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NEW YORK STATE ENERGY PLANNING BOARD

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Electricity Report

This report identifies New York’s electricity needs and evaluates the State’s ability to meet those needs over the 10-year planning horizon. It provides an overview of New York’s electricity system, including the structure and function of its regulatory framework and markets, and discusses its electric system infrastructure and the upward pressure on rates that will result from related capital expenditures required to maintain system safety and reliability. Replacements and improvements of existing, aging infrastructure are

critical to meet future energy needs. It is essential to guard against failures of the existing transmission system, since such failures not only raise safety and reliability concerns, but also can lead to increased system congestion, with related higher electricity costs and power plant emission levels. Introduction of “Smart Grid” concepts can facilitate more efficient system operation while providing cost savings. As strong as the need is to repair or replace aging infrastructure putting renewed upward pressure on New York’s relatively high electricity rates, there is also an enduring need to balance the potential benefits of any new policies and actions against their aggregate impact on the State and its ratepayers.

Due to the immense costs and difficulties in siting new transmission facilities, there is a need to identify, evaluate, and implement cost-effective means to optimize use of the State’s existing generation, transmission, and distribution systems. This could reduce the need for new facilities as well as contribute to lowering costs. Key to this effort is reducing peak load by implementing demand response programs and deploying interval meters, coupled with adoption of time-variant rates for large customers. Another promising strategy is the development of utility-scale energy storage facilities, which could help system operators take full advantage of generation from large wind projects. Storage facilities can increase system flexibility by storing energy during off-peak periods when energy is “bottled” and demand is low, for use during periods when energy demand is high.

The competitive electricity market structure in New York is designed to provide transparent price signals for both energy and capacity. Such transparency encourages investors to locate generation, transmission, and demand response resources where they are most needed and encourages investment in more efficient resources that can compete and bid into the market at lower prices. Since 2000, this market feature has provided incentives to entry of new generation resources totaling nearly 9,000 megawatts, while putting the risk of many of those investments on investors rather than on ratepayers. Further, the competitive market structure allows the system to be operated and dispatched in the most efficient manner (given system security constraints) to minimize total production costs, and provide electricity to customers at the lowest overall price in the long term. While New York’s electricity markets and the planning processes to develop them have largely been successful, improvements can be made to benefit both end-use customers and market participants. Continued monitoring and evaluation by the State can help to ensure that the expectations of the competitive market structure continue to be met.

The State has a diverse mix of electricity generation sources, including coal, nuclear, hydro, oil, gas, and renewables. In response to competitive markets, transparent price signals, and more stringent environmental regulations, generators have increased the use of natural gas in place of oil and coal as a primary fuel for electric generation. While this provides environmental benefits, the State also needs to safeguard against becoming overly dependent on any one particular resource for meeting its energy needs, as fuel supply disruptions or other factors could pose reliability risks and/or cause significantly increased price levels and volatility. It is important to continue safe operation of nuclear, coal, natural gas, oil, and hydroelectric generation resources in ways that support the State's energy, environmental, and economic objectives. Similarly, there is particular value in the continued availability of dual-fuel generation capability, i.e., natural gas and oil, especially in New York City and Long Island for continued ability to shift to oil should there be natural gas delivery problems.

Assessment and Outlook

Industry Overview

The electricity industry in New York is primarily comprised of investor-owned utilities, governmental utilities, generation companies, transmission-only companies, and energy service companies (ESCOs). Previously vertically integrated with generation, delivery, and customer service, the investor-owned utilities have divested the majority of their generation assets and retained primarily only transmission and distribution (T&D) delivery systems and customer service functions.¹ As the purchasers of those generation assets, independent power producers now serve as the primary generation suppliers in the State. The governmental utilities include New York Power Authority (NYPA), Long Island Power Authority (LIPA), municipally-owned electric utilities, and rural electric cooperatives. In general, generation suppliers engage in wholesale sales, i.e., sales for resale, of energy ancillary services, and capacity through competitive markets administered by the New York Independent System Operator (NYISO). Transmission-only businesses, ESCOs, and both the traditional and governmental utilities provide a variety of other services to end-users, which are described in this section.

Wholesale electricity sales and transmission services are regulated by the Federal Energy Regulatory Commission (FERC) under the Federal Power Act, whereas retail sales of energy, i.e., sales to end-use customers, and the accompanying service over local distribution lines (to the extent that they are owned by the investor-owned utilities) are regulated by the Public Service Commission (PSC) under the Public Service Law (PSL).² Independent power producers are subject to lightened regulatory requirements by the PSC. Moreover, the PSC has fostered the

1. Transmission is defined as an interconnected group of lines and associated equipment for the movement or transfer of electric energy between points of supply and points at which it is transformed for delivery to customers or is delivered to other electricity systems.

2. 16 USC §12. Federal Regulation and Development of Power.

development of ESCOs that provide energy to retail end-use customers as an alternative to energy supplied by an investor-owned utility. ESCOs are subject to limited regulation by the PSC, such as compliance with PSL Article 2, also known as the Home Energy Fair Practices Act, and other provisions identified in utility tariffs approved by the PSC.

Municipally-owned utilities, rural electric cooperatives, and public power authorities serve retail customers, and may own generation and/or T&D facilities. Public power authorities are subject only to limited regulation by the PSC, such as approvals for major transmission facilities. While the public power authorities generally are exempt from FERC jurisdiction, they have voluntarily agreed to participate in the NYISO-administered markets and thus are subject to the terms of the NYISO tariff. Municipally-owned electric utilities that take their entire electric generation supply from NYPA fall outside the PSC's ratemaking jurisdiction, while those utilities that receive supplemental power from sources other than NYPA are regulated by the PSC. The State's four rural electric cooperatives are exempt from PSC jurisdiction by virtue of Section 67 of the New York Rural Electric Cooperative Law. Municipally-owned utilities, rural electric cooperatives, and public power authorities typically oversee and take responsibility for their own infrastructure needs.

The NYISO was formed in 1999 as a not-for-profit corporation governed by an independent board of directors consisting of ten members with varying backgrounds in the power industry, environment, and finance.³ Unlike neighboring systems, the New York electric system is operated as a single-state independent system operator (ISO) organization, and the NYISO operates the State's bulk power system and wholesale markets in accordance with its FERC-approved tariffs.⁴ The PSC, the New York State Energy Research and Development Authority (NYSERDA), and the Department of State's Utility Intervention Unit (UIU), work with the NYISO and its committees to represent State and consumer interests with regard to all reliability and wholesale market issues.

3. The term "independent" here means that the members of the Board have no relationship with any market stakeholder.

4. The major electric transmission and generation system used for wholesale electricity transactions is referred to as the "bulk power system."

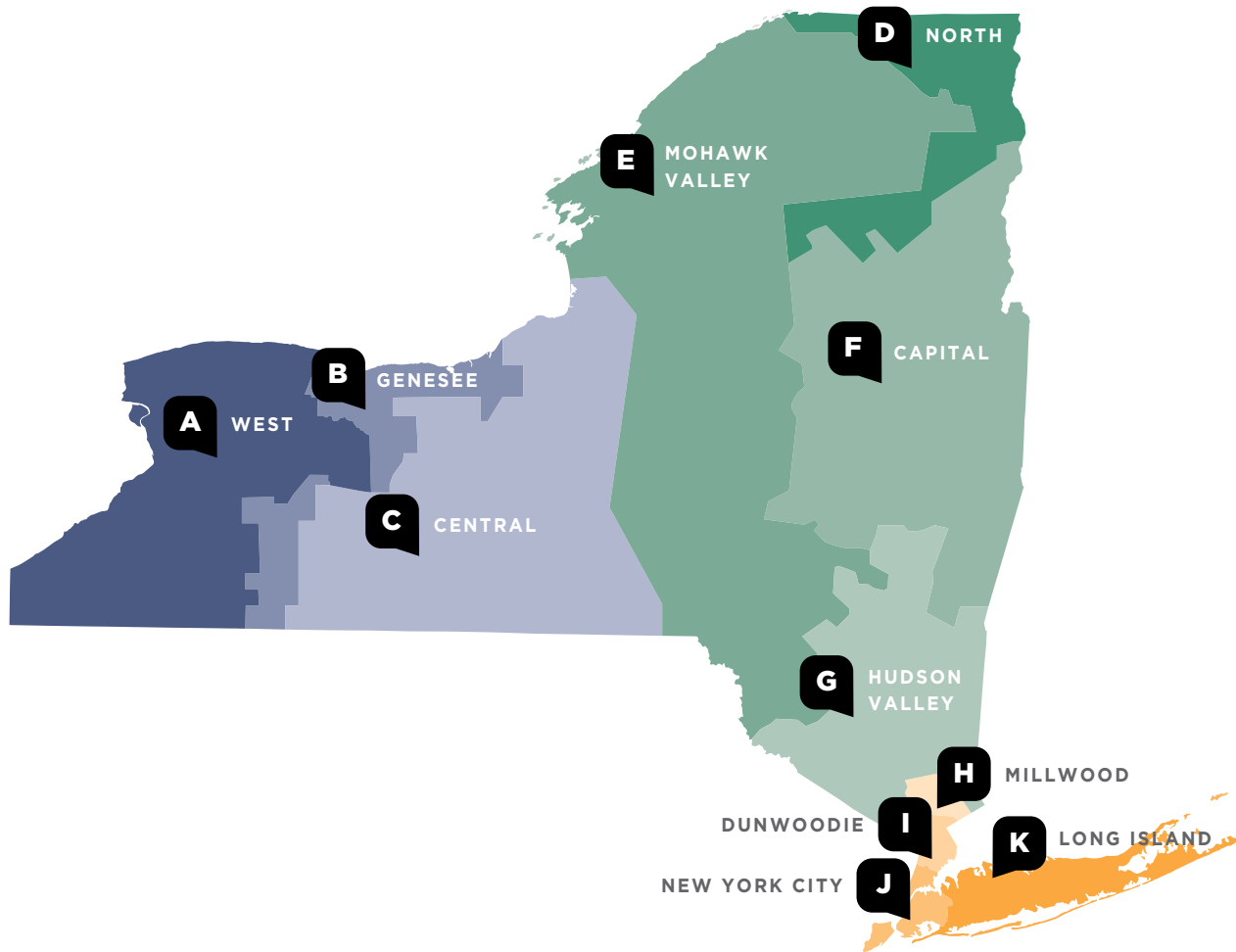
The PSC and FERC share authority over the reliability of the transmission system. FERC oversees the NYISO's reliability and economic planning processes, but it has limited authority to direct the construction of additional infrastructure. The PSC, however, has the authority to order the construction of facilities necessary to serve the public interest.

Jurisdiction over siting infrastructure facilities is divided among federal, state, and local governments. The siting of electric generation facilities is generally a state and local responsibility, depending on state and local laws. The siting of electric transmission facilities is also primarily the responsibility of state governments, except for FERC's back-stop authority under certain circumstances.

Reliability

The electricity system in the U.S. is divided into control areas for the purpose of managing/controlling the operations of the bulk transmission and generation systems.⁵ Unlike most other states, New York is a control area by itself for electrical purposes, and the NYISO is the designated operator for bulk power system operations. The New York Control Area (NYCA) is divided into 11 load zones, as illustrated in Figure 1. Divisions between zones are referred to as interfaces.

5. "Control area" refers to an electric system or systems, bounded by interconnection metering and telemetry, capable of controlling generation to maintain its schedule for interchange of electricity with other control areas and contributing to frequency regulation of any one of the five major electric system networks in North America. Regulation is the continuous balancing of resources with load variations to maintain scheduled frequency. *North American Energy Standards Board, Wholesale Electric Industry Glossary.*

Figure 1 | New York Control Area Load Zones

Source: NYISO. 2009.

Limits to the capability of the system to transfer electricity between the zones are referred to as interface limits. These interface limits constrain the amount of power that can be moved from one zone to another. Similarly, New York is interconnected with neighboring control areas, and there is limited transfer capability to and from each of those control areas: the Hydro Quebec (HQ) control area to the north, the Ontario control area to the west, the Pennsylvania-New Jersey-Maryland (PJM) control area to the south, and the New England control area to the east. New York is in fact integrated with the entire “Eastern Interconnection,” which encompasses the Midwest, South, Mid-Atlantic, New England, and Eastern Canada systems.

As electricity cannot easily be stored in large quantities, the production and use of electricity generally takes place in real-time. The NYISO and individual utilities work together to monitor and control

the electric system constantly. System operators ensure that electricity production is instantaneously balanced with electric demand and that the system is operated reliably. Reliable operation of the system is guided by established rules that specify voltage, thermal, and other limits within which the system must be maintained. While the goal is to serve load at all times, even under contingency situations, i.e. potential unexpected equipment failure, the operating rules are designed to interrupt load temporarily if necessary to prevent physical damage to the system.

The system is designed such that high voltage, high capacity lines are used to move power around the State and through neighboring systems. Closer to customer load, lines are operated at lower voltages and carry less electricity. While the higher voltage lines connect large load areas, the lower voltage lines generally consist of a series of small, local grids that are interconnected with the bulk power system. This design tends to keep local problems isolated, so that a low-voltage system problem in one area, e.g. Buffalo, will not affect customer service in another, e.g. Rochester. The overall bulk power system, however, is closely interconnected so that a system response to a disturbance on the bulk power system in Florida, for example, can be seen in the Dakotas.

This characteristic gave rise to the need for reliability standards that establish planning and operating protocols for the bulk power system, with the goal of preventing local system disturbances cascading into a neighboring system. Following the 1965 blackout, New York's utilities formed the New York Power Pool (NYPP) to operate the system and share planning information. Regional entities were then formed to share information and draft standards by which the utilities would operate the system and communicate with each other. The Northeast Power Coordinating Council (NPCC) is the regional standards entity for New York, New England, and eastern Canada. Recognizing a need to set overarching policies and protocols for system operation throughout the entire U.S. and Canada, the North American Electric Reliability Council (NERC), an association of all the regional entities, was formed in 1968.

