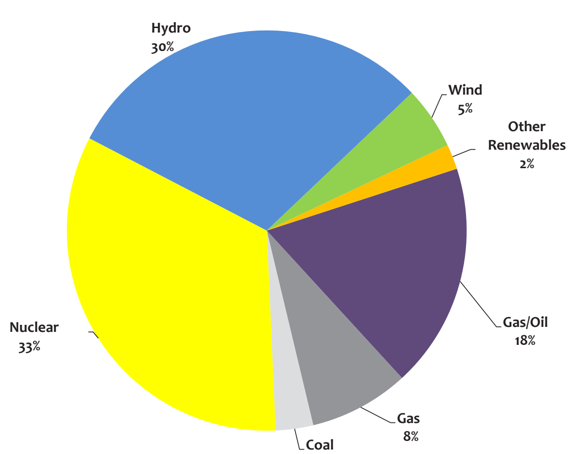
2016 Capacity	MW
Oil	1,752
Dual Fuel (Gas/Oil)	13,536
Gas	2,417
Nuclear	2,052
Hydro	78
Other Renewables	210
TOTAL	**20,044**

Figure 18 – Electric Energy Production in New York State by Fuel Source – Statewide, Upstate New York and Downstate New York: 2015



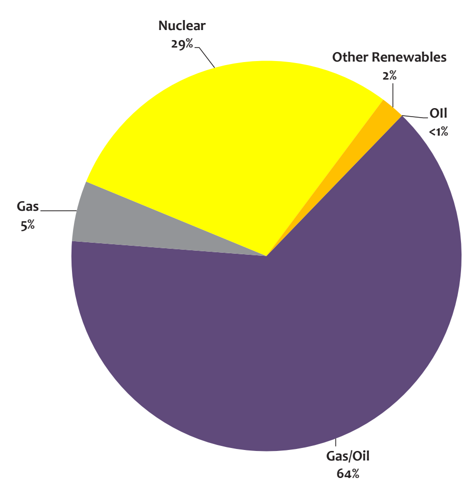
2015 Energy	*GWh*
Oil	*146*
Gas/Oil	*52,028*
Gas	*9,737*
Coal	*2,046*
Nuclear	*44,620*
Hydro	*25,879*
Hydro PS	*825*
Wind	*3,984*
Other Renewables	*3,080*
TOTAL	***142,346***

Upstate (Zones A-F): 2015



2015 Energy	*GWh*
Oil	*35*
Gas/Oil	*15,402*
Gas	*7,010*
Coal	*2,046*
Nuclear	*28,199*
Hydro	*25,699*
Hydro PS	*825*
Wind	*3,984*
Other Renewables	*1,660*
TOTAL	***84,860***

Downstate (Zones G-K): 2015



2015 Energy	*GWh*
Oil	*111*
Gas/Oil	*36,625*
Gas	*2,727*
Nuclear	*16,421*
Hydro	*180*
Other Renewables	*1,420*
TOTAL	***57,486***

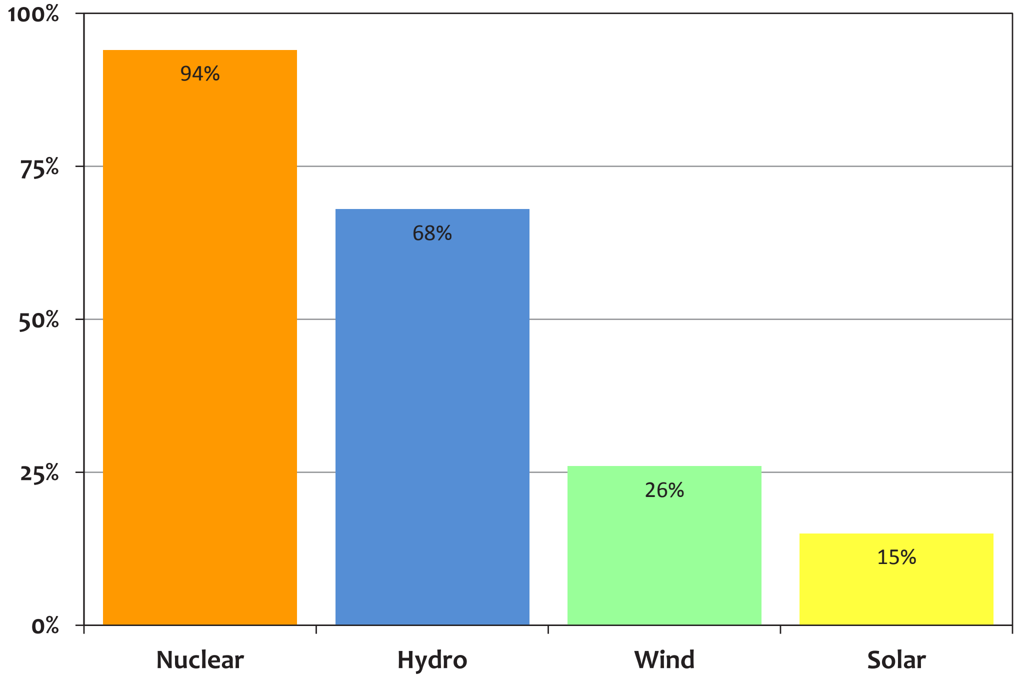
Renewable resources, such as hydro, wind and solar energy, have no fuel costs and are selected in wholesale market auctions to operate more frequently than older fossil units.

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 percent 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.

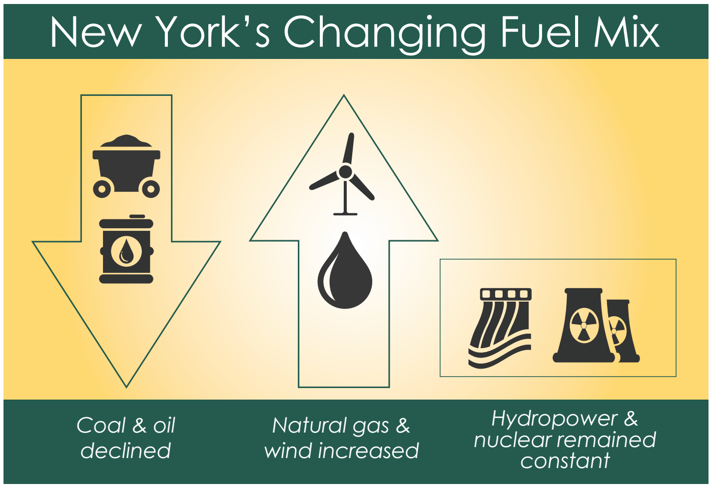
Consider, for example, a sampling of generation being considered for inclusion in New York State's proposed Clean Energy Standard – nuclear, hydro, wind and solar energy. Nuclear had a 94 percent capacity factor and hydropower had a 68 percent capacity factor in 2015. Windpower performed at a 26 percent capacity factor. Distribution-level solar photovoltaics performed at approximately 15 percent.[18]

Figure 19 – Capacity Factor of Generators by Type



The relative capacity factors of different types of generation are important considerations in planning the future fuel mix. For example, based on 2015 operating performance, it would require approximately 3.7 megawatts of wind capacity to produce the same amount of energy as 1.0 megawatt of nuclear capacity.

The combination of fuels used to produce power in New York has changed since 2000.



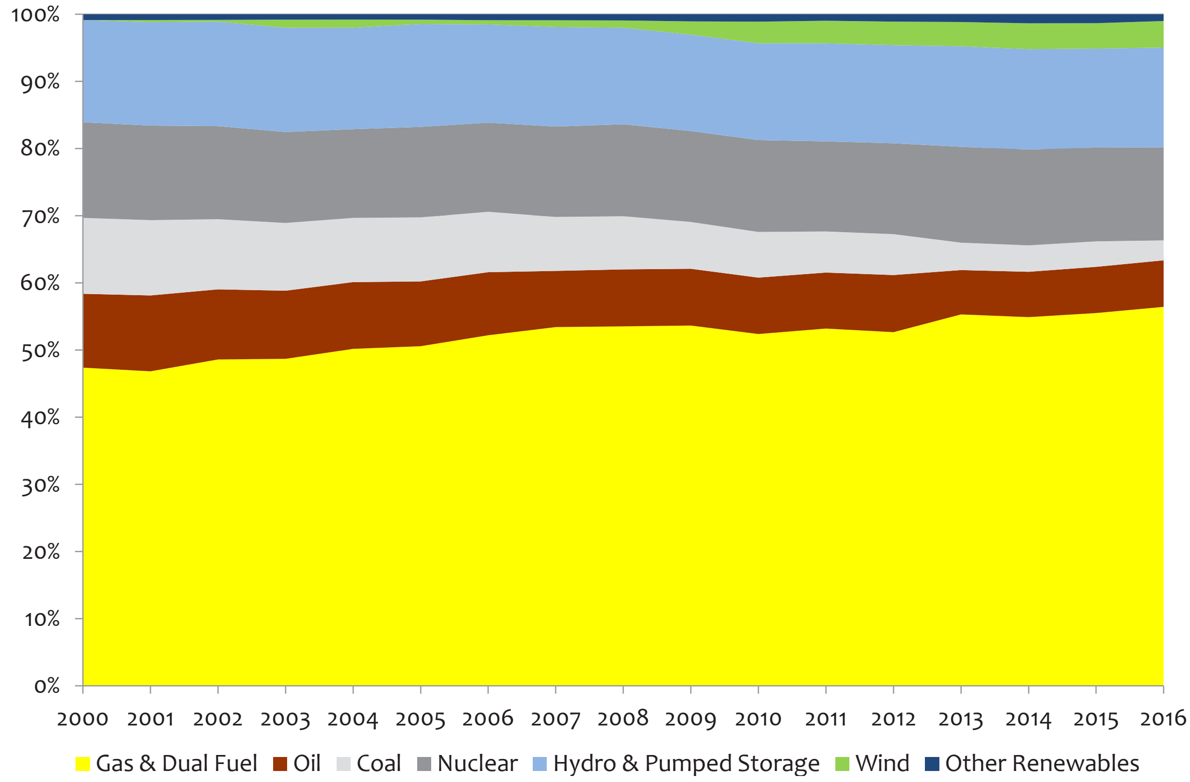
New York's ability to produce power from natural gas and wind has grown, as the generating capability from coal and oil power has declined.

The portion of New York's generating capability from natural gas and dual-fuel facilities grew from 47 percent in 2000 to 57 percent in 2016. Wind power, virtually non-existent in 2000, grew to 4 percent of New York State's generating capability in 2016.

In contrast, New York's generating capability from power plants using coal declined from 11 percent in 2000 to 3 percent in 2016. Generating capability from power plants fueled solely by oil dropped from 11 percent in 2000 to 7 percent in 2016.

The shares of generating capability from nuclear power plants and hydroelectric facilities have remained relatively constant since 2000. Nuclear accounted for 14 percent of New York's generating capability in 2000 and 2016. Hydropower (including pumped storage) represented 15 percent of the state's generating capability in 2000 and 2016.

Figure 20- New York State Fuel Mix Trends: 2000-2016



Electricity Prices & Fuel Costs

Wholesale electricity prices are directly influenced by the cost of the fuels used to produce power. Facilities fueled primarily by natural gas account for more than half of the electric generating capacity in New York State. The cost of fuel for these units is reflected in their offers. Consequently, the price of natural gas and the cost of electricity are closely correlated.

The average wholesale electric energy price in 2015 was $44.09 per megawatt-hour, the lowest in the history of the NYISO. The 2015 yearly average was significantly affected by low natural gas fuel costs.