Following the 2003 blackout, the Energy Policy Act of 2005 (EPACT05) transformed the Council's voluntary policies into mandatory standards under FERC's jurisdiction. The Council remains the main forum for the drafting of bulk power system reliability standards through an industry-supported American National Standards Institute process, but FERC must authorize the resulting standards and has the ability to penalize utilities for violations.

In 1999, the NYPP was transformed into the NYISO and its functions expanded from reliable operation of the bulk power system to operation of the wholesale market. Given that market needs often can test the limits of reliability standards, it was decided that an independent reliability entity should be formed. The New York State Reliability Council (NYSRC) was established to maintain, institute, and monitor the NYISO's implementation of standards, called rules, that are specific to the New York system. Additionally, EPACT05 specifically recognized New York's ability and right to establish and enforce standards that are more stringent than the national standards. The PSC has since adopted the NYSRC and NPCC standards as mandatory and enforceable in the State.

Ensuring the reliability and security of the electricity system are objectives of the highest priority. While the cost of infrastructure investment to ensure reliability is high, the cost of allowing reliability levels to slip is even higher. For example, the costs associated with the August 14, 2003, electric system blackout in the U.S. were estimated to be between \$4 and \$10 billion. There is, however, a great deal of uncertainty in the accuracy of the various estimates that have been made regarding the cost of power outages, primarily due to data limitations and the need to extrapolate existing subsets of data to a national level. One review of such estimates performed by the Lawrence Berkeley National Laboratory in 2004 produced a base case estimate of the annual cost of power interruptions nationally of \$79 billion. Sensitivity analyses performed on the base case resulted in a range of estimates from \$22 to \$135 billion. The costs associated with such failures of the electric system, however, cannot be quantified just in dollars; public health and safety are also at risk.

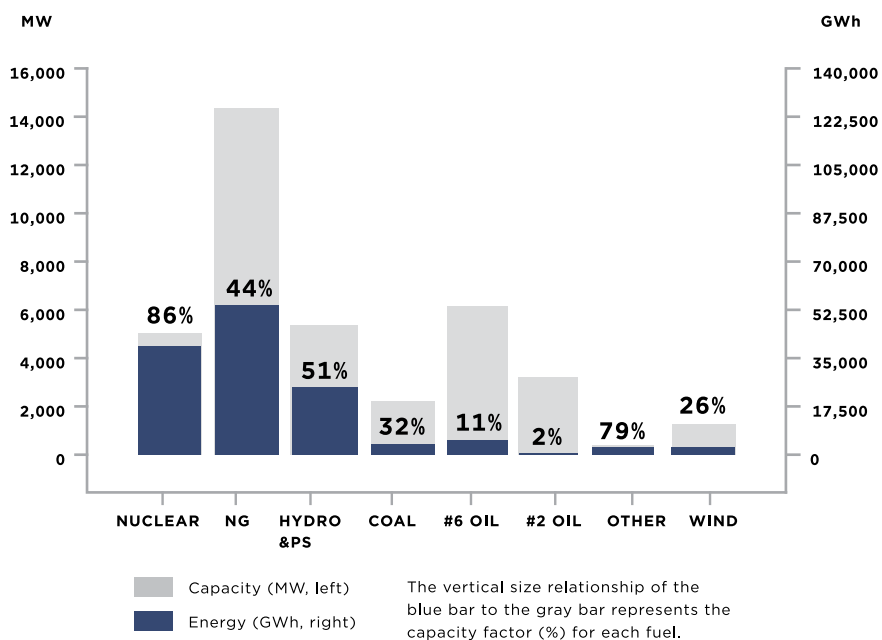
Generation

The generation sector in New York today consists of 25,681 MW of independently-owned generation; 1,349 MW of regulated utility-owned generation; 5,841 MW of generation owned by NYPA; 2012 MW owned by municipal electric companies; and 4,850 MW of generation owned by National Grid (facilities formerly owned by KeySpan and LIPA). These facilities are located throughout the State. An undetermined amount of customer-owned generation also exists throughout the State to provide for the needs of the facility owners at the sites where they are located. This section describes some of the characteristics of the generation available for use in the wholesale market in New York.

Fuel Mix and Capacity Factor

Figure 2 illustrates New York's 2013 aggregate capacity (MW) and 2012 generation (gigawatt-hour, GWh) by fuel type. The aggregate capacity factor (CF), i.e., actual annual generation as a percentage of annual potential generation, for each of the generation fuel types is depicted by comparing the vertical size of the outer bar to the vertical size of the inner bar for that fuel type. The capacity factors are also shown numerically, expressed as percentages. It is important to note, however, that the information shown for the natural gas and petroleum fuels (#6 oil and #2 oil) in Figures 2, 3, 4, and 5 are estimates due to uncertainties associated with dual-fueled units, as explained below.

Figure 2 | New York State 2013 Generation Capacity and 2012 Generation by Fuel Type



Notes: Units are classified according to their primary fuel. Energy generation (GWh) for dual-fuel units are estimated based on the unit's primary fuel type, as fuel-specific generation data for dual-fuel units are not available. "Other" includes wood, waste, solar, and methane. Capacity values are NYISO summer ratings. Nameplate ratings are used to measure wind unit capacity. Hydro total includes output from conventional and pump storage facilities.

Source: NYISO. 2013 *Load and Capacity Data Report*, Table III-2: Existing Generators

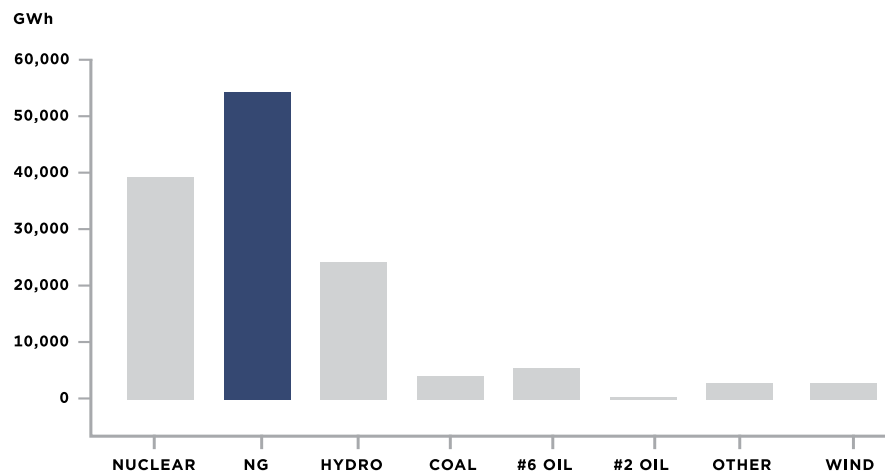
As shown in Figure 2, residual oil (#6) and distillate oil (#2) units typically exhibit very different operating patterns. The 2012 #6 residual oil aggregate capacity factor was 11 percent compared to 2 percent for the #2 distillate oil units, including kerosene. Most units that burn #2 distillate oil are peaking units that were never intended to operate a significant number of hours, as opposed to units that burn #6 residual

oil. Even so, note that capacity factors for both types of oil units generally have been lower in recent years in part due to the disproportionate increase in oil prices, compared to natural gas.

Figure 2 also illustrates that New York’s nuclear facilities had the highest aggregate capacity factor (86 percent) of all fuel types in 2012. Unlike natural gas and oil units, operations of nuclear and hydro units are often considered to be “base load” units. Base load units are generally less sensitive to wholesale electricity market clearing prices, largely due to the lower fuel costs inherent to these units.⁶ However, in recent years, due to relatively low natural gas prices, more natural gas plants have become “base load” units, operating at higher capacity factors than in previous years.

In 2013, 62 percent of New York’s existing generation capacity (MW) was fueled by natural gas or oil. Given the low aggregate capacity factors for natural gas and oil units shown in Figure 2, however, these fuels collectively accounted for only 45 percent of total in-state generation (MWh). This is because natural gas and oil units have higher operating costs than nuclear or hydro units, and thus will have fewer accepted generation bids and lower capacity factors than those base load units. Figure 3 shows the total 2012 New York generation by fuel type only. As with Figure 2, generation from natural gas and petroleum fuels are estimates, as precise information about which fuel is being used in dual-fuel units at any given time is not available.

6. Base load refers to generation that generally operates continuously to serve load, whether during peak or off-peak hours.

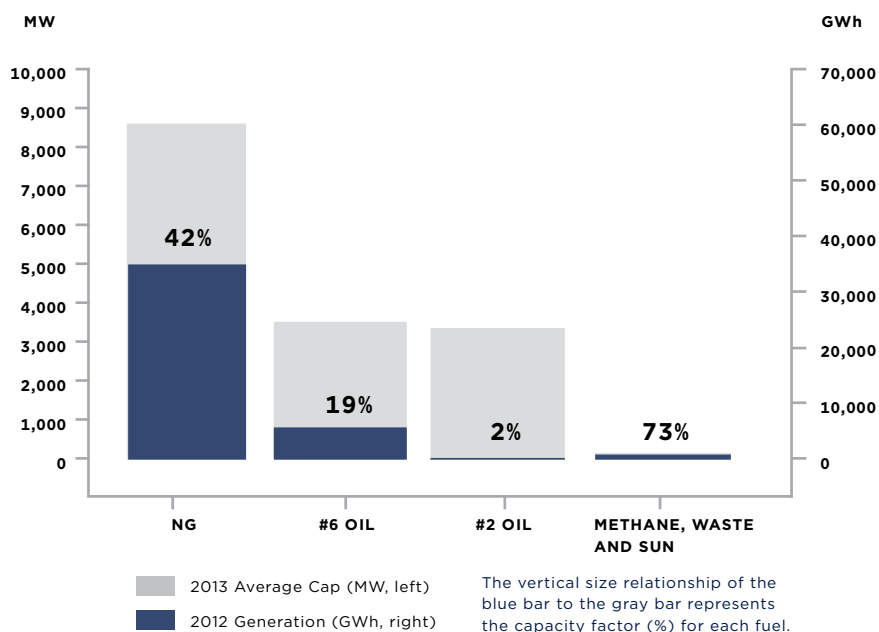
Figure 3 | New York State 2012 Electricity Generation by Fuel Type

Notes: Units are classified according to their primary fuel. Energy generation (GWh) for dual-fuel units are estimated based on the unit's primary fuel type, as fuel-specific generation data for dual-fuel units are not available. "Other" includes wood, waste, solar, and methane. Capacity values are NYISO summer ratings. Nameplate ratings are used to measure wind unit capacity. Hydro total includes output from conventional and pump storage facilities.

Source: NYISO. 2013 Load and Capacity Data Report, Table III-2: Existing Generators.

Figure 4 shows the combined New York City and Long Island generation capacity (MW) by fuel type, as well as each fuel type's aggregate capacity factor as of March 2013. Ninety-nine percent of generation capacity in New York City and Long Island is fueled by natural gas, oil, or both.

Figure 4 | New York City and Long Island 2013 Generation Capacity and 2012 Generation by Fuel Type



Notes: Units are classified according to their primary fuel. Energy generation (GWh) for dual-fuel units are estimated based on the unit's primary fuel type, as fuel-specific generation data for dual-fuel units are not available. "Other" includes wood, waste, solar, and methane. Capacity values are NYISO summer ratings. Nameplate ratings are used to measure wind unit capacity. Hydro total includes output from conventional and pump storage facilities.

Source: NYISO. 2013 Load and Capacity Data Report, Table III-2: Existing Generators.

In 2012, New York City and Long Island natural gas, residual oil, and distillate oil unit aggregate capacity factors were 42, 19, and 2 percent, respectively. The relatively low capacity factors are likely due to the following reasons:

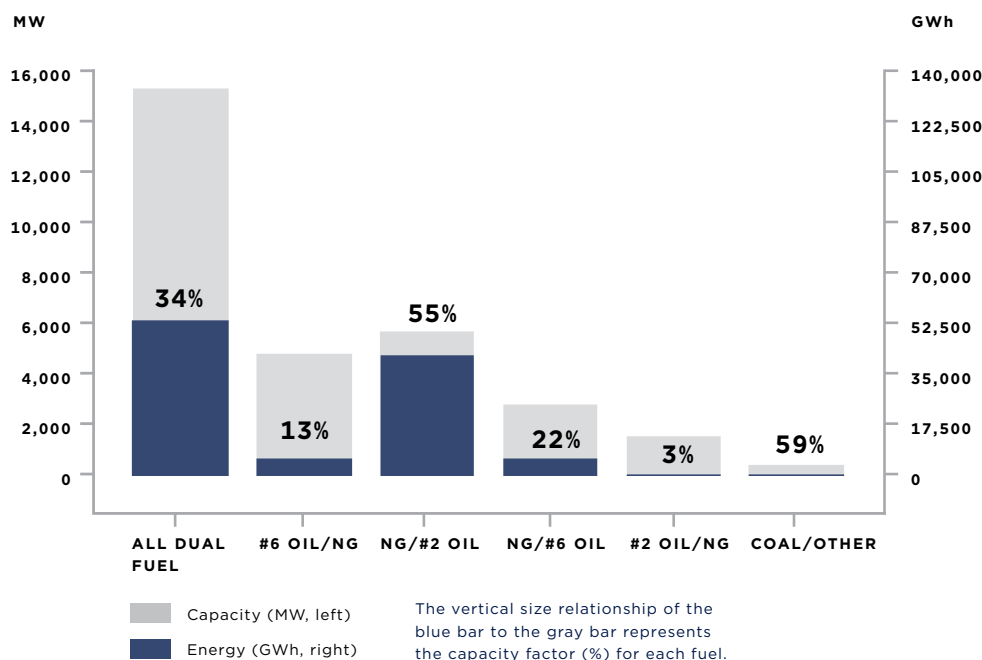
- Low load factor, which is the actual annual load as a percentage of total possible annual load, caused in part by high cooling load occurring for only a few hours of the year
- Need to comply with locational installed capacity requirements downstate⁷
- High downstate operating costs

7. A locational installed capacity requirement is a determination made by the NYISO regarding what portion of the statewide installed capacity requirement must be located electrically within a locality to ensure that sufficient energy and capacity are available in that locality and that appropriate reliability criteria are met.

The low load factor results in part from additional required capacity that is needed for only a few hours a year, providing downward pressure on downstate capacity factors. Additionally, because of downstate transmission constraints, the locational installed capacity requirements mentioned above have been developed to ensure reliability in New York City and Long Island. Despite the locational requirements, higher downstate operating costs, such as fuel costs, property taxes, and labor costs, still lead to the importing of as much lower-cost electricity as possible during the year from external sources, and are leaving local units idle more often.

Figure 5 depicts total New York dual-fuel capacity (MW) by fuel types as of March 2013. Almost 50 percent of New York generation capacity is capable of burning at least two fuels. In the event that the supply source for one fuel is disrupted, these units can burn an alternate fuel. This diversity provides New York consumers with a valuable electric reliability insurance policy, should one fuel supply source be compromised, particularly at a time of high electric system demand.

Figure 5 | New York State Dual-Fuel Units



Note: Units are classified according to their primary fuel. Energy generation (GWh) for dual-fuel units are estimated based on the unit's primary fuel type, as fuel-specific generation data for dual-fuel units are not available. "Other" includes wood, waste, solar, and methane. Capacity values are NYISO summer ratings. Nameplate ratings are used to measure wind unit capacity. Hydro total includes output from conventional and pump storage facilities.

Source: NYISO. 2013 Load and Capacity Data Report, Table III-2: Existing Generators.

Fuel Diversity

As shown above, New York has a diverse fuel mix. This diversity can benefit the State by mitigating the impacts of supply disruptions for any given fuel source, and by mitigating price volatility due to fuel price fluctuations. This, however, is not the case in New York City and on Long Island, which rely heavily on gas-fired generation, although some of those units also are able to burn oil.

The historic fuel diversity that has benefited New York is changing, impacted by ongoing changes in regulatory requirements and market conditions such as: licensing and permit renewals; new State and U.S. Environmental Protection Agency (EPA) regulations; and fuel prices, particularly natural gas prices impacted by new supplies of shale gas.

The near-term construction of a substantial number of new facilities burning coal or oil appears unlikely at this time. Almost all of the power plants placed in service recently in the Northeastern U.S. burn natural gas because they generally have the following advantages over other fossil fuel generators:

- Lower heat rates, and thus potentially lower operating costs;
- Smaller up-front investments;
- Lower emissions, including sulfur dioxide (SO₂), nitrogen oxides (NO_x), carbon dioxide (CO₂), and particulates;
- The ability to be located closer to urban centers due to lower emissions;
- Lower operating costs associated with the relatively low cost of natural gas.

The increasing reliance on gas-fired plants, while beneficial in some ways, presents several concerns. For example, the gas delivery infrastructure is generally sized to provide reliable supplies primarily to non-curtailable gas load and the increasing use of natural gas for electricity generation has strained that infrastructure, resulting in occasional curtailments of supply to power plants. Such curtailments are most likely to occur at times when demand for gas for other purposes is greatest, e.g., in extreme winter weather, when demand for electricity may also be high, which could potentially lead to a loss of electric supply as well. Extreme winter conditions also coincide with times of difficulty supplying coal to, and obtaining oil deliveries for, older plants.

As a result, reliance on natural gas for electric generation in New York City and on Long Island during periods of high demand has led to the adoption of a reliability rule to ensure that the loss of a single gas facility does not bring about a loss of electric load within the New York City

zone. The rule, for certain system applications, specifies minimum oil burn requirements, i.e., that minimum levels of fuel oil be used for select generators in New York City and on Long Island to mitigate the potential loss of electric supply due to generating units tripping off-line in the event of a sudden loss of gas supply.⁸

Other concerns regarding reliance on natural gas-fired generation include gas price volatility and the availability of adequate pipeline capacity. Even though natural gas facilities have relatively favorable environmental qualities, gas-fired generation facilities still emit approximately half the amount of CO₂ as do coal-fired facilities.

The capability of gas-fired facilities to burn oil, or some other fuel, in the event of a gas disruption or curtailment was fairly common in the past because the ability to burn the lowest cost fuel at any given point in time provided an economic as well as a reliability advantage. Many of the older units formerly owned by Consolidated Edison (Con Ed) and the former Long Island Lighting Company (LILCO) have that ability.

Dual-fuel capability in newer units upstate has become far less common because such capability requires additional capital investment to construct oil storage facilities and other equipment to be able to burn the second fuel and carry the oil inventory. In addition, environmental permits for newer units tend to be predicated on the use of natural gas to avoid the applicability of specific environmental regulations or to limit the impact applicable regulations may have on the economics of the unit. These trends, along with other factors such as limitations on the number of hours oil can be burned in dual-fuel units, limit operational flexibility and have a potential impact on fuel diversity and reliability of supply.

In an attempt to improve electric-gas coordination, the NYISO recently formed the Electric-Gas Coordination Working Group. The working group meets regularly and brings together gas producers and suppliers, interstate gas pipelines, and local gas distribution companies, along with the various market participants from the electric industry. The intent of the group is to facilitate communication between the electric and gas industries, regulators, reliability standards organizations, and the NYISO. Additionally, the group aims to identify the impacts that changing gas and electric industry business conditions, changes in the electric generation and gas technology, industry standards, and regulatory

8. This is referred to as the “minimum oil burn” rule.

requirements will have on the infrastructure needs and business practices of both the gas and electric industries for the short-term and long-term horizons.

The NYISO has also initiated a study to perform a comprehensive assessment of the adequacy of gas supplies and the transportation infrastructure together with the NERC defined gas/electric reliability interface. The first goal of the assessment is to have both the gas and electric industries develop a better understanding of how each industry plans, operates, and maintains their respective systems. The second goal is to have the industries evaluate and assess the challenges to reliable operations of both the electric and gas systems. The assessment will also evaluate the potential changes in current practices, communications, and infrastructure that may be needed as interdependencies between the two systems evolve.

Nuclear

Nuclear generation in New York represents approximately 5,411 MW, or 14 percent, of the State's installed generation capacity. In 2012, the six nuclear generators produced 40,817 GWh, or 29 percent of the electric generation in the State.⁹

Nuclear power has been a steady source of electricity generation in the State, advancing reliability of the electric system by providing a significant portion of the State's base load generation, providing lower-cost power, and operating with little to no greenhouse gas (GHG) emissions. Yet there are safety and health concerns with the use of nuclear power, highlighted by the potential release of radioactive material in the event of an earthquake, accident, or terrorist attack. These concerns are amplified for facilities located near densely populated areas such as the Indian Point facility, which is 38 miles north of New York City.

Indian Point has two operating nuclear power reactors in the lower Hudson Valley (Unit 2 and Unit 3 have net electrical capacities of 1,078 MW and 1,083 MW, respectively), and is seeking relicensing of the initial licenses, which expire in 2013 and 2015, respectively. The NRC's Atomic Safety Licensing Board is conducting a series of hearings and administrative proceedings on the license renewal applications. The

9. NYISO. *Gold Bank*. 2013

State of New York has petitioned the NRC in opposition to relicensing. The State is opposing the license renewals of Indian Point Units 2 and 3 due to significant safety and environmental impacts associated with their operation. Various topics, such as the integrity of containment structures, embrittlement of the reactor pressure vessels and associated internals, metal fatigue on key reactor components, and environmental impacts of radionuclide leaks from spent fuel pool leaks, are being reviewed by the U.S. Nuclear Regulatory Commission (NRC). A decision by the NRC regarding the license extensions is not expected until hearings on the above contentions are complete. Because the NRC proceedings are expected to extend beyond the expiration of the federal operating licenses, i.e., 2013 and 2015, Entergy sought and was granted approval from NRC to continue to operate under federal licenses during the pendency of those hearings, and any related appeals. As New York's electric system stands today, if the Indian Point nuclear plant were to become unavailable in 2016, replacement capacity of approximately 1,450MW would be needed that year to maintain the reliable operation of the New York bulk power system. The PSC has ordered Con Edison, NYPA, and other TO's to proceed with \$477 million of transmission upgrades to provide approximately 600 MW on the bulk power system by 2016 in the event that the Indian Point facility is not available.¹⁰

Nuclear power in general faces a number of challenges, particularly waste disposal. The Nuclear Waste Policy Act of 1982 gave the U.S. Department of Energy (DOE) the responsibility to construct and operate a geologic repository for high-level waste. DOE filed an application on June 3, 2008, with NRC seeking authorization to construct a geologic repository at Yucca Mountain in Nye County, Nevada. However, on September 30, 2011, the Atomic Safety and Licensing Board (ASLB) issued a Memorandum and Order suspending the review proceeding.

Until a federal repository is operational, reactor sites will hold spent nuclear fuel in either the wet spent fuel pools on site, or in dry casks outside. Currently in New York, the James A. FitzPatrick, R. E. Ginna, and Indian Point sites have separate Independent Spent Fuel Storage Installations (ISFSI) for dry cask storage, while the Nine Mile site is undergoing construction for a storage site to use in the near future. Spent fuel at Indian Point Unit 3 will be moved in small batches, first from

10. Case 12-E-0503 Proceeding on Motion of the Commission to Review Generation Retirement Contingency Plans.

the Unit 3 spent-fuel pool to the Unit 2 spent-fuel pool. From there, the Unit 3 fuel will be loaded into dry casks for storage at the ISFSI. Several factors, including crane weight limitations and pathway restrictions, prohibit spent fuel from being sent directly from the Unit 3 spent-fuel pool to dry cask storage at the ISFSI.

The decommissioning of nuclear plants also presents challenges. The NRC defines decommissioning as the safe removal of a facility from service and the reduction of residual radioactivity to a level that permits release of the property for unrestricted use and termination of the license. There are four basic aspects to nuclear plant decommissioning: radiological cleanup and removal, fuel, non-radiological, and site restoration. The NRC has established three decommissioning options for licensees: Decon (immediate dismantlement), SAFESTOR (storage, with deferred decontamination), and Entomb (radioactive contaminants are encased in a structurally long-lived material, such as concrete). Currently, all State nuclear plant owners plan to use the SAFESTOR method of decommissioning. This method is intended to permit radiological decay of isotopes over time; however, the licensees are also using this method to capture the time value of money to allow the monies, in the currently underfunded decommissioning funds, to grow in value.

New York opposes the use of SAFESTOR because there is a strong possibility that it will not leave sufficient non-radiological decommissioning funds for future use. The funds will need to cover future security, maintenance, and utilities for storing the spent fuel, and the funding has shown vulnerability to economic turmoil, increasing the likelihood of a funding shortage with an economic downturn. Additionally, the State has no control over the spending of decommissioning funds and no say in what constitutes non-radiological decommissioning and site restoration. The State has no authority to determine that decommissioning and restoration have been conducted satisfactorily. Furthermore, since funding for radiological and non-radiological cleanup and site restoration of nuclear decommissioning is commingled, and because non-radiological decommissioning and site restoration are the last steps in the decommissioning process, removal of structures and completion of site restoration following decommissioning may not occur if insufficient funds remain. Without separation of decommissioning funds, overruns in radiological decommissioning will reduce or eliminate available funding for site restoration.

Coal

New York's installed coal electric generating capacity and total generation output have been in a gradual decline over the past decade due to both market factors and state policy interventions. According to data from the NYISO, both coal and electricity capacity and output peaked in 1989. It remained fairly constant for close to a decade, providing 21 percent of State's supply. However, by 2012, coal accounted for only 3 percent of total generation, representing an approximate 85 percent decline in coal electricity production since 1998. This decline is expected to continue, due in part to competition from low priced natural gas-fired facilities. Simultaneously, there are environmental factors and restrictions and ongoing federal, state, and private initiatives that seek to limit, reduce, and capture emissions from coal plants, including the Regional Greenhouse Gas Initiative (RGGI), which was specifically designed to limit CO₂ emissions from fossil fuel power plants. The costs of regulatory compliance are increasing, and economics of coal use are becoming increasingly challenging.

Recently, certain units at two coal-fired generating facilities that were slated for mothballing were determined to be needed in the short term to maintain the reliability of the system. As a result, National Grid and the New York State Electric & Gas Corp. (NYSEG) entered into Reliability Support Services agreements with the owners of the Dunkirk and Cayuga plants, respectively. In accordance with provisions of the Energy Highway Blueprint, the PSC is examining whether it is more appropriate to build transmission to solve the reliability problem or to provide certain payments to the generation owners to support repowering of the facilities.

Storage

Electricity markets are unique among major commodity markets in that they generally require instantaneous matching of supply and demand. Other energy commodities, such as natural gas and oil, can be stored effectively in large quantities, providing a buffer between supply and demand.¹¹ Without an effective means of storage, the electric grid has traditionally maintained excess capacity in generation and transmission.

11. NYSERDA. *New York Battery and Energy Storage Technology (NY-BEST) Consortium*. 2013. <http://www.nyserda.ny.gov/BusinessAreas/Energy-Innovation-and-Business-Development/Research-and-Development/Advanced-Clean-Power/NY-BEST.aspx>

Although it is difficult to store electricity directly, electric energy can be stored in other forms, such as chemical and mechanical energy, and efficiently converted back to electricity as needed. Both bulk electricity storage, capable of providing hundreds of megawatts of power for several hours, and distributed energy storage, capable of injecting/absorbing up to several MW for seconds or minutes, can provide economic benefits, and improve the stability and reliability of the grid.

In addition to electric energy price arbitrage, bulk electricity storage can meet peak demand and reduce the need for new generation capacity, provide spinning reserve and voltage support, and provide black-start capability. It can reduce transmission congestion and associated line losses. Bulk storage provides capacity firming and time shifting of energy from renewable generation resources, will enhance the value of renewable generation, and reduce the impact of intermittent generation on the grid.

Distributed energy storage technologies include electrochemical batteries, super or ultra-capacitors, flywheels, above-ground mini-compressed air energy storage (CAES), and supermagnetic energy storage. These technologies are focused on the end user. Aggregated and coordinated control and dispatch of these storage technologies, however, can benefit the grid. Distributed storage can inject reactive power where needed for voltage support. Customers with time-of-use energy pricing and/or demand charges are able to reduce costs for electricity with storage systems. Electric power quality, which is increasingly important in the modern electronic world, as well as reliability are improved for customers with installed storage systems.