> **"A strong relationship between energy and natural gas prices is expected in a well-functioning, competitive market because natural gas-fired resources are the marginal source of supply in most intervals."**
>
> *2015 State of the Markets Report for the New York ISO, Potomac Economic, May 2016*

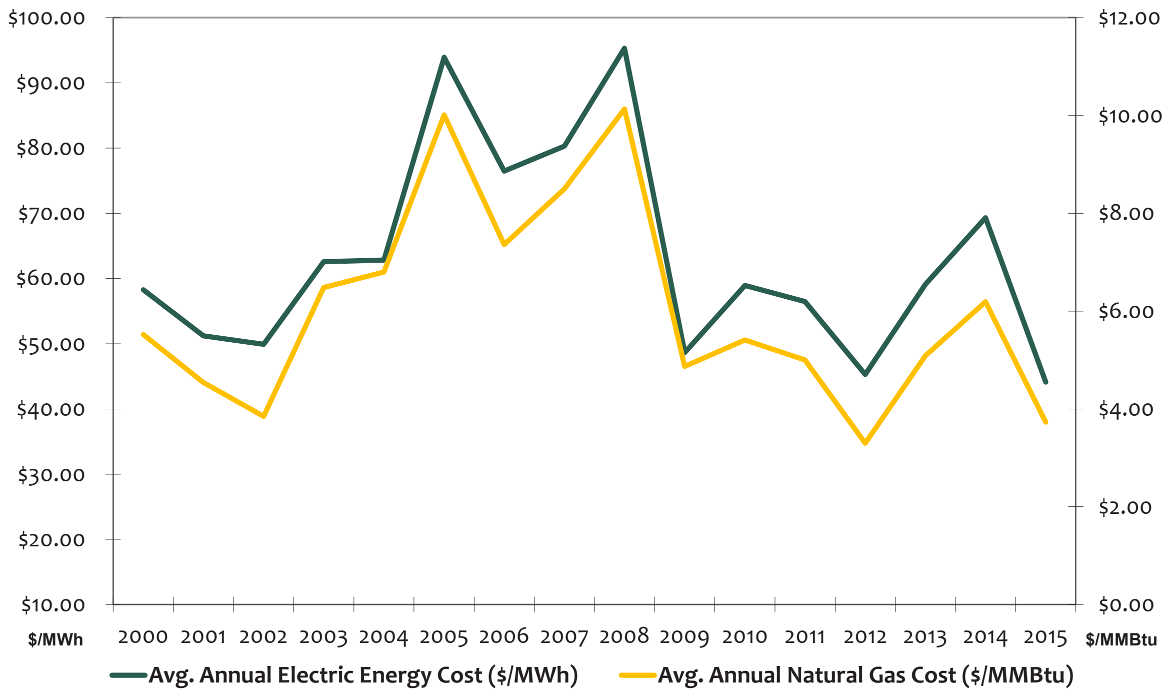
Energy Prices and Demand

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 2015, the average demand in New York rose slightly from 2014, but it was "still noticeably lower than those [average demand levels] from 2010 to 2013," according to the *2015 State of the Markets Report*.[19]

Capacity Prices

In 2015, capacity costs declined with the return to service of various generating units that added more than 1,000 megawatts of capacity in the Lower Hudson Valley and New York City. As a result, wholesale electric capacity prices declined from 2014 levels by 24 percent in Lower Hudson Valley, 19 percent in New York City, 17 percent on Long Island, and 40 percent in the Rest of State.

Figure 21 – Natural Gas Costs and Electric Energy Prices: 2000-2015



Challenges and Opportunities

Transmission as Enabler

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.[20] A 2015 update of that study stated, "Ultimately, our transmission grid is the backbone that supports all future policy changes in the electricity sector."[21]

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

New and upgraded transmission capacity would 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*

Increased transmission capability can further advance the integration of renewable energy resources by enabling wind resources in western and northern New York to serve the more populous southeastern region of the state.

Enhanced upstate/downstate transmission capability would likewise help to more efficiently serve southeastern New York's electricity demands when environmental regulations limit the production of local fossil-fueled generation.

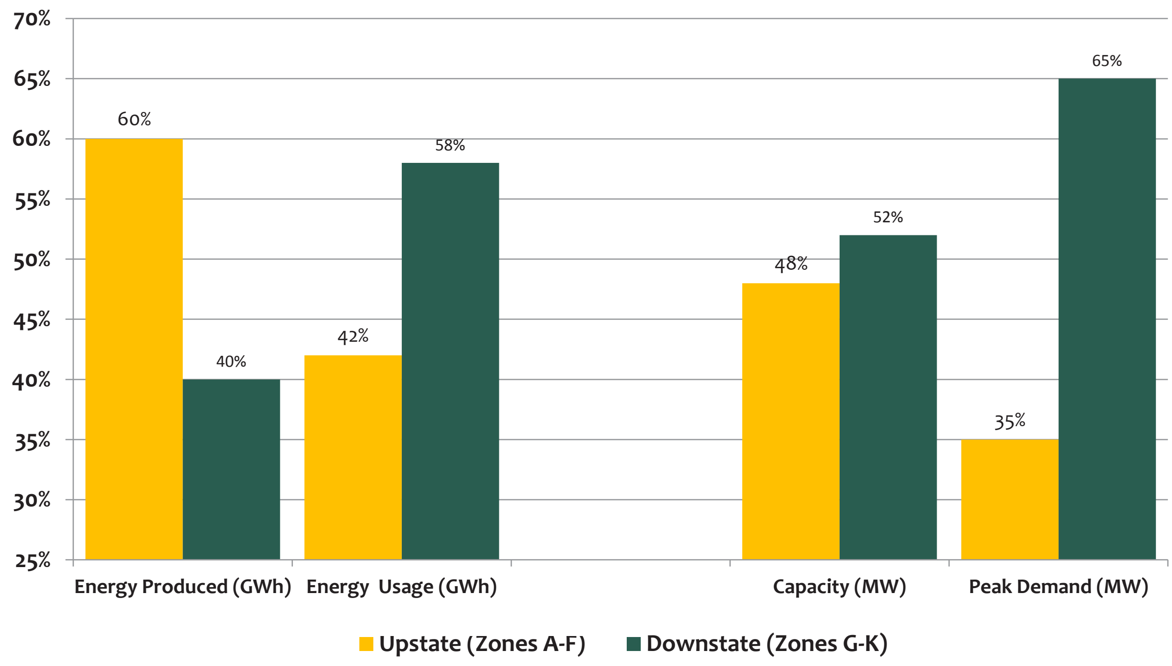
Transmission Congestion

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 (Lower Hudson Valley, New York City, and Long Island – Load Zones G-K) annually uses 58 percent of the state's electric energy. Yet, that region's plants generate only 40 percent of the state's electricity.

With regard to the regional variations in periods of highest demand for electricity, 65 percent of New York's peak power demand occurs downstate. Yet, that region's power plants are capable of supplying only 52 percent of New York's electricity needs during peak periods.

Figure 22- Regional Usage and Production in New York State

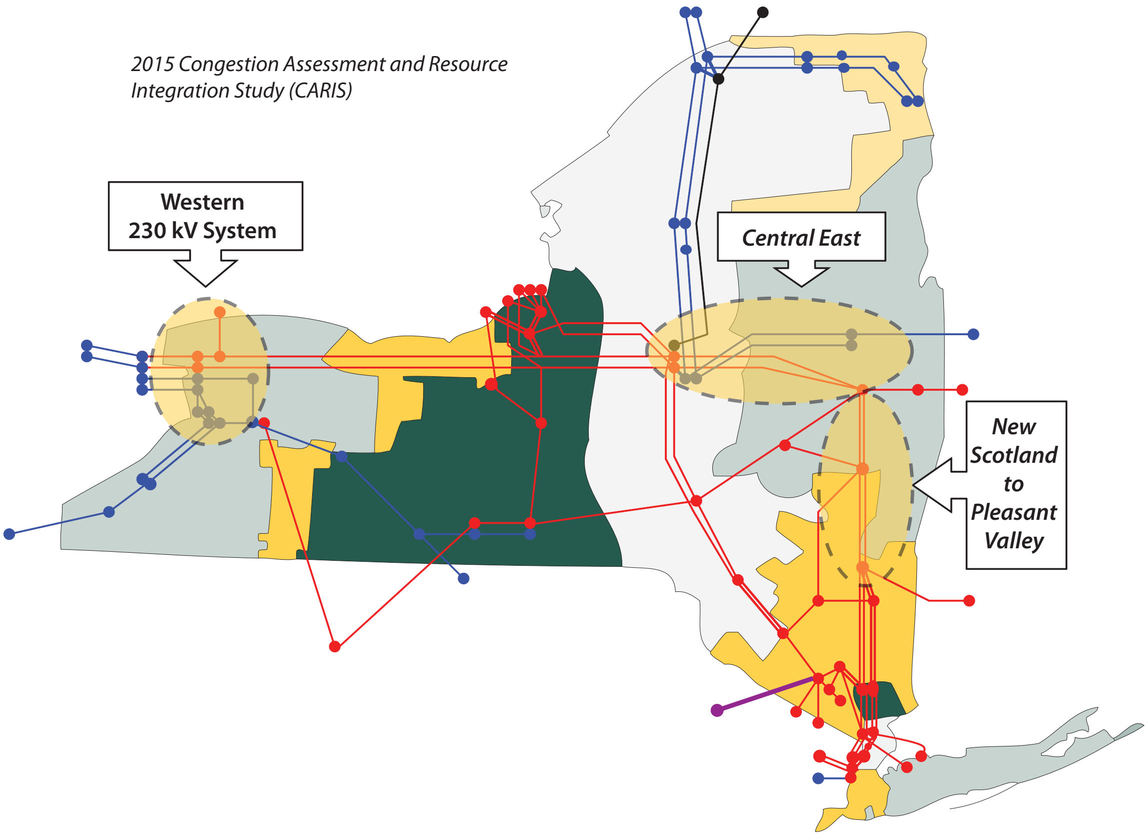


NYISO's markets are designed to use the lowest cost power available to reliably serve demand. However, physical transmission constraints limit the economically-efficient dispatch of electricity and can cause “congestion” on the system. The physical limitations of the transmission system, such as thermal 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, or employing measures to reduce demand for electricity in the congested locales. The NYISO, in consultation with its stakeholders, is working to enhance the CARIS process to better identify and fund economically efficient transmission projects.

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). Those areas include all or parts of the high-voltage transmission path from Oneida County through the Capital Region (Central East) and south to the Lower Hudson Valley (New Scotland – Pleasant Valley), as well as 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.[22]

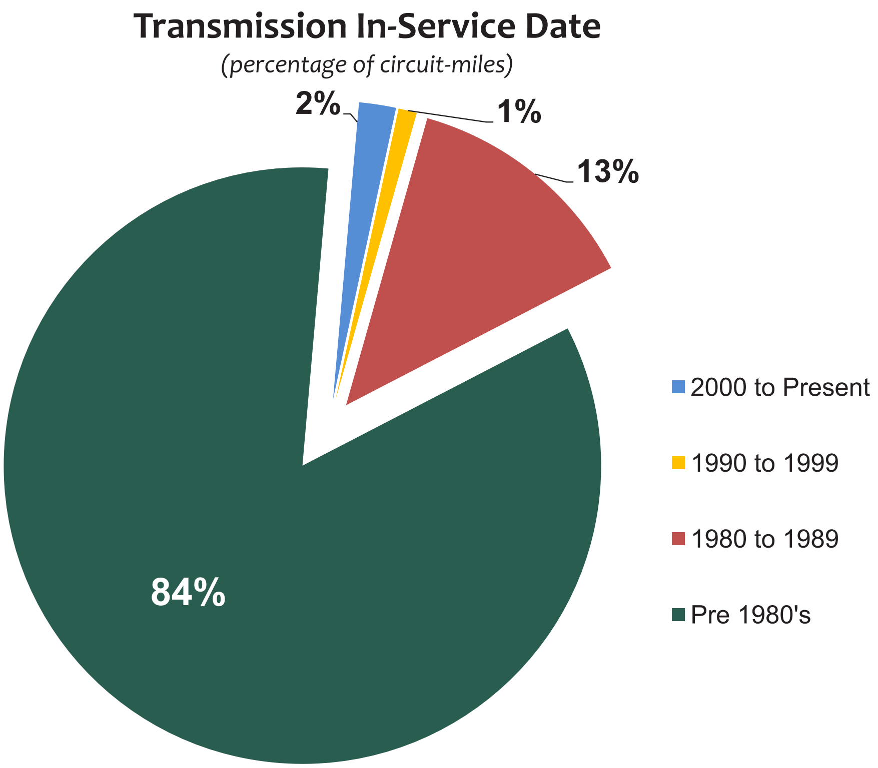
Figure 23 - Transmission Congestion Corridors in New York State



Aging Infrastructure

Over 80 percent 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.[23]

Figure 24- Age of New York Transmission Facilities by Percentage of Circuit Mile



New York State's *Energy Highway Blueprint* was issued in October 2012 by an interagency task force appointed by Governor Cuomo.[24] The *Blueprint* recommended actions and policies for significant investments in New York State's energy infrastructure.

Transmission-related elements of the *Blueprint* highlighted the congested corridors identified by NYISO's CARIS process and the State Transmission Assessment and Reliability Study (STARS), conducted by the owners of the interconnected electricity transmission facilities in New York State. The *Blueprint* recommended "the upgrade of existing lines and the building of new lines following existing rights-of-way" and estimated that cost-effective upgrades along congested corridors could provide 1,000 megawatts of additional transmission capacity between upstate and downstate New York.

Citing findings of the NYISO's 2010 *Growing Wind* study,[25] the *Blueprint* recommended upgrades to transmission serving northern New York to transport wind power produced from that region. Consistent with those recommendations, upgrades to two 230-kilovolt power lines in northern New York (New York Power Authority transmission lines connecting the St. Lawrence-FDR Power Project to a substation in the Town of Chateaugay) were completed in March 2014 to relieve transmission congestion and remove constraints on wind farms in Clinton and Franklin counties.[26]

As part of the Energy Highway initiative, the New York State PSC approved a set of projects collectively named the Transmission Owner Transmission Solutions (TOTS). The projects were placed into service in June 2016. They are expected to increase transfer capability into southeastern New York by 450 megawatts. The transmission projects include:

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

The goals of the Energy Highway Initiative were the focus of New York State PSC proceedings initiated in 2012 to expand AC transmission capacity.[27] To encourage transmission proposals developed 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).