Demand — Historical and Forecast

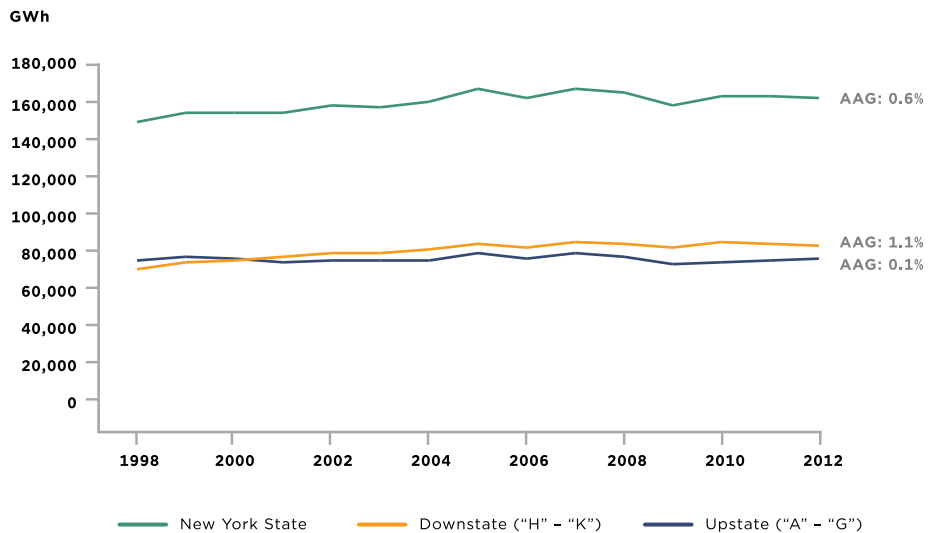
Electric Energy Requirements

As shown in Figure 6, New York electric energy requirements grew by an average of 0.6 percent annually from 1998 to 2012.¹² Downstate electric energy requirements, i.e., in NYCA load zones H through K (Millwood through Long Island) grew at an average annual rate of 1.1 percent, while upstate, which includes NYCA load zones A through G (Western New York through the Hudson Valley), collective growth averaged 0.1 percent

¹². “Electric energy requirements” refers to the amount of electric supply required to meet the demand of end-use customers as well as allow for energy losses that occur during the transmission and delivery of this supply.

annually. In 2012, zones J and K (New York City and Long Island) accounted for 47 percent of statewide electric energy requirements. For comparison purposes, in 1998, New York City and Long Island accounted for 43 percent of the total statewide electric energy requirements, indicating an increased need for additional energy resources in the downstate areas.

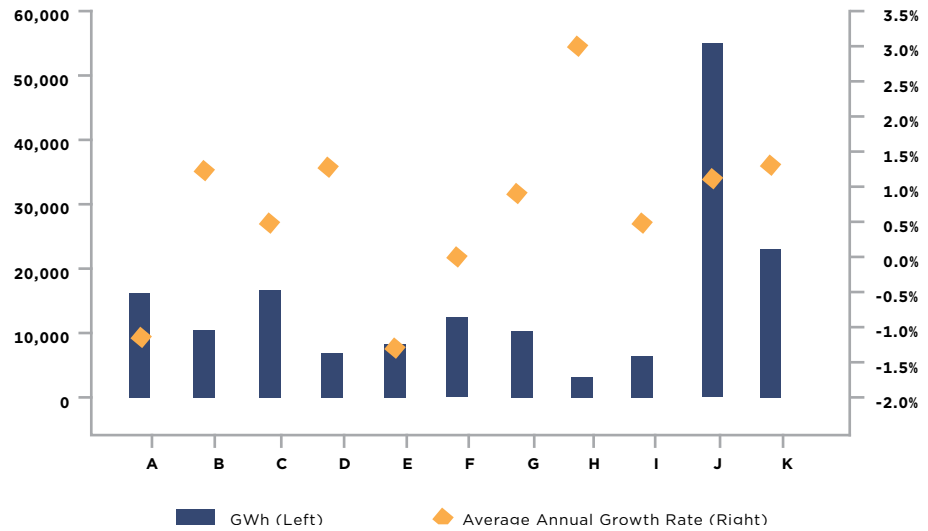
Figure 6 | Annual New York State Electric Requirements



Note: Average Annual growth (AAG)

Source: NYISO. 2013 and 2012 Load and Capacity Data Report.

Figure 7 shows the NYISO zonal electric energy requirements during 2012, and the 14-year historic average annual growth rate of electric energy requirements for each zone. For example, zone H (Millwood) consumed approximately 2,930 GWh of energy and experienced a 2.9 percent average annual growth in consumption over the 14-year period. Positive average annual growth is evident in all zones except A (Western New York), and E (Mohawk Valley), with growth rates of -1.1 percent to -1.3 percent, respectively. Zone K (Long Island) and zone J (New York City) requirements grew by an average of 1.2 and 1.1 percent annually, respectively, over the last 14 years.

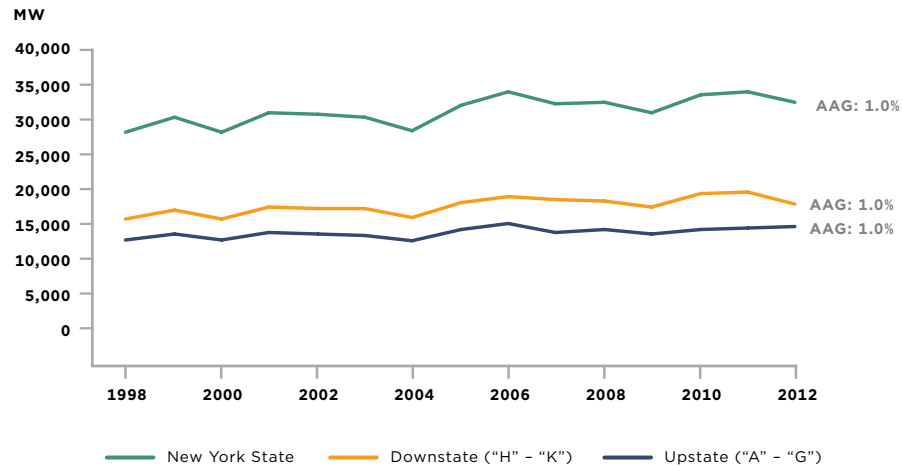
Figure 7 | New York State 2012 Zonal Electricity Requirements

Source: NYISO. 2013 and 2012 Load and Capacity Data Reports.

Electric Peak Demands

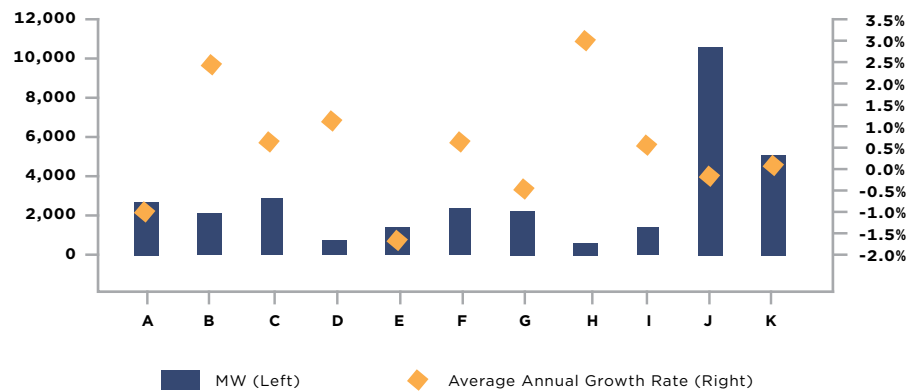
As previously noted, reducing system peak demand is important for improving system efficiency, reducing wholesale electricity prices, and delaying the need for additional infrastructure.¹³ Figure 8 illustrates the statewide, upstate, and downstate annual instantaneous peak demands from 1998 through 2012. While statewide electric energy requirements grew by an average of 0.6 percent annually from 1998 to 2012, the statewide electric peak demand grew by an average of 1.0 percent per year, as shown in Figure 8. Both upstate and downstate regions peak demands grew faster than their energy requirements over the 14-year period.

¹³. The data represent actual points in time and are not adjusted for weather conditions.

Figure 8 | New York State Annual System Peak

Source: NYISO. 2013 and 2012 Load and Capacity Data Reports.

Figure 9 shows the 2012 peak demands for each of the NYCA load zones and the average annual 14-year growth rate of peak demand for each zone. Similar to the change in electric energy requirements, negative peak demand growth occurred in zone E (Mohawk Valley). While zone A (Western New York) also had negative energy requirements growth, peak demand in the zone was positive. Although energy requirements were essentially the same downstate, peak demand in zone K (Long Island) grew at a faster rate than in zone J (New York City) over the last 14 years.

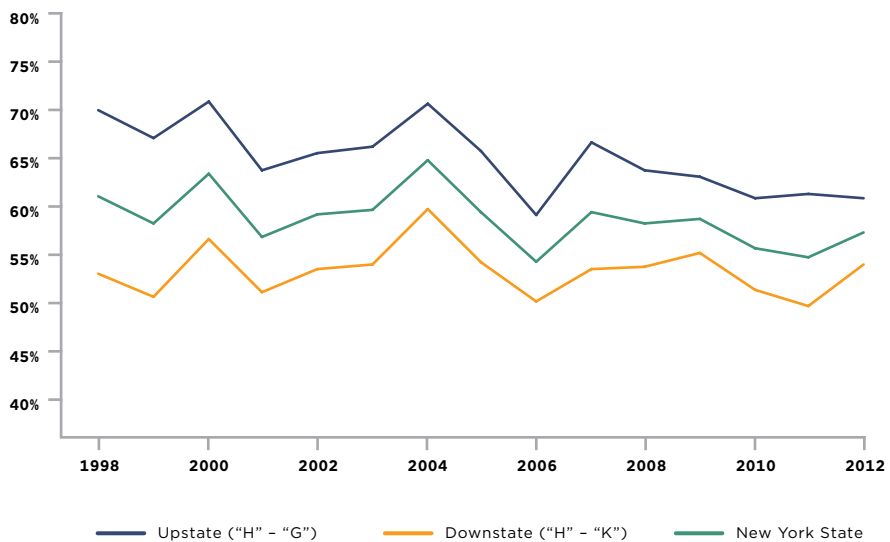
Figure 9 | New York State 2012 Zonal Peak Demand

Source: NYISO. 2013 and 2012 Load and Capacity Data Report.

Load Factor

Load factor is a measure of the degree of uniformity of demand over a period of time, usually one year, and equivalent to the ratio of average demand to peak demand expressed as a percentage. It is calculated by dividing the total energy provided by a system during a period by the product of peak demand during the period and the number of hours in the period.¹⁴ A high load factor indicates high utilization of a system's equipment and is a measure of efficiency. Using this measure, the trend in New York has been toward a less efficiently used system. Approaches, such as expanding programs for mandatory hourly pricing, demand response, and advanced metering, are being pursued to address this trend. Figure 10 shows the trends statewide, in upstate (zones A through G), and downstate (zones H through K) load factors from 1998 to 2012.

Figure 10 | New York State Annual Load Factor



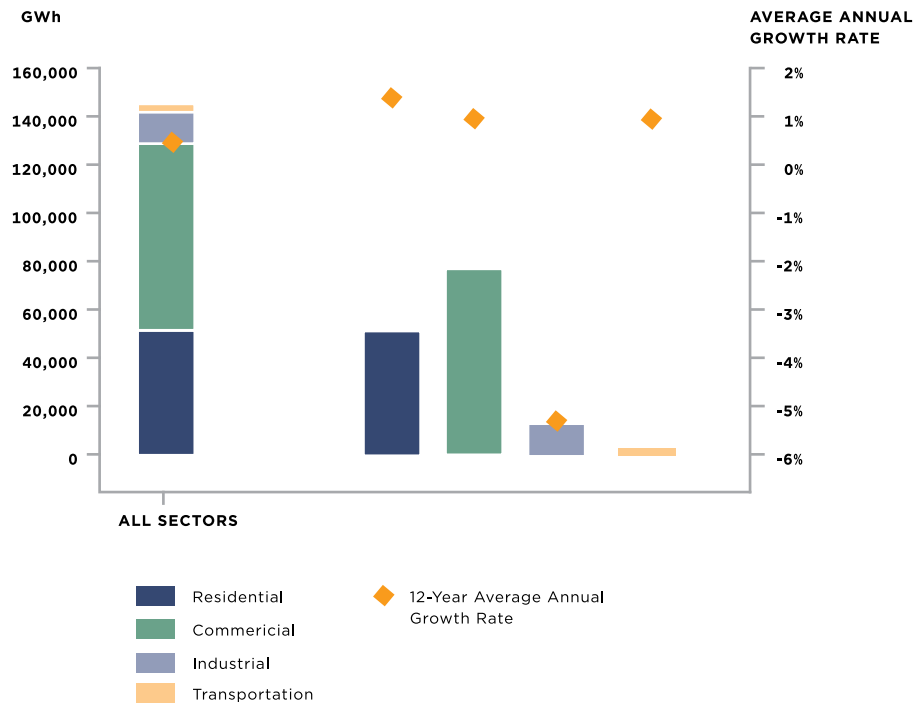
Source: NYISO. 2013 and 2012 Load and Capacity Data Report.

¹⁴. North American Energy Standards Board Wholesale Electric Industry Glossary.

Electricity Sales by Customer Sector

Figure 11 depicts 2011 New York electricity sales by sector, with the 12-year average annual growth for each sector also shown.¹⁵ Sales in the commercial sector made up approximately 53 percent of total sales in 2011, compared to approximately 49 percent in 1999. Sales growth in all sectors averaged 0.3 percent over the 12 years. Average annual growth in the residential, commercial, and transportation sectors was 1.5, 1.0, and 1.0 percent, respectively. While the industrial sector averaged a 5.3 percent annual decline in sales, part of this decline is due to a re-classification of customers by certain utilities.