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.

Planning for Public Policy Requirements

Among the components of FERC Order No. 1000 were requirements 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 that drive the need for transmission (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 project 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.[28] 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, and increased operational flexibility and efficiency.

The *2015 State of the Markets Report for the New York ISO* noted issues relating to the transmission constraints in Western New York, stating, "Transmission bottlenecks became increasingly common in the West Zone because of rising imports from Ontario and because reduced operation of coal-fired units in western New York and Pennsylvania have changed the pattern of flows across the network."

The NYISO solicited proposed solutions to the Western New York transmission need. Of the proposed solutions submitted by developers, the NYISO determined that 10 proposals were viable and sufficient.[29] Evaluation and selection of the more efficient and cost-effective solutions will proceed following New York State PSC review of the proposals.

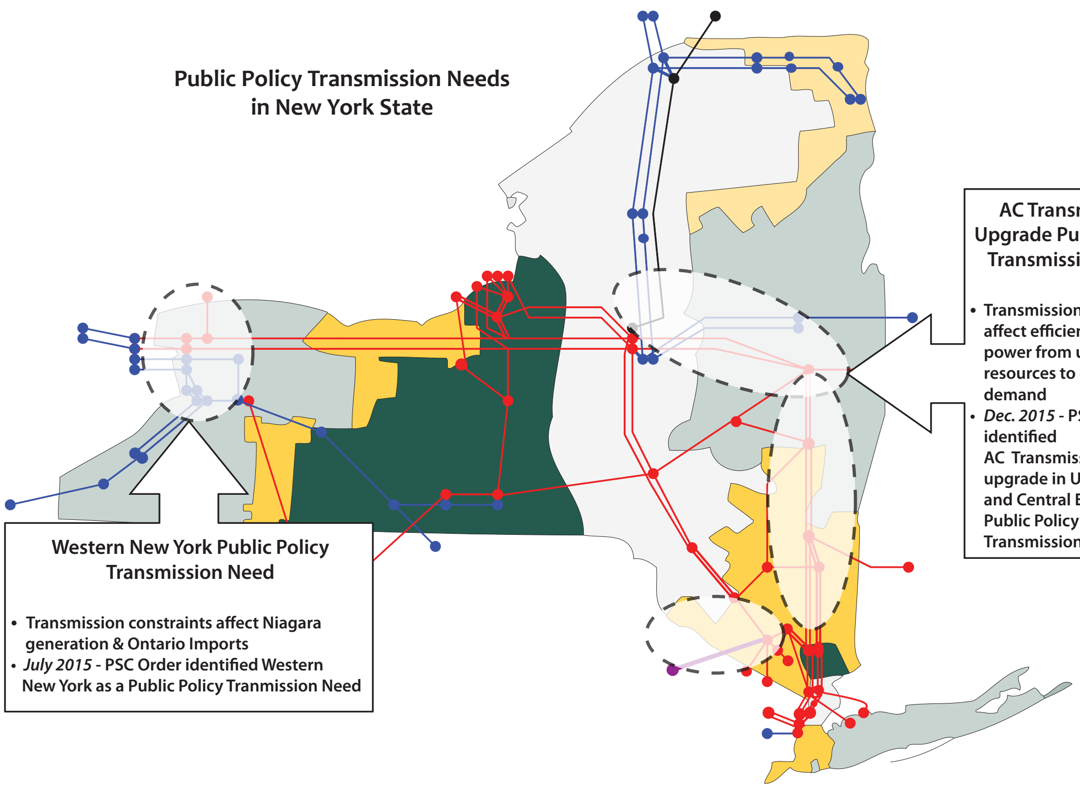
AC Transmission Upgrade Public Policy Need

As previously noted, the New York State PSC, in December 2015, identified a Public Policy Transmission Need to relieve congestion on the UPNY-SENY and Central East interfaces.[30] The Commission action limited the new transmission lines to replacing and upgrading existing lines within existing rights-of-way, and adding new substation facilities at several locations, which is intended to reduce or eliminate adverse environmental, landowner, and economic impacts.

The transmission improvements are proposed for 156 miles of high-voltage lines along the backbone of the State's electric transmission system running west to east and north to south. The transmission upgrade will have two primary segments. The first segment runs approximately 91 miles starting in Oneida County, through Herkimer, Montgomery and Schenectady counties, and ending in Albany County. The second segment runs 51 miles starting in Rensselaer County, through Columbia County and ending in Dutchess County. A related upgraded line runs 11 miles in Orange County. Any successful developer will need to obtain final siting permits from the PSC.

In April 2016, developers submitted 15 transmission projects and one non-transmission project in response to NYISO's solicitation of proposed solutions. The NYISO is currently assessing their viability and sufficiency to meet the transmission need.

Figure 25 – Public Policy Transmission Needs in New York State



Merchant Transmission Proposals

In addition to the transmission projects noted above, merchant plans for transmission have also emerged.

The Champlain-Hudson Power Express has been proposed by Transmission Developers Inc. This 300-plus mile, high-voltage direct current (HVDC) transmission project is designed to deliver up to 1,000 megawatts from Québec to New York City. The project has secured a New York State Article VII siting certificate from the PSC and the federal permit needed for international lines from the U.S. Department of Energy. The developer has also proposed a shorter, 145-mile alternative that would connect New York's Capital Region to New York City. Both alternatives have been submitted to the NYISO for interconnection studies.[31]

In April 2016, another 1,000-megawatt HVDC project, the Empire State Connector, was announced by transmission developer OneGRID. This 260-mile project would run between Utica and New York City. The developer has submitted a request for interconnection study to the NYISO and requested negotiated rate authority from FERC. Other permits applications are pending.[32]

Transmission Enabling Clean Energy

Transmission infrastructure enhancements along existing rights-of-way would enable the increased use of renewable resources envisioned by state and federal policy goals. Regions rich in renewables tend to be remote from the population centers that have high demand for electricity.

All of New York's existing wind power resources *(1,754 megawatts)* and all of the currently proposed wind projects *(3,700+ megawatts)* are located in predominantly rural areas of Northern and Western New York – hundreds of miles from metropolitan New York City and its suburbs on Long Island and in the Lower Hudson Valley.

New York's in-state hydropower resources are also situated on the western and northern borders – and significant Canadian hydropower resources lie beyond those borders in Quebec and Ontario.

Increasing the capability of the West-to-East and North-to-South transmission will greatly enhance the grid's ability to deliver renewable power throughout New York corridors and help to address the state's clean energy goals.

Interregional Planning

FERC Order No. 1000 requires that all transmission providers have a regional transmission planning process in place to meet reliability, economic, and public policy planning standards. As part of their regulatory requirements, ISOs, RTOs and other transmission providers conduct interregional planning.

In collaboration with its New England (ISO-NE) and Mid-Atlantic (PJM Interconnection) neighbors, the NYISO expanded the 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.[33]

No new needs for interregional transmission projects were identified by the plan, which summarized the regional ISO/RTOs planning efforts in 2014 and 2015. It noted that a new 345/115 kV interconnection between PJM and NYISO went into service in November 2015 and another is scheduled to go into service in June 2016.

The NYISO is also engaging in collaborative efforts 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 Eastern Interconnection Planning Collaborative (EIPC), which now involves 19 electric system planning authorities, was created in 2009 as the first organization to conduct interconnection-wide planning analysis across the eastern portion of North America.[34]

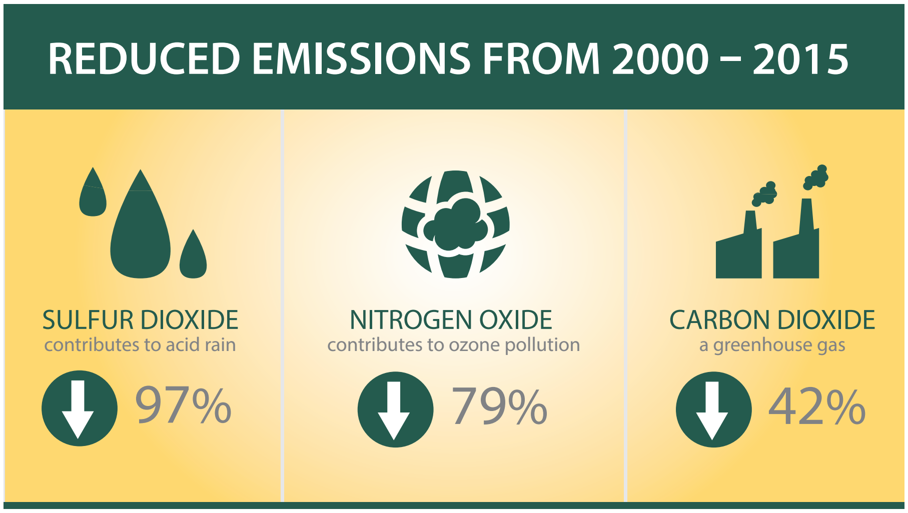
Among its efforts, the EIPC conducted studies assessing a range of possible "energy futures", which found the reliability plans of electric system planners in the Eastern Interconnection integrated well to meet potential reliability needs.

In addition, the EIPC conducted the Gas-Electric System Interface Study, reviewing the region's natural gas delivery infrastructure and its ability to support the growing use of natural gas for electric power production. Across the study region of six participating planning authorities (NYISO, PJM, ISO-New England, the Midcontinent ISO, the Tennessee Valley Authority and Ontario's Independent Electric System Operator), nearly 40 percent of installed generating capacity is fueled by natural gas or dual-fueled. (See *The Impacts of Natural Gas and the Future of Nuclear Power* section for more discussion.)

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 found additional transfer capability ranging from 336 megawatts to over 5,000 megawatts.

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



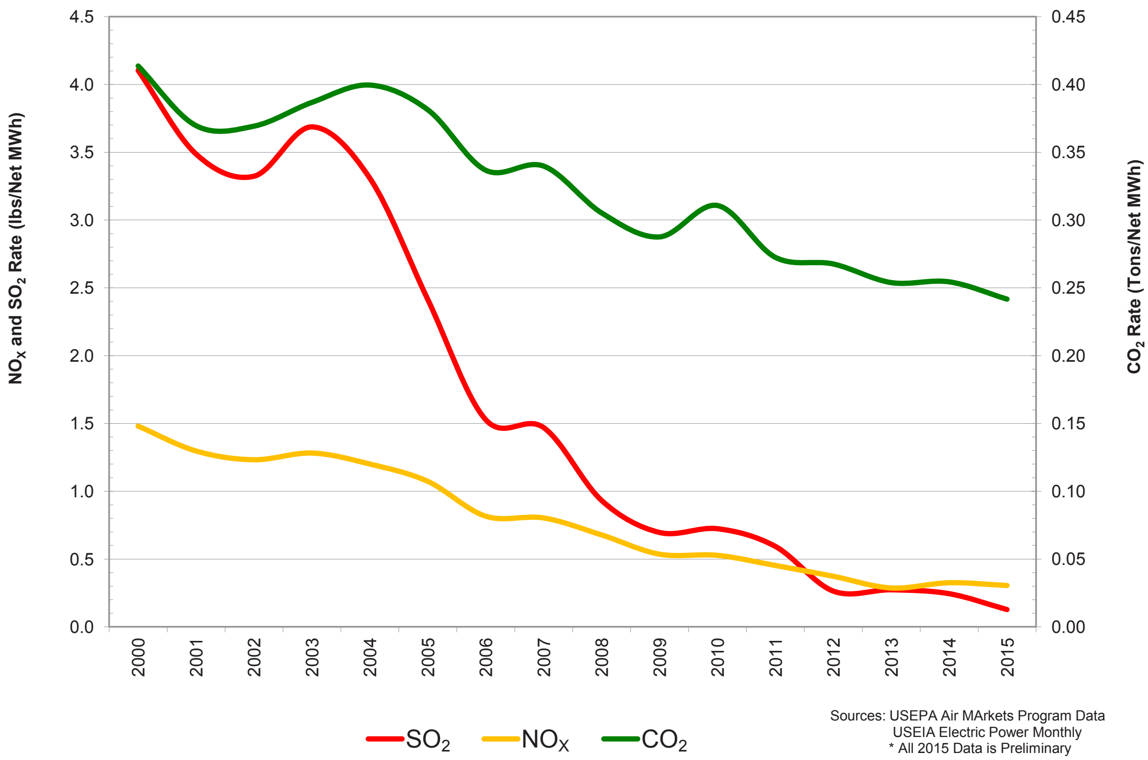
appropriate market-based provisions, electricity restructuring legislation could reduce carbon emissions by creating incentives to produce and use electricity more efficiently and with less pollution."[35]

Since their inception, wholesale electricity markets have worked in concert with energy and environmental policies to foster more efficient generation, expand renewable resources, and develop 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 have significantly improved since 2000. From 2000 through 2015, sulfur dioxide (SO_2) emissions rates dropped 97 percent. The emission rates for nitrogen oxides (NOx) and carbon dioxide (CO_2) declined by 79 percent and 42 percent, respectively, during that period.