Figure 11 | New York State 2011 Electric Sales by Sector



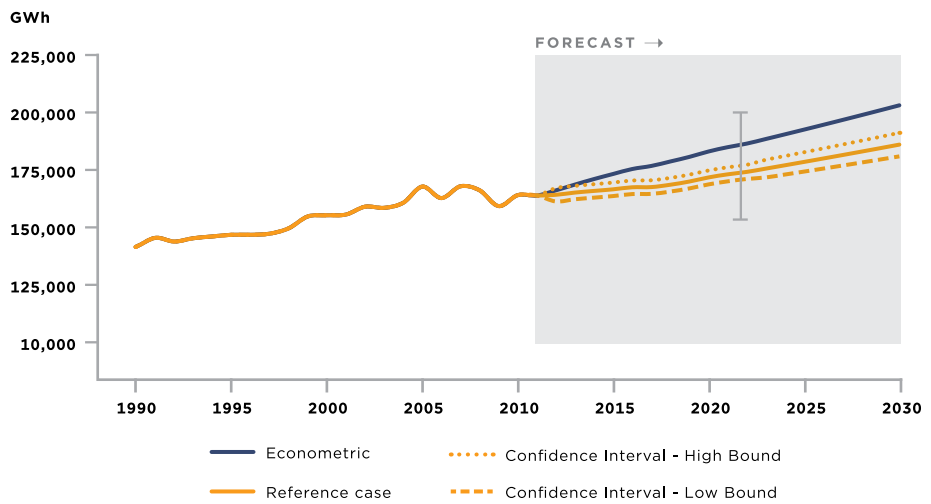
Source: EIA. *2011 Retail Sales of Electricity by State by Sector by Provider*. 2013.

¹⁵. 2011 data will not be available from the EIA until January 2013.

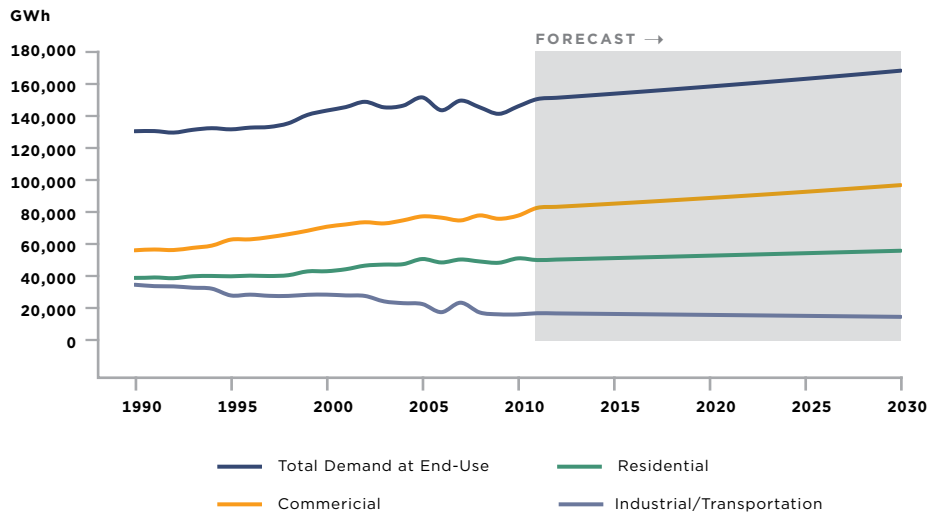
Forecast Demand

Figure 12 shows the historic and projected State electricity requirement through 2030. The NYISO load forecast extends from 2012 to 2022, and projects electricity load to grow at an annual rate of 0.52 percent over those years. Load forecast values for 2023 through 2030 are projected based on the average growth rate over the last five years of the NYISO load forecast. Figure 13 shows historic and projected electricity use by sector. As you can see, electricity use from the industrial/transportation sectors is projected to decline in the future.

Figure 12 | New York State System Level Electricity Requirement (GWh)



Source: 1990-2010 from *Pattern and Trends*. Total electricity requirement for New York for year 2011 and forecast through 2022 is from NYISO *Gold Book*, 2012. Forecast years 2022-2030 are based on 2013 *New York State Energy Plan* IPM modeling.

Figure 13 | Electricity End-Use by Sector (GWh)

Notes: Includes an average 9% system loss at the transmission and distribution level. Sector forecasts are based on gross state product and population projections.

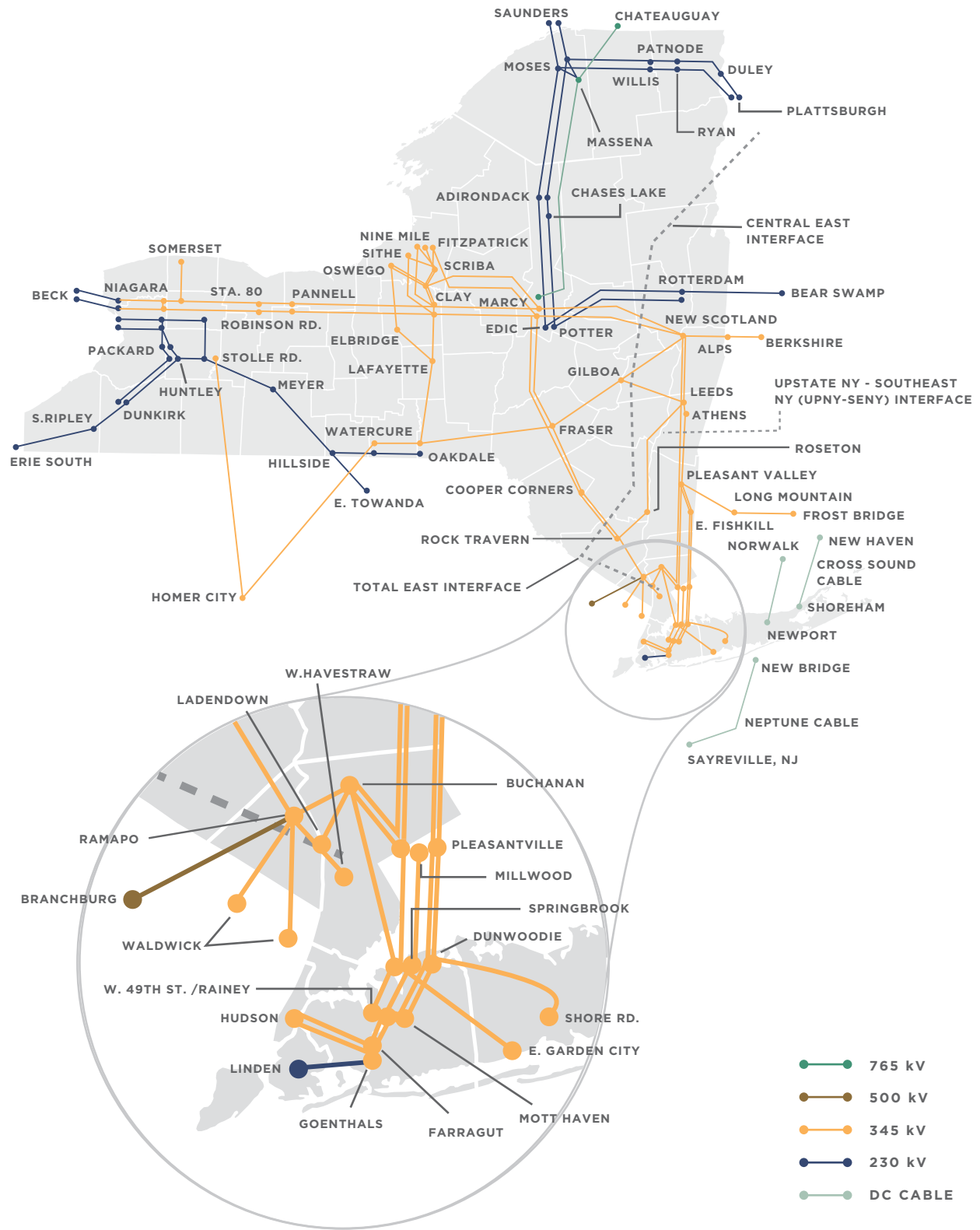
Source: NYSDERDA, *Patterns and Trends 1997-2011*. Forecast years are based on 2013 *New York State Energy Plan* IPM modeling.

Transmission

System Overview

Electric power transmission typically occurs between a central station power plant and a substation where the voltage is reduced, allowing it to be distributed either to a sub-transmission system or directly to a distribution system serving customer loads, neither of which are generally considered part of the bulk power system. Due to the large amount of power involved in transmission, this form of delivery normally takes place at relatively high voltages to minimize power losses along the way. Bulk power typically is transmitted over long distances through overhead power lines, although in New York City, underground circuits are used. The New York transmission system consists predominantly of alternating current (AC) transmission lines, similar to what exists in most of the U.S. Only a small portion of the New York system consists of direct current (DC) facilities.

Figure 14 illustrates the 230 kilovolt (kV) and greater bulk transmission system in New York under the control of the NYISO and neighboring power system operators. The many transmission facilities in the State lower than 230 kV, such as those rated at 115 kV and 138 kV, are not shown on Figure 14 due to their large numbers, although many of them are also considered part of the bulk power system.

Figure 14 | NYISO Transmission 230 (kV) and Greater (2011)

Source: NYISO. 2011 Congestion Assessment and Resource Integration Study. 2011.

System Constraints

The NYISO has a generation scheduling process that is designed to select and dispatch the lowest cost power to meet demand across the State.¹⁶ However, physical limitations of the transmission system, which are referred to as constraints or congestion, often require the dispatch of more expensive sources of electricity downstream of the constraint to ensure that the transmission system continues to operate reliably.¹⁷ Removal of constraints or congestion typically involves analyses to determine if the cost of the upgrade is acceptable in comparison to the benefits to be achieved.

To address congestion, various approaches need to be considered, such as construction of new transmission facilities, upgrading existing facilities, new generation, energy efficiency, or demand response. NYISO's Congestion Assessment and Resource Integration Study (CARIS), an economic planning process first implemented in 2009 and performed every two years, is designed in part to consider and measure the relative value of such alternatives.

The NYISO tracks the transmission facilities that account for the majority of congestion in the State, measured in terms of economic impact. In 2012, the major constraint within the State was along a corridor stretching from the Utica area through the Capital region and into the lower Hudson Valley accounting for 56 percent of the total economic congestion in the State. The next major constraining facility was the cable connecting the northern Con Ed system with Long Island: it accounted for 36 percent of the total economic congestion in the State.

The statewide value of congestion has been calculated by the NYISO since 2003, using a bid-production-cost-savings methodology.¹⁸ The value of gross congestion has varied from an annual low of approximately \$71.7 million in 2004 to a high of approximately \$243 million in 2008. In 2012, the value of gross congestion was approximately \$106 million. Note that these dollar amounts are estimated total statewide congestion costs that

16. Dispatch is a term used to describe the control and scheduling of multiple generation sources to meet customer demand and energy requirements.

17. Congestion is a term used to describe a transmission system operating at or near a security limit or limits, resulting in dispatch of more expensive electricity than would be dispatched in an unconstrained system. Security limits are set based upon thermal ratings of system components, e.g., lines and transformers, as well as voltage and stability considerations.

18. This methodology measures the societal resource cost savings gained by operating less expensive generation in place of more expensive generation located in transmission-constrained areas known as load pockets.

reflect the money that could be saved if all congestion within the State were eliminated; the cost of relieving the congestion would need to be subtracted from this amount to arrive at net savings. A specific project proposal to resolve congestion would need to be weighed by comparing the annual carrying costs of building and maintaining a facility with the congestion costs that can be saved.

To address transmission system constraints, the New York PSC has initiated a proceeding to invite developers and transmission owners to propose AC projects that will increase the transmission capacity of the corridor that traverses the Mohawk Valley Region, the Capital Region, and the lower Hudson Valley by 1,000 MW, consistent with the objectives of the Energy Highway Blueprint.¹⁹ It is expected that upgrading this section of the transmission system will bring near-term benefits such as enhanced system reliability, and long-term benefits such as job growth and development of efficient new generating resources at lower cost in upstate areas.

Criteria for Infrastructure Upgrade

The need for additional and upgraded generation and transmission infrastructure can be weighed against three sets of criteria: reliability, economics, and public policy. Reliability refers to the ability to operate the electric system within limits and without interruption of service to consumers. Economics refers to removal of constraints (or congestion) on the system that limits the ability to transfer relatively low cost power from one location to another. It should be noted, however, that an electric system can be operated reliably with congestion, i.e., times when the physical limits of certain elements of the transmission system are reached, although this may result in a more expensive and/or more polluting generation dispatch. Reducing environmental pollution, addressing global warming concerns, and promoting energy independence are examples of public policy considerations that may, via an increase in renewables and/or access to them, also drive the development of transmission for reasons other than reliability and economics. Public policy issues impacting transmission are likely to

19. Case 12-T-0502, Proceeding on Motion of the Commission to Examine Alternating Current Transmission Upgrades (issued November 30, 2012).

be addressed in the future by processes consistent with or developed pursuant to FERC Order 1000.²⁰

The NYISO and New York's transmission owning utilities and power authorities worked together to complete power grid upgrades that were part of a statewide \$75 million Smart Grid initiative, supported by \$37.8 million in Smart Grid Investment Grant (SGIG) program funds from the U.S. DOE under the provisions of the American Reinvestment and Recovery Act (ARRA) of 2009. Under this initiative, more than 40 phasor measurement units (PMU) have been installed across the State, which will improve grid operator's ability to more quickly detect irregularities, predict problems, and take corrective action to maintain reliability. Connecting with networks in neighboring regions will provide grid operators with broader situational awareness of grid conditions throughout the Eastern and help avoid major electric system disturbances like the 2003 blackout. New York's SGIG project also supported the deployment of new capacitor banks, which improved the efficiency of the bulk system by reducing the amount of electricity that is lost when carried over long distances.

Aging T&D Infrastructure

Maintenance of safe and reliable service at a just and reasonable cost, including guarding against the failure of existing Transmission and Distributions (T&D) facilities, is a primary objective for the State. While age is not the sole determinant as to when facilities should be replaced, the electric grid is composed of mechanical components that reach a point where maintenance costs exceed replacement costs. As such, the average age of facilities is an indicator of when large expenditures are likely to occur to replace infrastructure.