Figure 26 - New York Emission Rates from Electric Generation: 2000-2015



New York is part of the Regional Greenhouse Gas Initiative (RGGI), which is founded upon an agreement among nine eastern states to restrict carbon emissions from power plants. In 2014, the RGGI states agreed to set the cap at 91 million tons of emissions, declining by 2.5 percent per year through 2020. In addition to sustaining the CO_2 reductions that have already occurred, the cap is expected to yield an estimated 80-90 million tons of cumulative emission reductions by 2020.

Federal Clean Power Plan

In 2014, the U.S. Environmental Protection Administration (EPA) proposed the Clean Power Plan, a rule intended to limit CO2 emissions from existing power plants by 30 percent from 2005 levels. In comments on the proposal, the NYISO, other Independent System Operators and Regional Transmission Organizations (ISO/RTOs), New York market participants, and New York State agencies raised concerns about potential implications for electric system reliability and the lack of recognition of the progress New York has already made in achieving significant reductions in CO_2 emissions.[36]

When the EPA issued the final rule on its Clean Power Plan in August 2015, it addressed a number of the issues raised by the NYISO and others. The final rule reflected the significant progress New York has achieved in reducing emissions and contained provisions to address potential electric system reliability concerns. The combination of lower CO2 reduction targets for 2022 and 2030, and the inclusion of a reliability review and safety valve mean that New York should be able to meet the plan's obligations while maintaining a reliable electric system.

The reliability safety valve included in the final rule is patterned after a design recommended by the NYISO and other ISO/RTOs. It will allow a state to propose a modified emission standard for an affected generator for a temporary period of time to address an unforeseen emergency situation that threatens reliability. Further, EPA is requiring states to demonstrate that they have considered reliability when developing State Implementation Plans. The EPA responded positively to the recommendation that states seek an assessment and recommendation from ISO/RTOs on their implementation plans and include the response when filing their plans.

The EPA continued its recognition of RGGI as a potential compliance tool. The use of RGGI or a similar allowance trading mechanism would implement the carbon dioxide reductions in a manner consistent with competitive wholesale electricity markets.

In collaboration with the New York State Department of Environmental Conservation, the NYISO is preparing 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.

Subsequent to the publication of the final rule, legal challenges were initiated to request judicial review and suspend the plan's implementation pending such review. When the matter reached the U.S. Supreme Court, it ruled in February 2016 to stay the implementation of the plan pending review in the D.C. Circuit Court of Appeals.[37]

Cumulative Impact of Environmental Regulations

In addition to the Clean Power Plan, a diverse set of environment regulations -- already in effect or scheduled in the near future -- affects power generation. These regulations include control technology requirements for nitrogen oxides (NOx), mercury from coal plant emissions, interstate transportation of air emissions, and other emerging environmental standards. The regulations may affect 28,800-32,400 megawatts of generation -- 75-85 percent of New York's generating capacity.

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

Program	Description	Goal	Status	Estimated Capacity Affected (Megawatts)
NOx RACT Reasonably Available Control Technology for Oxides of Nitrogen	Limits emissions of nitrogen oxides (NOx) from fossil-fueled power plants by establishing presumptive limits for each type of fossil fueled generator and fuel used.	To reduce emissions from the affected generators by 50%	In effect Compliance Period began July 2014	27,100
BART Best Available Retrofit Technology	Requires an analysis to determine the impact of certain affected unit's emissions. If the impacts are greater than a prescribed minimum, then emission reductions must be made at the affected unit.	To limit emissions that may impact visibility in national parks. Emissions control of sulfur dioxide (SO_2), nitrogen oxides (NOx) and particulate matter (PM) may be necessary.	In effect Compliance Period began January 2014	8,400
MATS Mercury and Air Toxics Standard	Establishes limits for Hazardous Air Pollutants (HAP). Will apply to coal and oil-fired generators.	To limit emissions, under the federal Clean Air Act, of certain substances classified as hazardous air pollutants.	In effect Compliance Deadlines - April 2015/2016/2017	10,300
BTA Best Technology Available for Cooling Water Intake Structures	Would apply to power plants with design intake capacity greater than 20 million gallons/day and prescribes reductions in fish mortality.	To establish performance goals for new and existing cooling water intake structures, and the use of wet, closed-cycle cooling systems.	In effect Compliance deadline – Upon Permit Renewal	10,500-18,200
CSAPR Cross State Air Pollution Rule	Limits emissions of SO_2 and NOx from power plants greater than 25 megawatts in 28 Eastern States through the use of emission allowances with limited trading.	Attain and maintain air quality consistent with Nation Ambient Air Quality Standards.	In effect Compliance Deadlines January 2015 & 2017	23,100
NYC #6 Fuel Elimination	NYC program to eliminate the use of #6 residual fuel oil in electric generating units.	Generators will need to switch to #2 or #4 fuel oil when oil burning is required to comply with NYSRC Loss of Gas rules.	2020	3,100
RGGI Regional Greenhouse Gas Initiative	Multi-state compact to limit CO_2 emissions by power plants.	RGGI cap established in 2014 - 91 million tons of CO_2, declining 2.5% annually from 2015-2020.	In effect	23,200

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 any resource 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, imports from other regions, and 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 7,000 megawatts of older, and generally higher emitting, generation has retired or ceased operation.

Windpower

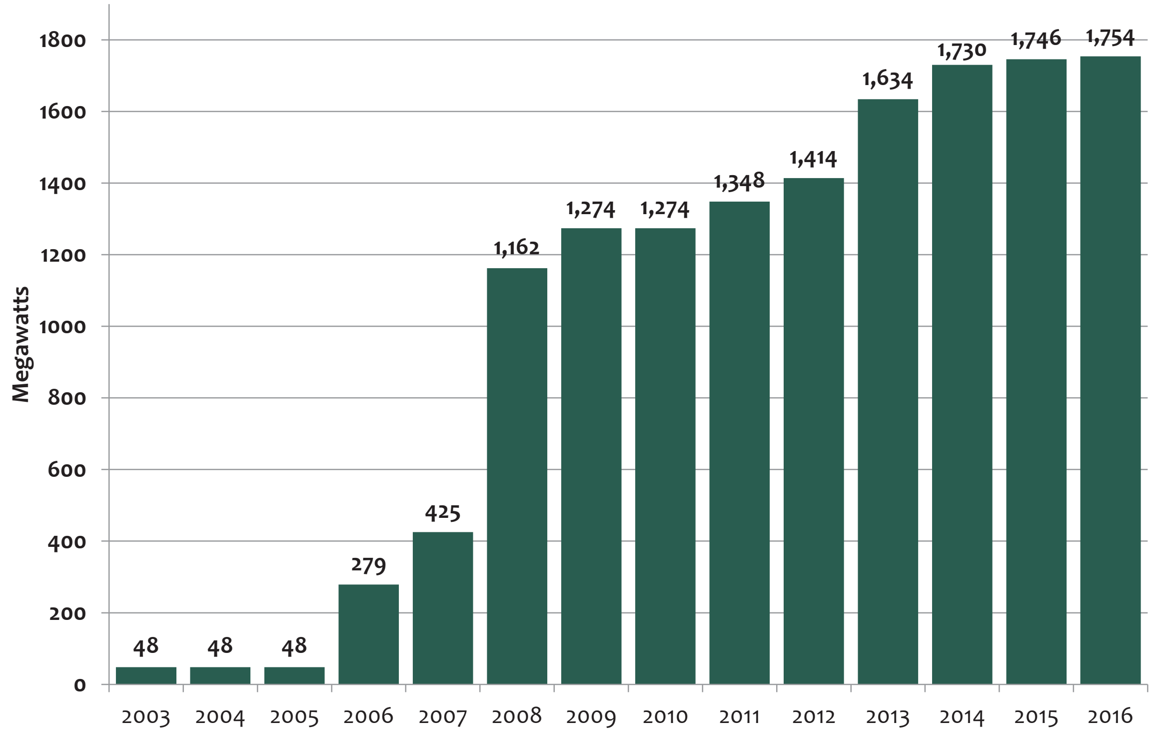
Over the past decade, the design of New York's wholesale electricity markets has been revised to address the unique characteristic of wind power by:

- *Recognizing wind in 2006 as a "variable energy resource" and revising market rules to exempt it from undergeneration 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.*

These and other market initiatives have contributed to the reliable integration and growth of New York's wind power resources. The generating capacity of wind-powered projects in New York grew from 48 megawatts in 2005 to 1,754 megawatts in 2016. Electricity generated by wind power increased from 101 gigawatt-hours in 2005 to 3,984 gigawatt-hours in 2015.

Projects capable of supplying another 3,700 megawatts of wind power currently are proposed for future interconnection with the New York bulk electricity grid. 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 windpower development, creating the potential for windpower resources in the downstate region.[38]

Figure 28 - Wind Generation in New York: Installed Capacity - 2003-2016



NOTE: Data represents nameplate capacity.

Figure 29 - Wind Generation in New York State: Energy Produced – 2003-2015

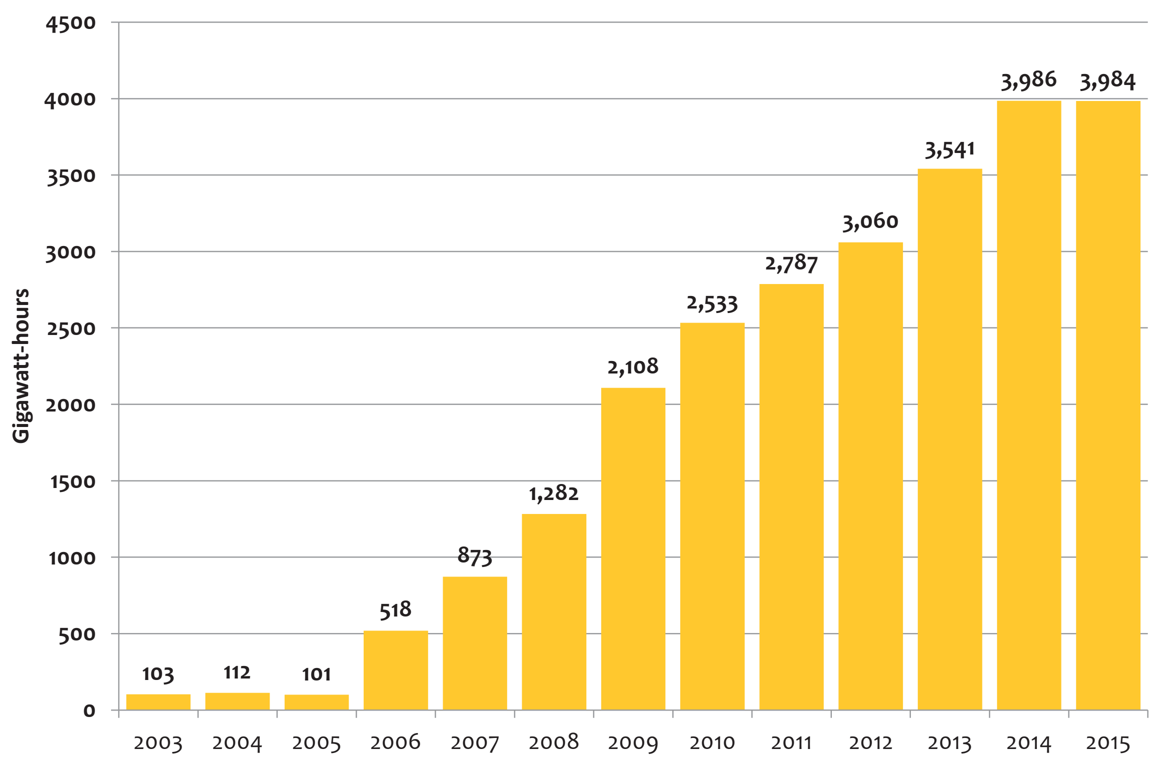
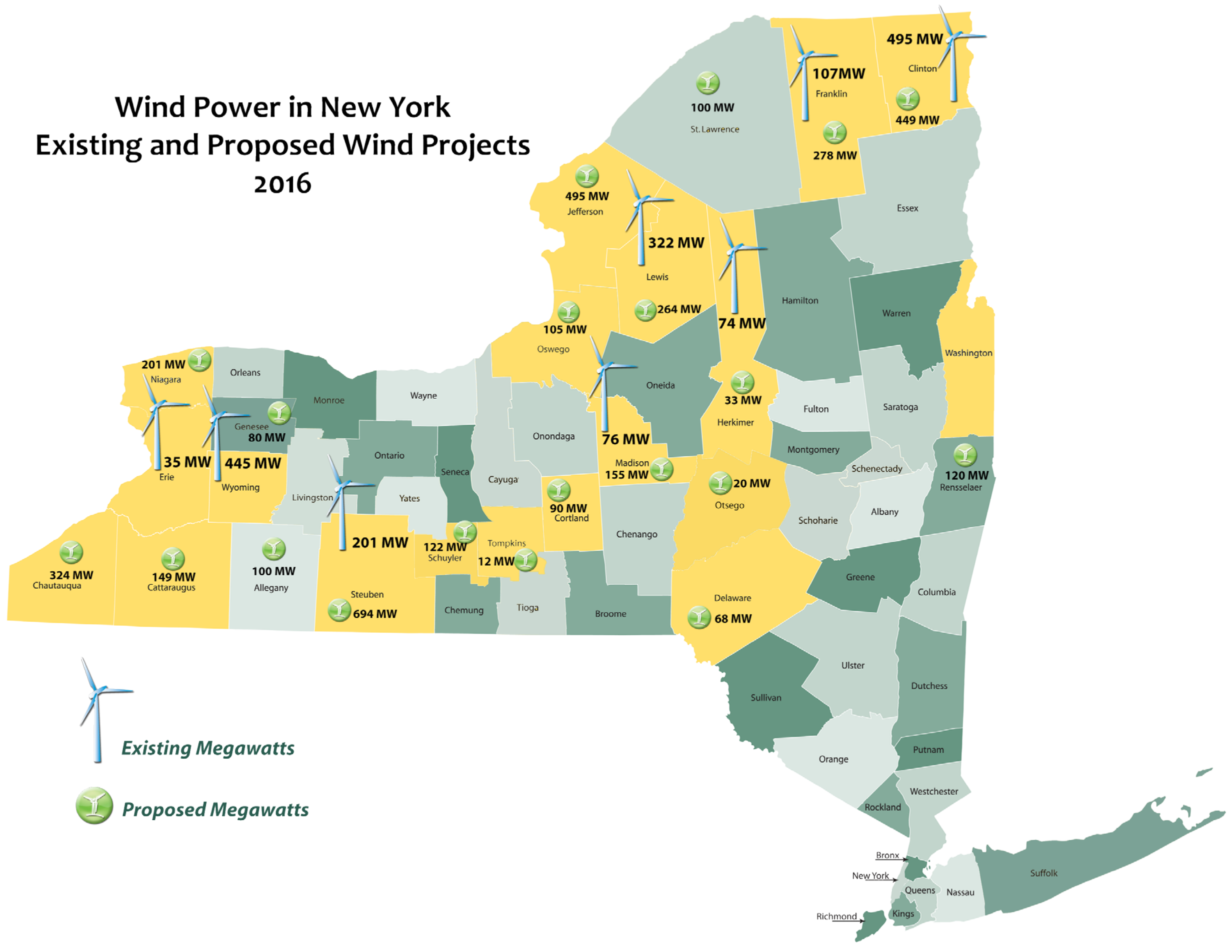


Figure 30 - Wind Power in New York: Map of Existing and Proposed Wind Projects – 2016



Energy Storage

The variable nature of the power output from renewable resources has highlighted the value of energy storage. In addition to supporting system reliability by balancing variable resources such as wind and solar, energy storage offers the potential to reinforce grid resilience during extreme weather events, reduce transmission and distribution costs by providing alternate means to address system needs, and shift demand away from higher-cost peak demand periods.

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. Storage systems, such as flywheels and advanced batteries, can inject power in microseconds when needed.

In addition to the development of the Limited Energy Storage Resource category, NYISO markets have several resource classifications that can accommodate participation of storage in the wholesale markets, including Energy Limited Resource, Demand Side Ancillary Services and Special Case Resource.

In March 2016, the NYISO launched an Energy Storage Market Integration and Optimization 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.

Solar Power

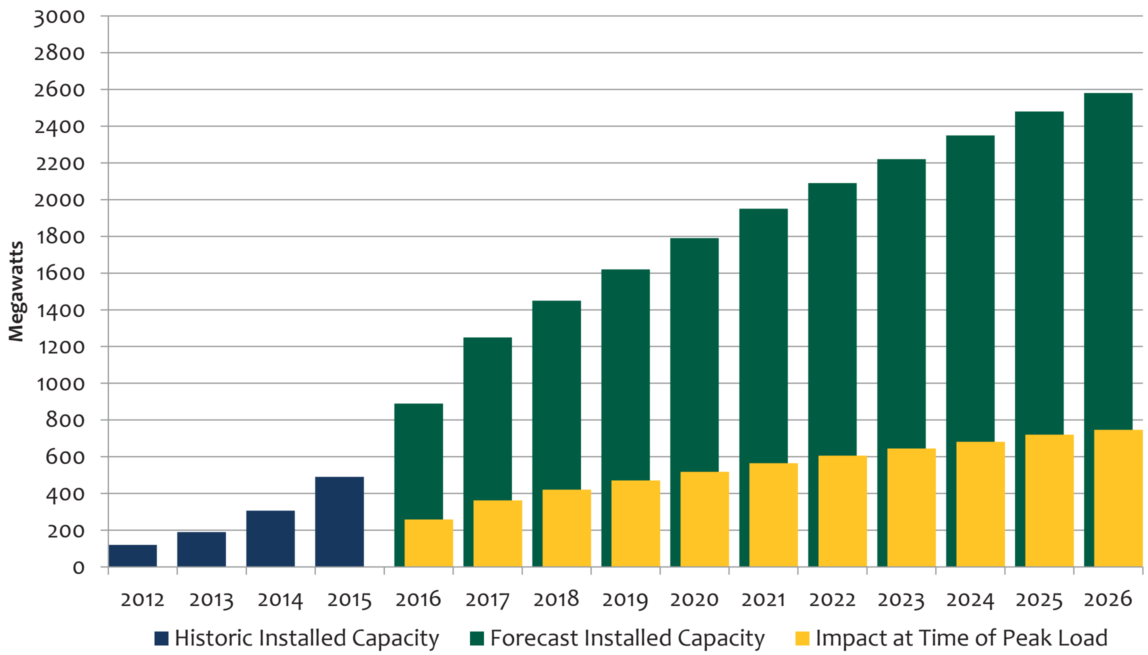
Much of the power produced by solar photovoltaics is generated either off-grid or at the distribution level of interconnection. According to a May 2016 report from NREL and Sandia National Laboratories, solar photovoltaics at the distribution level represented 61 percent of the nation's total photovoltaic capacity.[39] (See discussion of *Integrating Distributed Resources.*)

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 in New York. The Long Island Solar Farm, a 32-megawatt facility located at the Brookhaven National Laboratory, is the largest solar photovoltaic power plant in the Eastern United States. Another 233 megawatts of generating capacity from grid-scale solar photovoltaic projects are currently proposed for interconnection with the New York bulk electric system.

In June 2016, the NYISO completed a study, *Solar Impact on Grid Operations: An Initial Assessment*, which lays the groundwork for reliably managing projected growth in solar resources. Among its recommendations is development of forecasting tools to facilitate the reliable integration of solar resources.[40]

As distributed solar photovoltaic resources proliferate, their impact on peak demand and annual energy usage in New York is expected to triple by 2026. (See discussion of *Demand Trends*.)

Figure 31 - Distributed Solar Photovoltaics in New York: Historic & Forecast



NOTE: Data represent "behind the meter" solar photovoltaic only.

Clean Energy Policy

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.[41]

Expanding the supply of electricity from renewable resources and enhancing energy efficiency are among the longstanding goals of New York State's energy policy.

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 to 25 percent. In 2009, the PSC increased the target to 30 percent of forecasted electricity consumption by 2015.

In 2015, 32,943 gigawatt-hours of New York's electricity was produced by renewable resources (hydropower, wind, solar and other) representing approximately 23 percent of New York's electric generation. New York's large base of hydropower resources generated 25,879 gigawatt-hours of electric energy, representing 79 percent of the renewable power produced in New York in 2015. New York's wind power resources generated 3,984 gigawatt-hours, approximately 12 percent of the renewable power produced in the state in 2015.

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 gigawatt-hours by 2015. This equated to reducing statewide electricity consumption to a level of 152,352 GWh in 2015, a reduction of 15 percent from the forecast for 2015 of 179,238 GWh. Electricity usage in New York totaled 161,572 gigawatt-hours in 2015, a reduction of 10 percent from the EEPS forecast for 2015, but falling short of the EEPS goal.

With the expiration of the RPS in 2015, the Cuomo Administration advanced a series of renewable energy and energy efficiency measures consistent with goals outlined by the 2015 State Energy Plan.[42] The goals to be achieved by 2030 include:

- *40 percent reduction in greenhouse gas emissions from 1990 levels,*
- *50 percent of energy generation from renewable energy sources (the "50 X 30" goal), and*
- *23 percent decrease in energy consumption in buildings from 2012 levels.*

The New York State PSC began a proceeding in 2014 to develop a Clean Energy Fund as a part of a "strategy to bridge the transition from the current portfolio of clean energy programs to the new Reforming the Energy Vision (REV) market and required regulatory framework." 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.[43]

As previously noted, New York is part of the Regional Greenhouse Gas Initiative (RGGI). The initiative, which took effect in 2009, uses 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 percent per year through 2020. The cap is expected to yield an estimated 80-90 million tons of cumulative emission reductions by 2020.[44]

"The RGGI program is yet another example of a market-based emissions program that has accomplished emissions reductions cost-effectively and in a manner that allows for seamless implementation in centralized wholesale power markets," according to a May 2015 report by The Analysis Group.[45]

Clean Energy Standard

To convert the State Energy Plan goals into mandated requirements, Governor Cuomo directed the PSC to develop a Clean Energy Standard (CES). In January 2016, the PSC expanded the scope of an ongoing large-scale renewables proceeding to encompass the CES. The Department of Public Service *Staff White Paper on Clean Energy Standard* subsequently detailed the components of the proposal.[46]

The white paper identifies four principal policy objectives of the CES, which include an increase in renewable generation to achieve the 50 by 30 goal; support of construction and continued operation of renewable generation in New York; protection of upstate nuclear facilities from premature closure; and promotion of the market objectives of REV.

Under the proposed CES, electric utilities and others serving load in New York State would be responsible for supplying a defined percentage of that load from eligible renewable and nuclear resources. The load serving entities would comply with the CES by either procuring qualifying credits or making alternative payments. The credits would include:

- *Renewable Energy Credits (RECs).* Generators of renewable energy would earn one REC for each CES-eligible MWh of renewable energy generated. Generators would sell or trade RECs.
- *Zero Emission Credits (ZECs).* In addition to the renewable energy mandate, the CES would require load serving entities to obtain a certain amount of ZECs from upstate nuclear power projects.

> **"Through competitive markets and State energy policy, New York has established itself as a national leader with respect to clean energy production and reduced carbon emissions."**
>
> *NYISO Comments on Clean Energy Standard White Paper, April 2016*

In order to achieve the 50 by 30 goal, the Department of Public Service staff determined that generating 75,000 gigawatt-hours of total renewable energy by 2030 will require increasing energy from renewables by 33,700 gigawatt-hours from current levels. The white paper proposed a triennial review with annual targets in order to measure progress and make adjustments as needed.

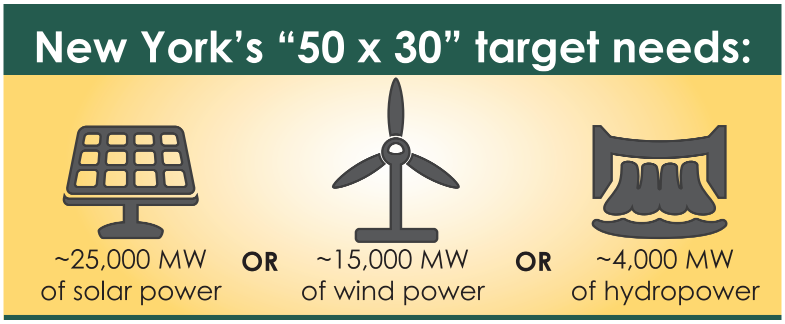
Separate compliance tiers are proposed to address the wide range of potentially eligible resources under the CES. The tiers include New Incremental Renewable Generation; Existing Renewable Generation; and Existing, Eligible Nuclear Facilities.

The white paper reviews various development options to achieve the CES target, with long-term bundled purchase power agreements (PPAs) as the primary compliance tool.