Major components of the T&D system are poles, cables, circuit breakers, and transformers. On average, these components are approximately 40 years old for the major electric utilities in the State.²¹ The electric utilities have capital investment programs where they examine their systems to determine what infrastructure improvements are needed to maintain safe and reliable service in their service

20. FERC Docket No. RM10-23-000, *Transmission Planning and Cost Allocation by Transmission Owning and Operating Public Utilities*, Order No. 1000. July 21, 2011.

21. Major electric utilities referenced here are Central Hudson, Con Edison, National Grid, NYSEG, O&R, RG&E, and LIPA.

territories. Over the last five years, the major electric utilities have invested approximately \$11.4 billion in infrastructure programs, and are expected to invest approximately \$12 billion from 2012 through 2016 on future programs. Such expenditure levels likely are to be required well into the future.

In addition, the State's transmission owners, including LIPA and NYPA, participated in a joint Statewide Transmission Assessment and Reliability Study (STARS) to develop a long-range plan to identify system's infrastructure needs for the future. The study found the need to replace nearly 40 percent of New York's transmission lines, comprising nearly 4,700 miles of transmission at operating voltages 115 kV and above, over the next 30 years. The study also found the need to upgrade local lines to take advantage of wind potential upstate, to reduce congestion through new transmission lines downstate, and to make upgrades to existing infrastructure.

Distribution System

Electric utilities are responsible for operating and maintaining their respective distribution systems in order to supply electricity to individual customers. Distribution systems are designed as either radial or network systems and can be located either overhead or underground. Radial distribution systems consist of a number of primary circuits extending radially from a distribution substation. The radial system is principally an overhead system and subject to interruptions caused by tree contact, accidents, and lightning. It should be noted, however, that service interruptions on the radial system are mitigated by fusing and reclosers that isolate customers downstream from the fault. Customer impact can be mitigated further by isolating the cause of the outage through manually reconfiguring the circuit through field ties. In some instances, utilities have installed switching equipment that automates the reconfiguration process. Advances in technology are making automation more cost-effective and will be used more in the future.

A network system is most frequently found in high-load-density metropolitan areas because a dense population of customers affords the economical design and installation of redundant parallel lower voltage feeder cables, network transformers, and protective relays. By design, the network systems are more reliable than radial systems because service interruptions generally occur only when there is a failure within the connection to the customer, erroneous construction activities, or when the substation supplying the network suffers a complete collapse in its

ability to serve the load. Con Ed's extensive underground system is an example of such a network.

One of the primary objectives for the State is to have the utilities maintain safe and reliable service at a just and reasonable cost. In order to accomplish this objective, the electric utilities have inspection programs and capital investment programs where they examine their systems to determine what infrastructure improvements are needed, including guarding against the failure of existing T&D facilities. A concern currently facing the State is that, on average, core system components, such as poles, cables, circuit breakers, and transformers, are approximately 40 years old for the major electric utilities in New York.²² A significant percentage of the high-voltage transmission facilities in the State went into service before 1980. While age is not the sole determinant as to when facilities should be replaced, the electric grid is composed of mechanical components that reach a point where maintenance costs exceed replacement costs. As such, the average age of facilities is an indicator of when large expenditures are likely to occur to replace infrastructure.

As plans for improving reliability or replacing aging infrastructure are being developed, the utilities are encouraged to consider the benefits of further modernizing their distribution system to include advanced technologies where appropriate. Currently, the electric grid in New York, as well as most other large power systems in the world, uses up-to-date, modern, and extensive technology and approaches to control electricity flow and operations. The transmission system is the most advanced because of its critical nature and the fact that it has fewer components than the distribution system. In general, monitoring and communication equipment is used for transmission systems above 115 kV. Distribution facilities, however, are typically less sophisticated than transmission systems, particularly in remote areas of the State. Continued increased use of advanced technology in New York, including Smart Grid concepts,²³ could result in significant improvements.

Given the costs and rate impact of certain projects, it is important that the benefits of advanced technologies are understood and realized.

22. Major electric utilities referenced here are Central Hudson, Con Edison, National Grid, NYSEG, O&R, RG&E, and LIPA.

23. Smart Grid encompasses use of advanced/enhanced technology and two-way communications to improve the operations and the efficiency, and thus the load factor, of the entire electric grid from generation to end-use consumption.

Therefore, the State is pursuing Smart Grid through an integrated approach and strategy through its work with utilities, on various task forces, and in consortiums. The State's efforts is complemented by the work of the New York State Smart Grid Consortium,²⁴ which has developed a work plan and vision statement to guide the phased development of the Smart Grid such that all stakeholders can understand their roles, responsibilities, and opportunities in a roadmap toward the New York Smart Grid. Several initiatives to expand the use of advanced technology and implement Smart Grid elements are under way in New York. Recent enhancements include Con Ed's 14 kV autoloop system, which is more resilient and sophisticated than most radial circuits, as well as its Dynamic Feeder Rating program for 345 kV feeders, which provides real-time information regarding thermal conditions of feeders to network operators, allowing for greater power transfers and operational flexibility. Con Ed is currently installing similar functionality on select 138 kV feeders.

Orange and Rockland Utilities Inc. (O&R) has a Smart Grid pilot project that will test increased monitoring and communication on two distribution circuits. Con Ed plans to use the Long Island City network as its primary location for hosting pilot projects, and will host a superconductor pilot project funded by DOE. O&R and Con Ed are participating in the Electric Power Research Institute (EPRI) Green Circuit program, which is an Research and Development (R&D) effort aimed at reducing distribution line losses. NYSERDA has also issued several notices to support R&D projects for Smart Grid technologies. The Advanced Energy Center at Stony Brook University is coordinating efforts to assist various business sectors of the Smart Grid community with R&D needs, as well as providing a center for validation and verification of product functions and capabilities. The Advanced Energy Center is working with universities from around the State to provide a comprehensive array of services. In addition, the Northeast States' RGGI may also serve as a funding mechanism for Smart Grid activities.

To address some of the pollution impacts of automobiles, hybrid (electricity and petroleum fuel) engine technologies have been

24. The New York State Smart Grid Consortium, comprised of representatives from the power generation, transmission, and distribution sectors, including utilities, transmission companies and independent providers, technology companies, State governmental entities, energy and grid technology researchers from universities, and the Brookhaven National Laboratory.

introduced to the market, and their use is expanding. Purely electric vehicles that charge the vehicle batteries through a plug-in arrangement with the local electric utility are also now on the market.

Installing Electric Vehicle Supply Equipment (EVSE), especially high-voltage EVSE, means using more electricity from the electric grid for transportation, which could potentially strain an electric grid that in some places already operates near capacity. A number of studies have investigated the effects of widespread electric vehicle (EV) use on the current electric grid, both at the transmission level and the local distribution level. These studies generally have found that even with relatively high concentrations of EVs, the electric grid has enough capacity to supply electricity to EVs without major new investments beyond regularly planned upgrades to the local distribution system.²⁵ This optimism depends in part on “smart charging,” or charging vehicles during off-peak hours when there is excess grid capacity, rather than during peak hours, when the grid is already near capacity. Smart Grid technologies and technologies built into vehicles or EVSE to set charging parameters can enable smart charging.

Maintaining and modernizing the T&D system requires significant levels of investment: the major electric utilities are expected to invest more than \$2 billion per year on such programs. Based on recent severe weather events, utilities are also replacing certain aged infrastructure with more resilient components to help mitigate the potential impact of future storms. Given the systems age and higher focus on resiliency, such expenditure levels likely are to be required well into the future.

25. NYSERDA. *Environmental Assessment of Plug-In Hybrid Electric Vehicles, Volume 1: Nationwide Greenhouse Gas Emissions*. July 2007. http://mistrada.com/yahoo_site_admin/assets/docs/epriVolume1R2.36180810.pdf

Distributed Generation/ Combined Heat and Power (DG/CHP)

In recent years, New York has led a growing number of efforts to support the expansion of Distributed Generation/Combined Heat and Power (DG/CHP) resources.²⁶ The CHP Working Group of the Governor’s Renewable Energy Task Force has led policy efforts to lower barriers to further DG/CHP development.²⁷ The PSC and the Department of Public Service (DPS) have also led initiatives to develop standardized interconnection requirements (SIR) for distributed generation. New York’s SIRs, which allow for the expedited processing and review of small installations (50kW and less), have been a model for other states. To help promote the use of DG/CHP in New York, certain distributed generator facilities may be exempt from standby rate requirements if they meet the eligibility criteria. The City’s PlaNYC includes a recommendation that building codes be modified to require any new residential or commercial development over 300,000 square feet to conduct a feasibility study of district energy systems, including CHP. While the code has not been formally changed, the City is encouraging all large developments now on the drawing boards to conduct such an analysis before proceeding further. These developments are also likely to have as yet undetermined impacts on bulk system operations and planning which could potentially be significant.

New York’s utilities recognized the benefits of distributed generation, and have worked to help implement DG/CHP projects in their service territories. For example, in New York City, DG/CHP projects are an important resource to delay or defer expensive utility infrastructure investments. As a result, Con Ed has worked diligently with DPS, NYSERDA, and the DG/CHP community to facilitate projects. Con Ed has a dedicated full-time DG/CHP ombudsman to help with DG/CHP siting and interconnection issues.

²⁶ DG is defined as power production resources that generally do not use the State’s electrical grid for delivery to consumers. Typically, such generation is located on the consumers’ site behind their meters and any interconnections with the State Grid. CHP, also known as “cogeneration,” is defined here as self-production of electricity on-site, i.e., a DG facility, but that also provides beneficial recovery of the heat byproduct from the generator for other uses at or near the generator site. Although DG units historically have been associated with peak-shaving, their use in association with CHP allows them to go beyond that single purpose use in many cases.

²⁷ Includes representatives of NYSERDA, DPS, New York City, and the general DG/CHP community, including developers, building owners, and economic and industrial development agencies.

Electricity Markets and Prices

Market Structure and Commodity Pricing

The current competitive generation market in New York began to take shape in August 1994 when the PSC instituted an investigation of the issues related to the emerging competition in the electric industry. As a result, a competitive wholesale electricity market was established and the NYISO was created in 1999.

An integral part of establishing a competitive wholesale electricity market in New York was the separation of the ownership of transmission and distribution assets from the ownership of electric generation assets. The PSC policies adopted in the mid-1990s have resulted in the divestiture of most utility-owned generating facilities, the exception generally being some small hydro units and natural gas turbines as well as units associated with the Con Ed steam system. The divestitures resulted in an upstate generation market with facilities owned by multiple entities, with no significant market power concerns. Still, there continues to be market power concerns in New York City. Under the resulting markets, the traditional transmission and distribution owners, such as investor-owned utilities, LIPA, and NYPA, continue to provide delivery service. Numerous owners of generation resources, providers and aggregators of demand-side resources, and a multitude of ESCOs are in place to provide commodity service to end-use retail customers. The NYISO has instituted planning processes looking 10 years out to ensure that the markets are prepared to provide resources needed to ensure reliable system operation. If the markets fail, there is a backstop process in place to ensure that utilities procure such resources for reliability purposes. The NYISO has also implemented an economic planning process to identify the potential for upgrades that could lower prices. Along with the advent of the NYISO came a new system for pricing wholesale electricity, i.e., commodity pricing, known as Locational-Based Marginal Pricing (LBMP). A LBMP consists of energy, congestion, and marginal loss components relative to a reference location; it represents the incremental value of an additional unit of energy injected at a particular location.²⁸ This system of pricing is designed to provide economically efficient price signals throughout the grid, taking all three factors into account. The

28. NYISO. *Technical Bulletin 62 – Locational-Based Marginal Pricing – Meaning and Myth*. September 21, 2010. http://www.nyiso.com/public/webdocs/markets_operations/documents/Technical_Bulletins/Technical_Bulletins/Technical_Bulletins/tb_062.pdf

NYISO operates both a day-ahead market and a real-time (or balancing) energy market, and produces prices for both energy and ancillary services such as operating reserves and regulation service.^{29, 30} Using the bids of both suppliers and demand-response resources, the NYISO software economically commits and dispatches resources at the least cost, consistent with transmission and other system constraints, using a uniform-price auction format. Essentially, this means the market clearing price paid to all suppliers is based on the marginal cost of the last unit chosen to serve load.³¹ Under this arrangement, suppliers, absent market power, have every incentive to bid into the market their marginal costs of production, because if they bid below it, they may run at a loss, and if they bid above it, they may not be selected for dispatch, and will neither run nor be paid. This results in the system being dispatched in the most efficient manner to minimize total production costs and provide power to consumers at the lowest possible price.

The markets are designed to provide transparent price signals for both energy and capacity that encourage investors to locate generation, transmission, or demand response where they are most needed for both economics and reliability. The markets are also intended to encourage investment in more efficient resources that can compete and be offered into the market at lower prices, and to place the risk of large capital investments on private-sector developers rather than captive utility ratepayers. It should also be noted that eliminating the inefficiencies in cross-border trading between New York and its neighbors can significantly reduce costs to consumers. The NYISO is pursuing several initiatives in this regard. Finally, as well as the NYISO markets function, it should be noted that addressing markets generally, including energy markets, does not necessarily internalize all societal values. For example, it is likely that electricity prices do not currently reflect the full cost to society of related carbon emissions. The State still has a role to assure that societal goals are addressed in electricity and other energy markets.

29. Operating reserves refer to capacity that is available to supply energy or reduce demand in the event of contingency conditions, including spinning reserves, 10-minute non-synchronized reserves, and 30-minute reserves.

30. Regulation service is defined as the capability of a specific generating unit with appropriate telecommunications, control, and response ability to increase or decrease its output in response to a control signal every 6 seconds. This ensures the continuous balancing of resources (generation and interchange) with load variations to maintain scheduled interconnection frequency.

31. The marginal cost is the cost to produce the next increment of output. The generating unit that produces that increment is called the marginal unit (or the unit on the margin) at that point in time.