In comments submitted to the PSC[47], the NYISO cited the success that New York State has achieved in developing renewable resources and improving environmental quality through the complementary efforts of competitive markets and public policy.

The NYISO estimated that the incremental increase of 33,700 gigawatt-hours of renewable energy would require generating capacity additions of approximately:

- *25,000 megawatts of solar photovoltaics, or*
- *15,000 megawatts of wind turbines, or*
- *4,000 megawatts of hydro power.*



The relative size of the required capacity additions reflects the different ability of solar, wind and hydro power to generate electricity compared to their installed capacity. For example, 100 megawatts of wind capacity is equivalent to approximately 20 to 30 megawatts of conventional generation due to the variable output of wind turbines.[48]

Providing a mix of resources at the least cost to consumers requires that policymakers be mindful of the impacts of the relative capability of intermittent resources to reliably supply power demands.

With regard to the procurement options proposed in the white paper, the NYISO noted different levels of compatibility with the competitive wholesale markets. The NYISO indicated its concern that long-term bundled PPAs distort the market signals that should be driving generation resource development, including renewable resources. In addition, these agreements transfer financial risks from private investors and developers to rate-paying consumers.

PPAs essentially guarantee that renewable resources receive a certain level of revenue. This market insulation distorts the incentive for renewable resources to properly locate their facilities in areas of highest value and respond to dispatch instructions. Under PPAs, renewable resources may submit large negative offers to ensure their dispatch regardless of market prices, system conditions, or their actual marginal cost of generation. In the long term, this formulation would increase costs to consumers, who could be forced to pay the bundled price regardless of the resources' performance.

Artificially lowered market prices also may accelerate retirement or suspended operation of conventional generation facilities, or stall the development of new generation. Conventional resources (such as natural gas or nuclear units) are needed to maintain reliability by balancing the variable output of renewable resources. The insulated renewable resources, however, would remain unaffected because their revenues would be sustained regardless of market outcomes.

According to the National Renewable Energy Lab (NREL) and the Lawrence Berkeley National Lab (LBNL), in restructured markets with competitive retail markets, renewable portfolio standard compliance obligations are "generally placed on [load serving entities] LSEs, and compliance is achieved through the purchase and retirement of RECs. Retail suppliers in these markets typically do not have long-term certainty regarding their load obligations, and therefore typically purchase RECs through short-term transactions for unbundled RECs."[49]

Consistent with the NREL and LBNL findings, the NYISO has determined that RECs provide the appropriate incentive for renewable resources to come to markets and provide related environmental and societal benefits in areas with competitive energy markets such as New York.

The Impacts of Natural Gas & the Future of Nuclear Power

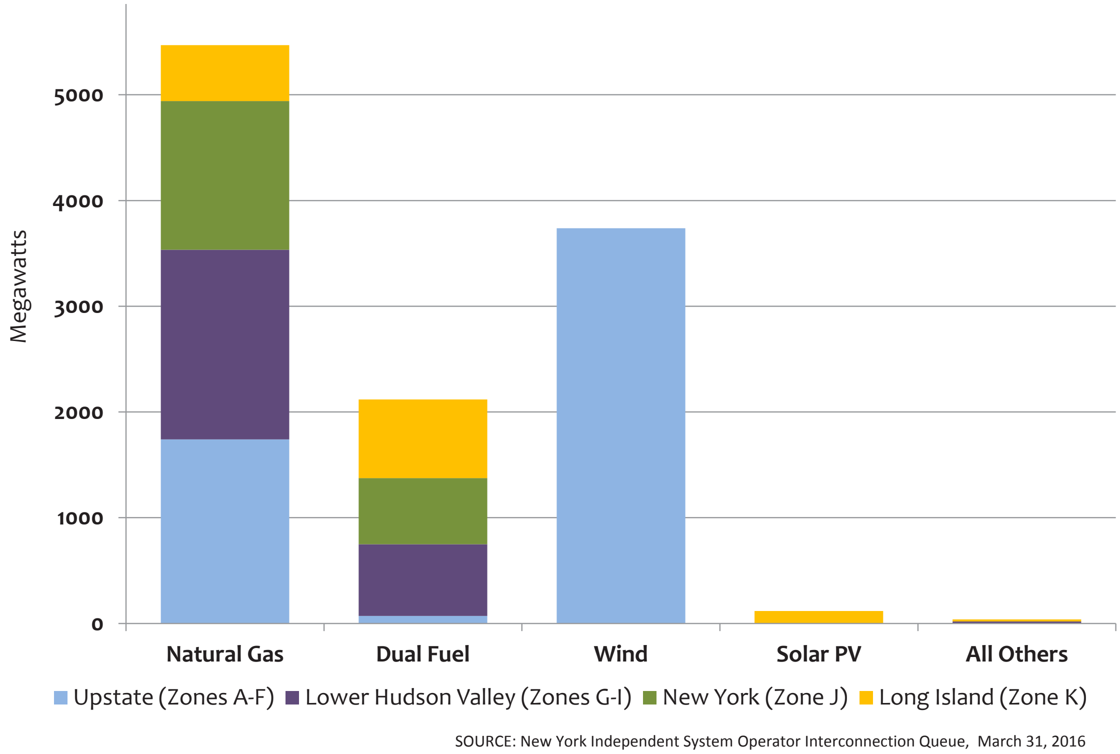
Persistently low natural gas costs have contributed to recent reductions in wholesale electric energy prices. While providing savings to consumers in the near term, the lower prices are contributing to emerging resource issues as nuclear plants retire and the electric system's fuel mix becomes less diverse.

Natural Gas

In the U.S., during 2015, natural gas and coal each provided about one-third of all the electricity generated in the nation. For many decades, coal had produced half or more of U.S. electricity, but natural gas' role in fueling power plants has grown with the emergence of abundant, low-cost supplies. The U.S. Energy Information Administration is forecasting that 2016 will be the first year that natural gas-fired generation exceeds coal generation in the United States on an annual basis.[50]

Natural gas and dual-fuel power plants produced 44 percent of New York's electricity in 2015. The NYISO interconnection queue shows that power projects using natural gas account for more than 65 percent of all proposed generating capacity.

Figure 32 - Proposed Generation by Fuel Type and Region: 2016



Today, power plants using natural gas total 57 percent of New York State's generating capability. Within that set of gas-fired power plants, 47 percent are dual-fuel facilities that can use either natural gas or an alternative fuel (typically oil). During periods of high usage, reliability rules require many of these plants to switch to burning oil. Outside of peak times, dual-fuel generators may choose to run on whichever fuel is less expensive. This operational flexibility provides both fuel diversity and reliability benefits.

The increasing dependence upon natural gas raises concerns regarding the potential impacts of gas availability on electric system reliability and power costs. Disruptions in natural gas supply and/or delivery can affect the ability of gas-fueled generation to provide power, which could impact electric system reliability.

The growing demand for natural gas by power generators, coupled with uncertainty over the likelihood of future natural gas infrastructure expansions, raises strategic concerns over the gas system's ability to keep pace with the needs of gas utilities serving residential, commercial and industrial customers, while meeting the expanding needs of gas-fired power plants, especially during peak demand conditions in winter and summer.

A 2014 study, commissioned by the Eastern Interconnection Planning Collaborative (EIPC) assessed the adequacy and resilience of the gas delivery infrastructure to supply the needs of gas-fired electric generation across several study regions, including New York.[51]

In analyzing contingencies that might disrupt reliability on the power grid, the study concluded that New York was well positioned to withstand any single contingency on the gas pipelines and would have sufficient time to take remedial actions to preserve reliability in the face of electric system contingencies that impacted gas delivery to generators. The study concluded that New York's dual-fuel capabilities bolstered its ability to sustain reliability in the event of disruptions to natural gas supplies. The study also noted that proposed natural gas infrastructure expansions would enhance New York's ability to maintain fuel assurance.

Gas-Electric Coordination and Fuel Assurance

The NYISO, in its stakeholder process, has been working on 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.

Through the NYISO Electric and Gas Coordination Working Group, stakeholders collaborate to address 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.[52]

In February 2016, FERC issued an order approving changes to NYISO's market mitigation rules aimed at improving electric-gas coordination.

Working with stakeholders, the NYISO adopted several energy market design enhancements to provide price signals for generators to maintain fuel assurance. 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. The design allows energy prices to reach increased levels at times when the Real-Time energy market is unable to procure sufficient reserves or regulation to meet requirements. 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, which might otherwise produce price reductions once the resources are activated and work to suppress demand. Through the Comprehensive Scarcity Pricing design targeted for implementation in 2016, the NYISO will begin incorporating 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, it may prompt examination of potential capacity market changes to supplement energy market fuel assurance signals.

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

As the rating agency Moody's reported in March 2016, "Low natural gas prices have devastated most of the U.S. merchant power sector because gas-fired power plants often serve as the marginal plant during times of peak power demand. 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."[53]

Nuclear Energy Trends

There are currently 99 nuclear power plants operating in the U.S. In 2015, nuclear facilities produced 19 percent of the nation's power.[54] New York's six nuclear power projects generated 31 percent of the state's electricity last year.

Few new nuclear power projects have been built in the past three decades. However, five new reactors, all located in the southeastern U.S., are expected to come on line by 2021. The Tennessee Valley Authority's Watts Bar Nuclear Plant Unit 2, originally permitted in the 1970s, is scheduled to become the first new nuclear power plant to come on line in 20 years when it begins commercial operation in the summer of 2016.

In recent years, however, owners of several nuclear-powered generating projects have deactivated their units or announced plans 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 operation are negatively influencing the economics of nuclear power projects.

According to the Nuclear Energy Institute, between 2002 and 2014, nuclear fuel costs increased 25 percent, capital expenditures by 109 percent, and operating costs by 13 percent (in 2014 dollars per megawatt-hour).[55]

Entergy Corporation shut down its Vermont Yankee Nuclear Power Station in southern Vermont at the end of 2014. Among the reasons cited by the company for the closure decision were the impact of natural gas costs on wholesale electricity prices and the "financial impact of cumulative regulation" that challenges single-plant nuclear units."[56] More recently, Entergy announced plans to retire its Pilgrim Nuclear Power Station in Plymouth, Massachusetts in May 2019, due to market conditions and increased costs.[57]

In January 2014, Exelon Corporation announced that it was considering retiring the Ginna Nuclear Power Plant, located on Lake Ontario near Rochester, N.Y. Subsequent to a NYISO review of the reliability impacts, the New York State PSC authorized Rochester Gas & Electric and Exelon Corporation, Ginna's owner, to negotiate a reliability support services agreement to keep the plant in operation in order to maintain system reliability in western New York, which remains in effect until April 2017.

In November 2015, Entergy Corporation announced plans to retire the FitzPatrick Nuclear Power Plant, located on Lake Ontario near Oswego, N.Y. at the end of its current fuel cycle. In February 2016, Entergy Corporation confirmed its plans and announced a closure date of January 2017. The company attributed its decision to close the plant on the continued "deteriorating economics of the facility."[58] A NYISO review, based on the most current long-term forecast of electric demand, did not identify any resource adequacy or transmission security reliability needs relating to a FitzPatrick deactivation.[59]

In addition to reviewing reliability impacts of specific power project retirements, the NYISO identifies risk scenarios that could adversely affect reliability of the electric system as part of its comprehensive reliability planning process. Among the scenarios studied in past Reliability Needs Assessments is the unplanned retirement of large amounts of generation, such as a potential retirement of the Indian Point Energy Center.

The Indian Point Energy Center, located in Westchester County, includes two nuclear power generating units capable of producing a total of 2,060 megawatts. Entergy, which owns the units, has applied to the Nuclear Regulatory Commission for a 20-year renewal of the licenses. The federal operating license for Unit 2 of the Indian Point nuclear power project, originally scheduled to expire in September 2013, remains in effect until the license renewal process is complete. The license for Unit 3 expired in December 2015, but remains in effect while the relicensing application is pending. (Indian Point Unit 1 was shut down permanently in 1974.) The State of New York is opposing the license renewals of Indian Point units 2 and 3 based on safety and environmental concerns.

The *2014 Comprehensive Reliability Plan*, issued in July 2015, found that resource-related reliability violations would occur immediately if Indian Point Energy Center becomes unavailable in 2016. The study found that, to compensate for the loss, approximately 500 megawatts would need to be built in southeastern New York to satisfy resource adequacy criteria.[60]

The New York State PSC asked Con Edison and the New York Power Authority to develop contingency plans so resources are in place by 2016 to address power supply needs in the event of Indian Point's closure. The PSC approved plans to build three transmission projects capable of reducing capacity needs, which entered into service this June. It also approved a set of energy efficiency, demand response, and combined heat and power programs designed to reduce downstate electricity use. These projects are intended to provide 125 megawatts of load reduction in New York City this year. The PSC determined that the solutions "provide net benefits to customers even in the event IPEC continues operating beyond its current license term."[61]

The NYISO's *2016 Reliability Needs Assessment*, currently under development, will again evaluate the potential impact of an Indian Point Energy Center deactivation on resource adequacy, as well as evaluating a scenario in which all of New York's current fleet of nuclear power plants are deactivated.

In addition to the electric system reliability impacts of nuclear project deactivations, the emission reductions that would be required by the federal Clean Power Plan and New York State's clean energy goals are highlighting the emission-free attributes of nuclear generation. The New York State Department of Public Service *Staff White Paper on Clean Energy Standard* acknowledges that "forward progress in reducing carbon also requires steps to ensure that existing, safe emission-free sources of electricity remain operational."[62]

Most renewable resources produce power intermittently due to the variable nature of their fuel supplies. Consequently, conventional generation and energy storage resources must also be retained and developed to maintain system reliability. In comments submitted to the New York State PSC on the Clean Energy Standard, the NYISO said, "Nuclear resources should play a significant role in maintaining reliable system operation during the transition to a higher concentration of renewable resources and intermittent technologies… the continued operation of existing nuclear resources is a key component to meeting the State's CES and State Energy Plan ("SEP") goals because of their consistent, reliable zero-emission energy production."[63]

Integrating Distributed Resources

As the electric system strives to reduce its environmental impact, foster cleaner, renewable resources, and promote energy efficiency, attention increasingly turns to the potential of distributed energy resources (DER).

In the traditional model of the centralized power system, electricity is said to flow "downhill" from large power plants to a widespread set of residential, commercial and industrial customers. The emergence and growth of distributed resources is changing the landscape of the electric system.

DER include an array of power generation and storage resources that are typically located on or near an end-user's property and supply all or a portion of the end-user's electricity. Such resources also may deliver power into the grid. Distributed energy technologies include solar photovoltaic (PV), combined heat and power (CHP) systems, microgrids, wind turbines, microturbines, back-up generators, and energy storage devices.

A growing number of customer-sited PV installations are connected to the grid and take advantage of available net metering opportunities. Net metering, authorized by New York State law in 1997, enables customers to provide power generated by their distributed energy system to their host utility in return for credits on their electric bill. It is available on a first-come, first-served basis to customers of New York State's major electric utilities, subject to technology, system size, and aggregate capacity limitations.

Examining grid-connected distributed resources, the Electric Power Research Institute (EPRI) clarified an important distinction between DER that is connected to the grid and resources that are truly integrated into grid operations. The study stated, "…*rapidly expanding deployments of DER are connected to the grid but not integrated into grid operations, which is a pattern that is unlikely to be sustainable.*"[64]

A 2014 report conducted for the NYISO assessed the state of distributed technologies and their prospects for growth in New York State. According to that report, New York's DER base was led by small-scale CHP with 57 percent of the state's distributed generation capacity. In other states, solar PV is the dominant DER technology. Solar PV ranked second in New York at 41 percent. Energy storage accounted for the remaining two percent.[65]

Reforming the Energy Vision (REV)

The NYISO study was conducted to help inform New York State's REV initiative, begun in April 2014 by the New York State PSC. In launching the initiative, a report by Department of Public Service staff[66] recommended considering changes including *"A new business model in which distributed energy resources becomes a primary tool in the planning and operation of electricity systems. Utilities would be encouraged to invest in DER that mitigate or lessen the need for traditional distribution system investments."*

Such changes are already taking shape in the form of Consolidated Edison's Brooklyn-Queens Demand Management project. Demand trends in parts of Brooklyn and Queens were forecast to outpace existing infrastructure by the summer of 2018. As an alternative to a substation that would cost $1.2 billion or more, the $200 million demand management plan is designed to reduce electricity use by 52 megawatts through a combination of efficiency and conservation measures by consumers as well as new distributed power sources, such as fuel cells and neighborhood-scale solar, and utility-scale projects.[67]

While the reformed system envisioned by REV is still taking shape, distributed resources are expected to play a much larger role in the grid of the future. Proliferation of customer-installed solar photovoltaic systems, development of community-level microgrids, expansion of combined heat and power systems, and increased consumer interest in electric vehicles present various complex challenges for the electric system. The wholesale electricity markets will need to adjust to address the challenges of DER, much as they have changed to integrate grid-scale renewable resources.

In collaboration with stakeholders, the NYISO is developing a Distributed Energy Resource Roadmap to develop wholesale market designs and grid operation procedures to plan and reliably operate the bulk power system in an environment that includes greater levels of distributed energy resources.[68]

The NYISO proposed changes in market rules to enable behind-the-meter generation with excess capability to take part in wholesale markets. The change could introduce more than 100 megawatts of existing behind-the-meter capacity into the NYISO markets. In its comments on the proposed change, the New York State PSC told FERC, "The NYISO's proposed tariff changes will help promote distributed generation and provide developers with the opportunity to gain additional revenue through the sale of extra energy and capacity, while promoting system resiliency."

FERC conditionally accepted the tariff changes in May 2016, recognizing the potential benefits of reducing obstacles to using excess capacity of behind-the-meter resources in the NYISO's wholesale markets. The FERC order said, "Their participation should improve the competiveness, efficiency, and reliability of those markets."[69]

As distributed resources grow, they can be expected to modify the load profile. The NYISO's real-time and long-range load forecasting techniques will consequently need data currently concealed "behind-the-meter." As noted in the discussion of renewable resources, the NYISO is engaged in a study designed to enhance forecasting of solar PV generation.

A Smarter, More Secure Grid

The transformation of the electric system occurring with the emergence of distributed resources is closely linked to the deployment of advanced technology aimed at making the grid "smarter." 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.

Among the advanced technologies being deployed by grid operators and transmission owners are synchrophasors and phasor measurement units (PMU) that will help avoid major electric system disturbances like the 2003 blackout. These sophisticated monitoring devices relay system electric conditions at a rate of up to 60 times per second—360 times faster than previously available.

The NYISO's control center employs the capabilities of these devices, installed as part of a 2013 Smart Grid Investment Grant project funded by a grant from the U.S. Department of Energy (DOE) with matching state funding. DOE worked with utilities throughout the nation to increase the number of synchrophasors five-fold, growing from less than 200 in 2009 to more than 1,700 in 2014.[70]

Connecting with PMU networks in New England, the mid-Atlantic, and the Midwest provides the NYISO faster and wider situational awareness of grid conditions throughout the eastern United States.

Grid Security

Protecting the grid from threats, natural and man-made, is a fundamental requirement of electric system reliability. As the systems that control and monitor the power grid become more technologically advanced and interconnected, the scope of cyber security concerns is expanding. Concurrently, heightened concern about terrorist threats to critical infrastructure, including the electric system, are also putting physical security issues in the national spotlight.

Mandatory federal reliability standards include Critical Infrastructure Protection (CIP) standards. Developed by the North American Electric Reliability Corporation (NERC) and approved by the Federal Energy Regulatory Commission (FERC), these standards cover both physical and cyber security. They address asset identification, security personnel and training, incident reporting, and response/recovery planning.

Mandatory CIP standards for owners and operators of the bulk electric system were developed by the North American Electric Reliability Corporation (NERC) and approved by FERC in 2008. Those standards undergo continuous updates as the nature and scope of threats change. The NYISO participated in the development of the standards and remains actively engaged in improving them, collaborating with various government agencies, such as NIST, and other entities involved in maintaining rigorous cyber security protections.

FERC approved the latest version of the standards (CIP Version 5) in 2013. It uses a tiered approach to identify and classify bulk electric system cyber assets according to their potential impact on electric system reliability. The plan includes requirements for electronic security perimeters, systems security management, incident reporting, response planning, recovery plans, configuration change management, and vulnerability assessments. The new standards take effect in July 2016.

In testimony to Congress, NERC President and CEO Gerry Cauley, noted, "Today, the electric sector (along with nuclear) remains the only critical infrastructure sector subject to mandatory, enforceable cybersecurity standards."[71]

Subsequent to a 2013 California incident involving gunfire that damaged a major substation, FERC directed NERC to develop new physical security standards. 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 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. In November 2015, the NYISO joined more than 10,000 participants from approximately 350 organizations as NERC conducted a simulated attack on the U.S. power grid. The GridEx III exercise was 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.

Markets Sustaining Reliability & Enhancing Efficiency

More than two and a half decades ago, the electric industry began a period of transformation set in motion by federal and state policies that restructured the electric system. Those policy decisions were founded on the conviction that competitive wholesale electricity markets can most efficiently and effectively enable the grid to adapt to changing technology, economics and public policy. New York's experience with wholesale electricity markets has verified that conviction. New York's competitive wholesale electric markets have provided significant benefits to the State and its electricity consumers. Since 2000,[72] the markets have contributed to:

- *improved generation efficiency and lower reserve requirements that produced $7.7 billion in savings;*
- *reduced carbon emissions equivalent to taking nearly 5 million cars off the road, and*
- *increased renewable generation that provides enough wind-powered electricity to serve half-a-million New York homes.*

New York's electricity markets and state energy policy have combined to establish New York as a national leader in clean energy production and reduced carbon emissions. New York's generation fleet is one of the cleanest in the country and wholesale market signals provide a platform for renewable generation to flourish in New York.

Working in New York's marketplace for electricity, power producers have added newer, cleaner, more efficient generation to meet the needs of New York's energy consumers and improve environmental quality. Energy service organizations have enlisted consumers to provide significant demand response resources. Interstate transmission has been built to serve the high-demand southeastern New York region and progress is being made in the development of needed intrastate transmission upgrades and expansion.

Market signals have driven investments needed to meet reliability needs. Since the onset of markets in 2000, New York has seen the addition of 11,655 megawatts of generating capacity. That is approximately 30 percent of New York's current generation.

Markets have consistently responded to the reliability needs identified by the NYISO planning process. Of the seven reliability assessments conducted since the NYISO began its reliability planning process in 2005, five assessments identified emerging reliability needs. In each and every case, market-based solutions responded with resources to address those needs.

Broader Regional Markets

The electric system has a long tradition of interconnected operations to bolster reliable operations across utility and regional boundaries, as well as mutual aid among utilities when recovering from major disasters. Removing barriers to the efficient flow of power between electric systems is a vital component of enhanced operational flexibility. Increased flexibility in system operations, gained through expanded collaboration, helps address the need to balance the variable output of renewable resources, integrate distributed energy resources, and bolster system resilience during extreme weather events. Accordingly, grid operators, market administrators and system planners from the electric systems serving North America have recognized that greater interregional collaboration can enhance efficiency on the electric grid system and deliver cost savings for consumers.

The Broader Regional Markets initiative helps New York and its neighboring wholesale electricity markets better coordinate their operations. The effort focuses on avoiding or minimizing conditions on the grid, such as loop flows and congestion, which add cost, while also facilitating a more dynamic system. Through the regional initiatives, the need to use more expensive local power is reduced if less costly power is available from a neighboring grid operator. Coordination efforts also shorten the time commitment for moving power across control area borders, allowing faster responses to changing conditions.

In addition to the NYISO, the regional initiative involves PJM Interconnection, ISO New England, Midcontinent ISO, Ontario's Independent Electricity System Operator, and Hydro Québec.

These efforts are being completed through a combination of physical and market-based tools designed to maximize the flexibility of operators' response to real-time conditions on the grid.

Real-time market coordination between the NYISO and PJM, which has been in effect since 2013, has delivered more efficient dispatch solutions to manage the real-time transmission constraints that impact both markets. The estimated value of this coordination to New York was $17.9 million in 2015.

Coordinated Transaction Scheduling (CTS), effective with PJM in 2014, began with ISO-NE in 2015 as well. This enhanced scheduling enables market participants to access the least-cost source of power within the two regions and helps lower the combined energy production cost of the two systems.

Enhanced Interregional Transaction Coordination was implemented by the NYISO with Hydro Québec in 2011 and with PJM in 2012.

Enhanced Interregional Transaction Coordination

Enables market participants to access the least-cost source of power across regions and helps lower the combined energy production cost across systems. Operators more efficiently use the transmission lines connecting regions, and coordination minimizes counterintuitive power flows by explicitly incorporating projected price differences among markets into interregional scheduling decisions.

Phase 1 – 15-minute scheduling (NYISO/HQ)	Complete
Phase 2 – Ancillary Service Concepts	Complete
Phase 3 – 15-minute scheduling (NYISO/PJM)	Complete
Phase 4 – Coordinated Transaction Scheduling (NYISO/PJM)	Complete
Phase 5 – Coordinated Transaction Scheduling (NYISO/ISO-NE)	Complete
Phase 6 – Coordinated Transaction Scheduling (PJM/MISO)	2017

Concluding Comments

New York state'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 providing real value to New York consumers and the Empire State's economy.

The energy issues facing our state and nation are complex and intricately interconnected. Underlying the complexity are several fundamental concepts. 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.