Installed Capacity Pricing

To ensure resource adequacy, the NYISO administers an Installed Capacity (ICAP) market. Capacity suppliers commit to being available to serve load when called upon. The NYISO requires sufficient capacity to serve peak-load reliably. To accomplish this, Load Serving Entities (LSE), i.e., utility affiliates and ESCOs that supply electricity to end-use customers, are required to acquire capacity at least equal to their forecast peak load plus a required reserve margin (established annually) to ensure that sufficient resources exist to serve peak load. The current statewide minimum capacity requirement for May 2013 through April 2014 is 117 percent of forecast peak load. Due to transmission constraints that limit the ability of upstate generation to serve downstate load, LSEs serving New York City and Long Island must acquire a portion of their capacity from local generation. FERC has recently approved the creation of an additional capacity zone that would include the lower Hudson Valley and New York City. The current minimum locational requirements for New York City and Long Island are 86 percent and 105 percent of forecast peak load, respectively. The proposed locational requirement for the new zone is 88 percent.

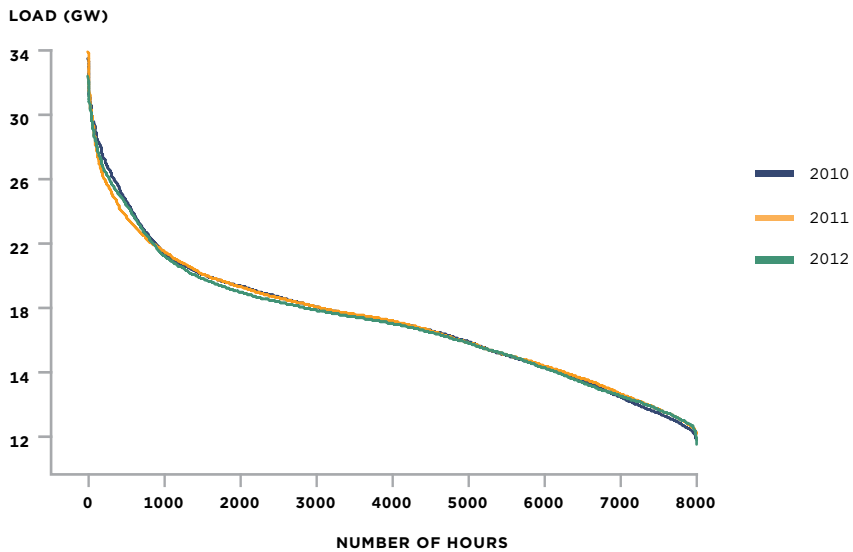
In addition to the statewide market, there are separate capacity markets for New York City and Long Island generation, along with the proposed new South Eastern New York (SENY) zone (encompassing lower Hudson Valley and NYC). Market participants can choose to buy or sell the required capacity either through bilateral contracts or through voluntary strip or monthly auctions. The strip auctions are held biannually and cover all six months of the capability period. The auctions are held monthly and allow for trading in any of the future months of that capability period. To enforce the purchase requirements, LSEs that do not procure enough capacity voluntarily through the strip or monthly auctions, or via bilateral transactions, must purchase the rest at a price determined in the spot auction, which is held at the end of each month, for the upcoming month's capacity.

Capacity markets have proven contentious in New York and elsewhere. In 2012, the NYISO contracted with FTI Consulting for a re-examination of the current capacity market and alternative market structures. The report included recommendations for enhanced scarcity pricing rules, and modifications for the current mitigation rules including a merchant exemption. The report also included an analysis of a forward capacity market design, and recommended against moving to a forward capacity market design due to the complexities and unclear benefits of a forward market structure.

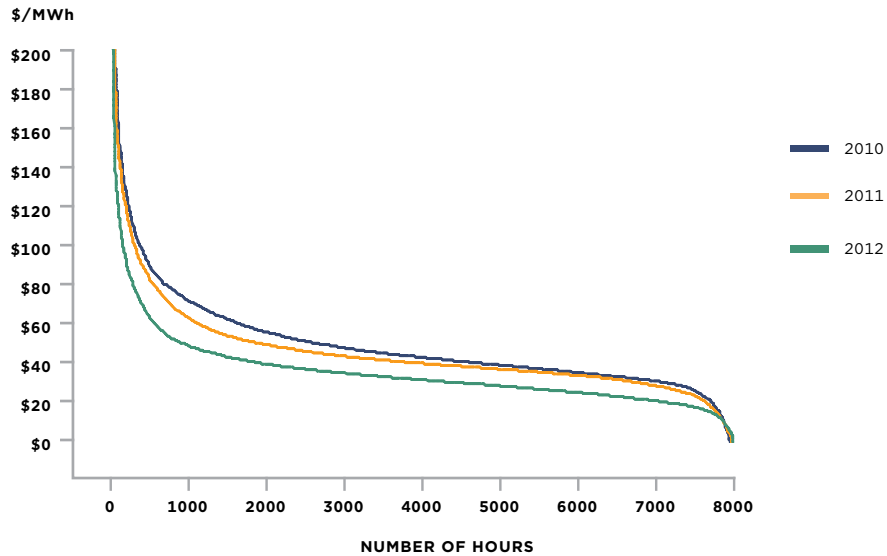
Load versus Price

The importance of the pricing and market structure is illustrated in the statewide load and price duration curves shown in Figure 15 and Figure 16. Numerous demand-response programs, discussed below, have been initiated to reduce demand and the need for supply resources in these high load hours, particularly during summer heat waves. These curves show the system load and wholesale energy price based on the number of hours they occur or were exceeded in a year. The near proximity of these annual curves demonstrates that statewide demand generally changes only modestly from year-to-year. Much of the small variation can be explained by variations in weather. The position of the price duration curves relative to each other is largely driven by the year-to-year change in the price of natural gas. These figures show in tandem how the hours of highest load, which require use of the most expensive resources to meet that load, result in the highest prices. They also show that the need to carry a significant amount of capacity to supply load occurs during only a very few hours of each 8,760-hour year. Numerous demand-response programs, discussed below, have been initiated to reduce demand and the need for supply resources in these high load hours, particularly during summer heat waves.

Figure 15 | Load Duration Curves (2010-2012)



Source: NYISO. *Annual State of the Market Report*. 2013.

Figure 16 | Price Distribution Curves Statewide Average Real-Time Price (2010 to 2012)

Source: NYISO. *Annual State of the Market Report*. 2013.

Because the wholesale price of electricity varies from month to month and year to year, largely driven by swings in the price of natural gas, retail prices can be volatile over time. Consequently, the PSC requires that the regulated utilities maintain supply portfolios in order to reduce the volatility of the commodity prices they charge residential, small commercial, and industrial customers who elect to take commodity supply from them instead of from alternative providers. The supply portfolios include a combination of fixed hedges, indexed hedges, and, where applicable, their own generation. These hedges can be either physical or financial. By utilizing hedging, customers enjoy the benefit of reduced volatility in their monthly bill. The balance of the supply portfolio is spot market purchases.

The PSC also requires the regulated electric utilities to measure and monitor the price volatility of their supply portfolios and file quarterly reports. DPS staff regularly meets with each utility to discuss its hedging plan for the upcoming capability year as well as for future years. Such efforts to mitigate volatility have been consistently successful.

Demand Response

There are numerous initiatives under way in New York that can reduce the need for additional generation, transmission, and distribution capacity and also improve system efficiency. Demand response programs take advantage of customer load that can respond to day-ahead or real-time price signals or can respond in order to preserve reliability. Such

reductions, often referred to as “peak shaving,” lower the demands in peak periods and improve system efficiency. Reducing peak load lowers the need to build additional generation and transmission facilities. Customer response can take the form of reducing electricity consumption or use of on-site generation, both of which reduce the use of supply from the grid. The load and price duration curves previously shown illustrate the substantial reduction in price volatility and the need for peaking capacity achievable by reducing load during a relatively few hours of the year.

NYISO Demand Response Programs

The NYISO is primarily responsible for running most of the statewide demand response programs currently in place. For customers to respond effectively to the NYISO’s demand response notifications, they must have interval meters that can record the customer loads at least hourly. Three of these programs are designed to improve system reliability, while another is focused on giving wholesale customers the opportunity to submit economic load reduction bids. The programs are open to all types of end-use customers that meet eligibility requirements, and each program has different performance requirements and incentives. Customers can sign up for these programs through their LSE or through an independent curtailment services company.

The NYISO’s Installed Capacity Special Case Resource (ICAP/SCR) program is focused on improving system reliability; and involves paying electricity customers to provide load reduction capability for a specified contract period as a capacity market resource. Based on system condition forecasts, participants are obligated to respond when called on to do so with two or more hours notice, provided they were notified the day ahead. Performance is mandatory, and any under-performance could result in a penalty. SCR resources are also eligible for energy payments during demand response events.

The Emergency Demand Response Program (EDRP) provides resources an opportunity to earn the greater of \$500/MWh, or the prevailing market price for electricity when the NYISO calls on them. The EDRP program is voluntary, so there are no consequences for enrolled EDRP resources that fail to respond. Demand response resources may enroll in EDRP or ICAP/SCR, but they cannot participate in both programs.

The NYISO introduced a Targeted Demand Response Program (TDRP) in July 2007. TDRP is a newer reliability program that deploys existing EDRP and SCR resources on a voluntary basis, at the request of a transmission owner, in targeted subzones. The targeted program is only available in New York City in nine subzones designated by Con Ed. Prior

to the TDRP, the NYISO was required to call all resources within a zone when the above-listed EDRP and SCR programs were activated.

Since the Summer of 2001, the NYISO has activated the EDRP and SCR programs a total of 27 times: four times each in 2001 and 2002; twice in 2003 (during the August blackout restoration); once in 2005; six times in 2006; twice in 2010; twice in 2011; and six times in 2012. No deployments of EDRP or SCR occurred in 2007, 2008, or 2009.

Nine of these events were called statewide; the remaining events were called predominantly in the eastern and southeastern zones (zones F-K) in various combinations; in 2012, two upstate zones were deployed in combination with southeastern zones. The NYISO activated EDRP and ICAP/SCR resources under the TDRP Program in zone J twice in the following years: 2007, 2010, and 2012.

Highlights of NYISO's reliability demand response programs include the following:

- During the Summer of 2012, more than 5,000 retail loads were enrolled;
- Approximately \$35 million in energy payment incentives have been paid to EDRP/SCR program participants between 2001 and 2012;
- The NYISO's reliability demand response programs accelerated the recovery process after the August 2003 blackout;
- Peak load was reduced by as much as 1,400 MW during emergency demand response events in the Summer of 2011 (July 22, 2011) and 1,000 MW during NYISO's previous all-time peak in August 2006.

The enrollment levels for SCR/EDRP programs, for June 2013, are shown in Table 1 and Table 2.³²

Table 1 | Special Case Resources (SCR) June 2013

LOCATION	LOAD REDUCTION (MW)	ON-SITE GENERATION (MW)	TOTAL MW
Upstate	628.8	31.5	660.3
New York City	326.6	84.4	411.0
Long Island	85.7	4.8	90.5
SCR TOTAL	1,041.0	120.7	1,161.7

Source: NYISO, 2013.

32. As determined from the NYISO's June 1, 2012 filing with FERC.

Table 2 | Emergency Demand Response Program (EDRP) June 2013

LOCATION	LOAD REDUCTION (MW)	ON-SITE GENERATION (MW)	TOTAL MW
Upstate	70.8	4.9	75.7
New York City	0.6	0.7	1.3
Long Island	0.6	0.7	1.3
EDRP TOTAL	72.0	6.3	78.2

Source: NYISO. 2013.

Finally, the NYISO's Day Ahead Demand Response Program (DADRP) is an economic program that offers electricity customers a chance to bid load-reduction capability in New York's wholesale electricity market. To participate, customers bid their load reduction capability, on a day-ahead basis, into the wholesale electricity market, where these load reduction bids compete with generators' offers to meet the State's electricity demands. As of June 2013, there are 37 MW enrolled in the DADRP program.

NYISO is also now allowing demand response resources to participate in the ancillary services markets. No customers are currently participating in this program; however, several have filed applications, and are in various stages of installing the necessary communication devices and instantaneous meters that are required to operate in this market.

Con Edison Demand Response Programs

While all of the utilities have tariffs in place that allow customers to participate in the NYISO demand response programs, only Con Ed has its own separate programs. It administers six demand response programs: Distribution Load Relief Program (DLRP), Direct Load Control Program (DLCP), Commercial System Relief Program (CSRP), Residential Smart Appliance Program (RSAP/CoolNYC), and the Network Relief Program (NRP).

The DLRP provides compensation for load reduction during distribution system load relief periods designated by Con Ed for its system reliability. Third-party aggregators are allowed to aggregate customers to participate, and both curtailable load and distributed generation are allowed. The program has a two-tiered reservation payment, with higher payments to participants in higher priority electrical distribution networks designated by Con Ed. The program operates during a summer capability period from May through October. Approximately 181 MW of generation and load participated in the

program as of July 2013; 157 MW on a mandatory basis and 23 MW on a voluntary basis.

The DLCP is a thermostat-controlled program operated by Con Ed through a telecommunications device. It focuses on central air conditioners. Customers are awarded an incentive to sign up to participate on a voluntary basis. No further payments are made under this program to customers. A participant can override the thermostat with no penalty. As of July 2013, there was potential reduction of approximately 32 MW of load that could be controlled.

The CSRP is a mandatory load-reduction program that provides reservation payments monthly and energy payments for load reductions made by the customer during event hours. This program is activated by Con Ed during its summer peak days or system critical situations. The program is operational from May 1 through October 31. As of July 2013, 77 MW of load was enrolled in this program.

The RSAP pilot program, also called CoolNYC, targets demand response from residential customers in New York City by allowing Con Ed to control the customer's window or wall air conditioners during an event. For participating in the program, Con Ed provides a smart outlet (modlet) remote thermostat and gateway device allowing control via a web portal and smartphones. Participation in event hours results in an incentive payment of \$25. As of the end of July 2013, 2 MW of load was enrolled in this pilot program.