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.

Change is constant. That is clear. And New York is on the cutting edge of this new energy future. New York is transforming the power grid as it strives to achieve the goals of cleaner energy, improved efficiency, and robust economic growth.

Continuing New York's commitment to competitive markets will maintain and enhance the Empire State's leadership in energy.

Glossary

The following glossary offers definitions and explanations of terms and phrases used in *Power Trends 2016* and others 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.

Adequate: A system is considered adequate if the probability of having sufficient transmission and generation resources to meet expected demand is greater than the minimum standard to avoid a blackout. A system has adequate resources under the standard if the probability of an involuntary loss of service is no greater than one occurrence in 10 years. This is known as the loss of load expectation (LOLE), which forms the basis of New York's installed capacity (ICAP) requirement.

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 regions 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 grid 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..

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 of electricity. That generator would have an annual capacity factor of 100 percent.

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 and Comprehensive Reliability Plan. Using the most recent reliability planning model, economic planning is conducted through the Congestion Assessment and Resource Integration Study 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. The DAM sets prices based on a least-total cost methodology, based on generation and energy transaction bids offered in advance to the NYISO.

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. These 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 megawatts 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 generation (See "Distributed Generation"), energy storage technologies, combined heat and power systems, and microgrids. A DER is generally customer-sited to serve the customer's power needs, but may in some instances sell excess energy production 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.

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 Highway Initiative: In the 2012 State of the State Address, New York Governor Andrew Cuomo proposed an "energy highway" to transport surplus power supplies in upstate New York and north of the border in Quebec to high-demand regions in downstate New York. The Energy Highway Task Force appointed by the Governor solicited proposals and produced an *Energy Highway Blueprint* that outlines plans for 3,200 MW of new generation and transmission funded by public/private investment of up to $5.7 billion.

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 Regulatory Commission (FERC): The federal energy 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.

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 percent 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 (an end-use device or customer) or the amount of energy (megawatt hour - MWh) or demand (megawatt - MW) consumed.

Load Serving Entity: An entity, including an investor-owned utility, public power authority, municipal electric system or electric cooperative, authorized or required by law, regulatory authorization, or contractual obligation to supply energy, capacity and/or ancillary services to retail electricity customers.

Locational Installed Capacity Requirement: A NYISO determination of that portion of the statewide installed capacity requirement that must be located electrically within a locality to provide that sufficient capacity is available there to meet the 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 (subject to the level of the availability of those resources, load uncertainty, available transmission system transfer capability and emergency operating procedures) 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 LOLE that is not greater than one occurrence of an involuntary load disconnection in 10 years, expressed mathematically as 0.1 days per year.

Marcellus Shale: A black shale formation extending deep underground from Ohio and West Virginia northeast into Pennsylvania and southern New York. Geologists estimate that the entire Marcellus Shale formation may contain up to 489 trillion cubic feet of natural gas, although it is not yet known how much gas will be commercially recoverable from the Marcellus in New York.

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. 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.

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 July 21, 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 any designated interval of time and measured in megawatt hours (MWh). Peak demand, also known as peak load, 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') interconnection-wide awareness of the system's state 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 driven by Public Policy Requirements identified for evaluation, 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.

Resource Adequacy: The ability of the electric system to supply aggregate electrical demand and energy requirements at all times, taking into account scheduled and unscheduled outages of system elements.

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 transmit on 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 during normal or emergency system conditions.

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

Endnotes

[1] Data presented in Power Trends 2016, unless otherwise noted, are from the 2016 Load and Capacity Report (the "Gold Book"), New York Independent System Operator, April 2016.

[2] 2015 State of the Markets, Staff Report to the Federal Energy Regulatory Commission, March 17, 2016.

[3] Potential Reliability Impacts of EPA's Clean Power Plan: Phase II, North American Electric Reliability Corporation, May 2016.

[4] Peak-to-average electricity demand ratio rising in New England and many other U.S. regions, Today in Energy, U.S. Energy Information Administration, February 18, 2014.

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

[6] Order Instituting Section 206 Proceeding And Directing Filing To Establish Reliability Must Run Tariff Provisions, New York Independent System Operator, Inc., Federal Energy Regulatory Commission Docket No. EL15-37-000 (Issued February 19, 2015).

[7] New York Independent System Operator, Inc. Docket Nos. ER16-120-000, EL 15-37-001, Order on Compliance and Rehearing, 115 FERC P61,076 (April 21, 2016).

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

[9] 2015 Assessment of Demand Response and Advanced Metering, Staff Report, Federal Energy Regulatory Commission, December 2015.

[10] NYISO 2015 Annual Report on Demand Response Programs, New York Independent System Operator, January 12, 2016.

[11] Electric Power Supply Association v. FERC et al., Court of Appeals for the District of Columbia, May 23, 2014.

[12] Electric Power Supply Association v FERC et al., U.S. Supreme Court, January 25, 2016.

[13] Scarcity pricing refers to the pricing rules used for energy and certain ancillary services in real-time during periods when NYISO has called on Special Case Resources and Emergency Demand Response Program resources to provide load reduction to assist in maintaining system reliability.

[14] Consumer Impact Analysis: Comprehensive Scarcity Pricing, Consumer Interest Liaison, New York Independent System Operator, September 8, 2015.

[15] Summer 2016 Energy Market and Reliability Assessment, Office of Electric Reliability and the Office of Enforcement, Federal Energy Regulatory Commission, May 19, 2016.

[16] 2014 Comprehensive Reliability Plan, New York Independent System Operator, July 2015.

[17] U.S. Renewables Portfolio Standard; 2016 Annual Status Report, Galen Barbose, Lawrence Berkeley National Laboratory, April 2016.

[18] Solar capacity factor is a nominal value. The capacity factor of distribution-level solar photovolatics in New York has varied between 13 and 16 percent.

[19] 2015 State of the Markets Report for the New York ISO, Potomac Economics, May 2016.

[20] The Benefits of Electric Transmission: Identifying and Analyzing the Value of Investments, The Brattle Group, July 2013.

[21] Toward More Effective Transmission Planning: Addressing the Costs and Risks of an Insufficiently Flexible Electricity Grid, Brattle Group, April 2015.

[22] 2015 Congestion Assessment and Resource Integration Study (CARIS) Phase 1 Report, New York Independent System Operator, November 2015.

[23] New York's State Transmission Assessment and Reliability Study Phase II Study Report, STARS Technical Working Group, March 30, 2012.

[24] New York Energy Highway Blueprint, New York Energy Highway Task Force, October 2012.

[25] Growing Wind: Final Report of the NYISO 2010 Wind Generation Study, New York Independent System Operator, September 2010.

[26] N.Y. Power Authority Announces Completion of Energy Highway Transmission Project to Harden the North Country Electric Grid, New York Power Authority, March 3, 2014.

[27] Case 12-T-0502, Proceeding on Motion of the Commission to Examine Alternating Current Transmission Upgrades, New York State Public Service Commission (issued November 30, 2012).

[28] PSC Invokes Public Policy Planning Process for Transmission Lines, New York State Public Service Commission, July 16, 2015.

[29] Western New York Public Policy Transmission Need Viability & Sufficiency Assessment, New York Independent System Operator, May 31, 2016.

[30] PSC Votes to Advance Transmission System Upgrades for Further Review, New York State Public Service Commission, December 17, 2015.

[31] Champlain Hudson Power Express website.

[32] Empire State Connector website.

[33] 2015 Northeastern Coordinated System Plan, April 11, 2016.

[34] Eastern Interconnection Planning Collaborative website.

[35] President Clinton's Climate Change Proposal - Fact Sheet On Electricity Restructuring – White House Initiative on Global Climate Change, October 22, 1997.

[36] Comments of the New York Independent System Operator, Inc. On The Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units, Docket ID No. EPA-HQ-OAR-2013-0602, December 2, 2014.

[37] Northeast Power Markets Emissions Watch, ESAI, Inc. February 2016.

[38] Announcement of Area Identification: Commercial Wind Energy Leasing on the Outer Continental Shelf Offshore New York, Bureau of Ocean Energy Management, March 16, 2016.

[39] On the Path to SunShot: Emerging Issues and Challenges in Integrating Solar with the Distribution System, National Renewable Energy Laboratory and Sandia National Laboratories, May 2016.

[40] Solar Impact on Grid Operations: An Initial Assessment, New York Independent System Operator, June 2016.

[41] U.S. Renewables Portfolio Standards: 2016 Annual Status Report, Lawrence Berkeley National Laboratory, April 2016.

[42] The Energy to Lead: 2015 New York State Energy Plan, New York State Energy Planning Board, July 2015.

[43] Order Authorizing the Clean Energy Fund Framework, New York State Public Service Commission, Issued and Effective January 21, 2016.

[44] RGGI States Propose Lowering Regional CO2 Emissions Cap 45%, Implementing a more flexible cost-control mechanism, News Release, RGGI, Inc. February 7, 2013.

[45] Carbon Control and Competitive Wholesale Electricity Markets: Compliance Paths for Efficient Market Outcomes, The Analysis Group, May 2015.

[46] Staff White Paper on Clean Energy Standard, New York State Department of Public Service, January 25, 2016.

[47] Comments of the New York Independent System Operator - Proceeding on Motion of the Commission to Implement a Large-Scale Renewable Program and a Clean Energy Standard [Case 15-E-0302], April 22, 2016.

[48] Growing Wind: Final Report of the NYISO 2010 Wind Generation Study, New York Independent System Operator, September 2010.

[49] A Survey of State-Level Cost and Benefit Estimates of Renewable Portfolio Standards, National Renewable Energy Lab and Lawrence Berkeley National Lab, May 2014.

[50] Natural gas expected to surpass coal in mix of fuel used for U.S. power generation in 2016, Today in Energy, U.S. Energy Information Administration, March 16, 2016.

[51] Gas-Electric System Interface Study: Existing Natural Gas-Electric System Interfaces, Levitan & Associates for the Eastern Interconnection Planning Collaborative, April 2014.

[52] Fuel Assurance & Pipeline Adequacy Study, Levitan and Associates, October 2013.

[53] Moody's: Fall in natural gas prices may lead to large-scale plant retirements, SNL Energy, April 8, 2016.

[54] Nuclear Power in the USA, World Nuclear Association, March 2016.

[55] Delivering the Nuclear Promise: Advancing Safety, Reliability and Economic Performance, Nuclear Energy Institute, February 2016.

[56] Entergy to Close, Decommission Vermont Yankee, News Release, Entergy Corporation, August 27, 2013.

[57] Entergy Intends to Refuel Pilgrim in 2017; Cease Operations on May 31, 2019, Entergy Corporation, April 14 2016.

[58] Entergy to Close James A. FitzPatrick Nuclear Power Plant in Central New York, Entergy Corporation, February 23, 2016.

[59] Generator Deactivation Assessment: James A. FitzPatrick Nuclear Generating Facility, New York Independent System Operator, April 22, 2016.

[60] 2014 Comprehensive Reliability Plan, New York Independent System Operator, July 2015.

[61] Indian Point Contingency Plans Move Forward, News Release, New York State Public Service Commission, October 17, 2013.

[62] Staff White Paper on Clean Energy Standard, New York State Department of Public Service, January 27, 2916.

[63] Comments of the New York Independent System Operator - Proceeding on Motion of the Commission to Implement a Large-Scale Renewable Program and a Clean Energy Standard [Case 15-E-0302], April 22, 2016.

[64] The Integrated Grid: Realizing the Full Value of Central and Distributed Energy Resources, EPRI, February 2014.

[65] A Review of Distributed Energy Resources, DNV-GL for the New York Independent System Operator, September 2014.

[66] Reforming the Energy Vision: NYS Department of Public Service Staff Report and Proposal, CASE 14-M-0101, April 24, 2014.

[67] Brooklyn-Queens Demand Management Program, Consolidated Edison, August 15, 2015.

[68] Distributed Energy Resources Roadmap Kickoff, New York Independent System Operator, May 24, 2016.

[69] Order Accepting Proposed Tariff Revisions Subject To Condition, Federal Energy Regulatory Commission, Docket No. ER16-1213-000, May 17, 2016.

[70] How Synchrophasors Are Bringing the Grid into the 21st Century, Patricia Hoffman, U. S. Department of Energy website, April 16, 2014.

[71] Testimony of Gerry Cauley, President and Chief Executive Officer, North American Electric Reliability Corporation to the House Transportation and Infrastructure Committee Subcommittee on Economic Development, Public Buildings, and Emergency Management, April 14, 2016.

[72] The estimates presented update the figures reported in Powering New York Responsibly, New York Independent System Operator, May 2015.

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 policy makers, stakeholders and investors in the power system*

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

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

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

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

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

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

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

New York Independent System Operator
10 Krey Boulevard
Rensselaer, NY 12144
www.nyiso.com