The NRP targets specific electrical distribution networks that are in need of system relief. Requests for proposals (RFP) are used to obtain DR resources to provide relief in specific networks, at certain hours, over a specific number of years, in an attempt to defer the need to build additional T&D infrastructure in particular networks.

Mandatory Hourly Pricing

Enhancing the information provided to electricity consumers in advance of, or at the time of use, facilitates informed decision-making and helps reduce customer energy bills. Providing electricity pricing information to consumers at the time consumption decisions are being made, and charging consumers accordingly, enhances economic efficiency and can also help reduce system peaks.

The PSC has taken action in this regard, requiring that the State's largest commercial and industrial customers be billed on an hourly basis if they remain with the utility. Since 2006, the Commission has expanded the class of hourly priced customers. The hourly pricing threshold is at 300 kW for most utilities in the State. To provide further incentives

to reduce peak usage, the PSC has encouraged all of the utilities to base the capacity charges of hourly pricing customers based on the customers' usage during the system peak. In contrast, the vast majority of residential and small commercial electricity customers are informed of the applicable price of electricity only on receipt of a monthly bill, up to 30 days after the fact. That unit price represents an average throughout the billing period and does not reflect the consumer's pattern of energy use throughout the month. These small customers generally receive little information about their consumption behavior, and how changes in usage patterns can reduce their energy bills.

Retail Market Structure – Customer Choice

New York's end-use electricity customers may choose to purchase their electric supply from the local electric distribution utility or from an ESCO. The local electric distribution utilities' electric rates, which at one time were stated as single price per unit of use, have since been unbundled into electricity delivery and commodity supply charges to facilitate customer choice and competition among electricity commodity suppliers.³³ According to PSC records, approximately 24 percent of residential customers purchase electricity supply or the commodity from ESCOs, as do 35 percent of small commercial customers, and 74 percent of large industrial customers.³⁴ More than 100 ESCOs are currently serving electricity customers around the State. The remaining customers purchase their electricity supplies directly from their local electricity distribution utilities or others. Electricity retail competition in New York began in the mid-to-late 1990s. During the initial years of retail competition, the PSC noted inconsistencies in the retail access rules and procedures across the electric and natural gas utilities. In 1999, the PSC issued Uniform Business Practices for Retail Competition to address those inconsistencies.³⁵ In 2001, the PSC adopted Uniform Retail Access Billing and Payment Processing Practices, and approved policies and data

³³. Unbundled or unbundling is the separation of utility cost of service into its component parts, e.g., for an electric utility into commodity and delivery charges.

³⁴. This translates into about 49 percent of the statewide consumer load and 16 percent of the statewide customer accounts.

³⁵. PSC. *Case 98-M-1343: In the Matter of Retail Access Business Rules – Order adopting Uniform Business Practices and Requiring Tariff Amendments*. January 22, 1999. <http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId={73A71A99-5A36-48E9-A645-FD9152DF292F}>

standards for the implementation of electronic data interchange in New York.³⁶

In 2002, the State's Home Energy Fair Practices Act was modified to apply to ESCOs as well as traditional delivery utilities. Under the modified statute, residential customers purchasing their energy commodity from ESCOs were provided the same essential consumer protections as customers who bought their commodity supply from the utilities.³⁷ Important safeguards, such as deferred payment agreements, low-income customer protections, cold weather rules, medical emergency provisions, and deposit regulations were now applicable to customers of all commodity suppliers. These protections provided a level playing field among LSEs, both utilities and ESCOs, so that consumers comparing services could do so with the knowledge that core consumer protections apply to all providers.

Electric System Planning

The NYISO has two main responsibilities: 1) administration of the capacity and energy markets; and, 2) ensuring reliable operation of the bulk electric system. A major part of ensuring reliability is the performance of long-term planning studies. The NYISO performs studies through a stakeholder process that examines system needs over the following ten years. The New York planning process is unique among independent system operators across the country as it is an all-resource planning process that takes into account transmission, generation, and demand response solutions to identified system needs. All other processes focus on transmission solutions. The planning process works hard to support the New York markets by looking to merchant projects to resolve system needs before resorting to regulated solutions. The NYISO Comprehensive System Planning Process (CSPP), specifically the Congestion Assessment and Resource Integration Study (CARIS), Comprehensive Reliability Plan (CRP), and Resource Needs Assessment (RNA), as well as developing regional planning efforts, have been, and

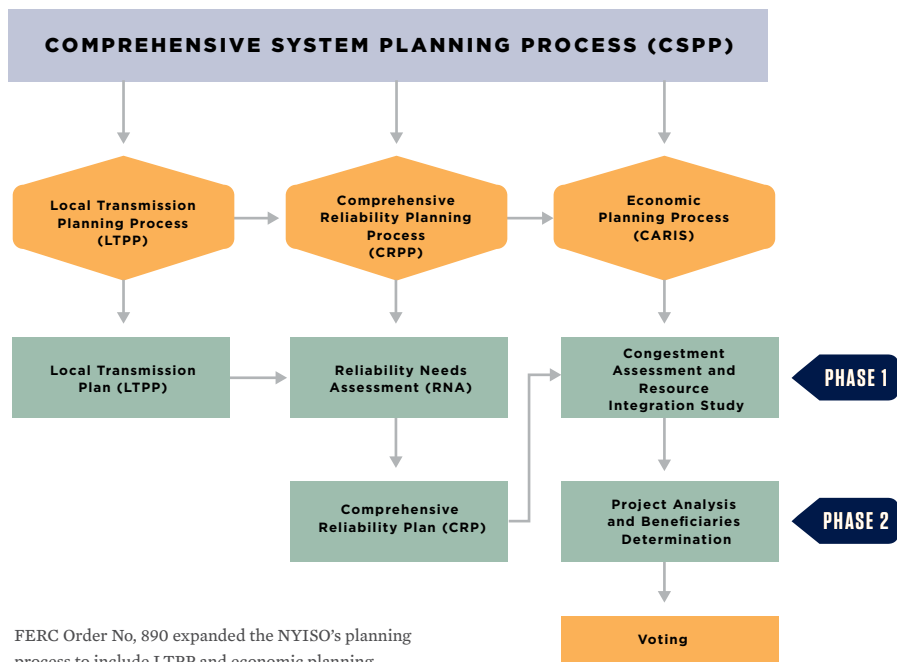
36. PSC. *Case 99-M-0631: In the Matter of Customer Billing Arrangements. Case 98-M-1743. In the Matter of Retail Access Business Practices – Order Establishing Uniform retail Access Billing and Payment Processing Practices.* May, 18, 2001. <http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId={BAF2691D-2A61-4CC4-AC06-1423F91A9562}>

37. The Home-Energy Fair Practices Act relates to both electricity and natural gas.

continue to be, developed to provide a comprehensive approach to system planning under a competitive wholesale market structure.

NYISO – Comprehensive System Planning Process - CSPP

The majority of planning in New York State is conducted through the NYISO's CSPP. The CSPP begins with the Local Transmission Planning Process (LTPP) in which each of the incumbent transmission owners (TO) in the State submit their most up-to-date Local Transmission Plans (LTP) for the following ten years. These LTPs show regional system upgrades and changes, and are included in the combined base case for system modeling purposes. Following the submittal of the TO's LTPs, the CSPP considers two types of planning; reliability planning and economic planning. Within the next year, the NYISO has plans to add a third tier to its CSPP for Public Policy Requirements Planning, a requirement directed by the FERC's Order 1000, to study transmission upgrades which could be the result of needs driven by public policy. The following chart outlines the NYISO's current two-year process to complete both the reliability and economic planning studies:



FERC Order No. 890 expanded the NYISO's planning process to include LTPP and economic planning process called CARIS, that together with the reliability planning process (CRPP) compose a new 2-year planning process known as CSPP.

Comprehensive Reliability Planning Process – CRPP

Reliability planning in New York is conducted primarily through the NYISO's CRPP. The CRPP begins with an annual assessment of

the State's reliability needs, determined through the RNA. The RNA evaluates the New York bulk power transmission facilities to determine if reliability criteria are met, and identifies reliability needs if they are not met. Solutions will be requested to mitigate any identified needs and maintain system reliability throughout the 10-year study period. The RNA feeds into the NYISO's CRP, which indicates any reliability needs identified in the RNA, as well as proposed market based, and regulated backstop solutions to meet such needs. The CRP provides an outline for meeting the reliability needs of the State's bulk power system over a 10-year planning horizon.

The most recent CRPP, which concluded in March 2013, identified reliability needs in both the first and second five years of the studies. The market-based solutions proposed to meet those reliability needs were deemed adequate, and were included in the CRP base case. The NYISO and market participants will continue to monitor the market-based solutions and the timeline for the reliability needs to ensure that they will continue to be in place in time to meet the reliability needs. If the market-based solutions do not continue as expected, the NYISO has the opportunity to trigger a regulated backstop solution to ensure the reliability need is addressed in time.

Congestion Assessment and Resource Integration Study – CARIS

The second part of the NYISO's CSPP is based on economic system planning and is known as CARIS. Transmission congestion results from physical limits on how much power high-voltage lines can reliably carry. Phase 1 of CARIS identifies the three most congested corridors of New York's bulk power system, projected over a 10-year period, and conducts a benefit/cost analysis of generic solutions to address the congestion on those corridors. Phase 2 of CARIS provides the opportunity for developers to propose projects to solve the identified congestion. If a proposed project satisfies the benefit/cost threshold requirements, the developer may seek regulated cost recovery for the project. The project costs would be allocated on a beneficiaries pay model, which would require consent of a super-majority vote (80%) of the project's beneficiaries. There have been two CARIS cycles completed to date, and each has resulted in a project being proposed in Phase 2; however, neither project has moved forward beyond the study.

Regional Planning

The level of inter-regional, electric system analysis has increased significantly in recent years. In 2004, the NYISO, New England

Independent System Operator (ISO-NE), and PJM signed the Northeastern ISO/RTO Planning Coordination Protocol (Protocol), which provides a platform to perform coordinated and joint regional studies. Quebec, Ontario, and New Brunswick utilities, while not signatories to the agreement, participate in the studies. The Protocol has been recently expanded to include new provisions for Inter-regional Transmission Planning and Cost Allocation as required by FERC Order 1000. These new provisions include coordination of each of the regions' plans, and a study to determine if there are inter-regional projects which could help solve the needs of a region more efficiently or cost-effectively than an individual regional solution could. This regional study will take place through the Joint Interregional Planning Collaborative (JIPC), which includes the participants of the Northeastern Protocol.

The Eastern Interconnection Planning Collaborative (EIPC) is a DOE-funded, first-of-its-kind effort to develop a model of the Eastern Interconnection.³⁸ The EIPC engaged in a three-year stakeholder-driven effort to: 1) merge all the planning base cases from all the utilities and planning authorities to check for compatibility; 2) test the compiled base case under different possible policy directives, e.g. CO₂ restrictions, federal renewable targets, and increased use of energy efficiency; and 3) determine what new transmission would be required under three different policy scenarios. A final report was delivered to DOE in December 2012. The first phase of the EIPC study compiled a transmission system model encompassing all of the transmission grids in the Eastern U.S. and Canada. Importantly, that study found that all of the power grids east of the Rocky Mountains operate together reliably to service electric consumers without violating any reliability standards. In the second phase of the EIPC studies, members analyzed the cost and economic benefits of the resource and transmission build up in all three policy scenarios. The intent of the study was to inform local planning processes of projects that might have inter-regional transmission benefits. The EIPC intends to repeat a similar analysis on a cyclical basis so that inter-connection wide models will be maintained. The EIPC is launching another multi-year DOE-sponsored eastern inter-connection wide study to analyze gas and electric industry mutual planning issues.

38. The Eastern Interconnection comprises the electric grid in all or part of 39 states plus the District of Columbia that reaches from the Atlantic to as far west as parts of Montana and New Mexico, and includes major portions of Canada (Maritimes, Ontario, Manitoba, and Saskatchewan).

Electricity System Modeling

Electricity sector modeling was performed to develop “Reference Case” points of comparison that can be used as an analytical background for evaluating the impacts of potential system changes, market changes, technology changes, or policy directions. Modeling enables potential impacts to be estimated with respect to future capacity needs, generation mix, fuel diversity, net imports of electricity, wholesale electricity prices (including both energy and capacity), emissions, and emission allowance prices.

The modeling analysis was coordinated by NYSERDA staff, working closely with NYISO.³⁹ The analysis was performed using the Integrated Planning Model (IPM), developed by ICF International. IPM is a linear programming model, which incorporates the New York electricity system, the systems managed by the ISO-NE and PJM, as well as the systems extending throughout the rest of the U.S. and Canada. The objective is to solve for the optimal system dispatch of electricity by fuel type (including imports and exports), new capacity, retirements and repowering, given the specified demand, system characteristics, reserve margins, and environmental constraints. Key input data include existing and planned generation units, annual electricity demand by zone, load shapes, transmission system capacities and transfer limits, generation unit level operation and maintenance costs and performance characteristics, fuel prices, new capacity and emission control technology costs and performance characteristics, zonal reliability requirements, national and State environmental regulations, and financial market assumptions.

The Reference Case is based on the “Gold Book” electricity load forecast used by the NYISO for its system planning activities.⁴⁰ The NYISO load forecast extends from 2012 to 2022, and projects electricity load to grow at an annual rate of 0.59 percent over these years. Load forecast values for 2022 through 2030 are projected based on the average

³⁹. The Reference Case is based as closely as possible on the system planning assumptions used by the NYISO for its system and reliability planning activities, including the continued operation of the Indian Point nuclear units.

⁴⁰. NYISO, *2012 Load and Capacity Data*, April 2012. The NYISO uses moderately risk adverse assumptions which have been widely vetted among market participants with respect to their use in analysis of system reliability. The NYISO load forecast assumes only currently authorized funding levels for energy efficiency programs, which translates into the assumption that approximately 64% of the Program Administrator goal (per 2008 NYPSC Order) for energy efficiency is achieved by 2015 and 93% are achieved by 2022.

growth rate over the last five years of the NYISO load forecast, resulting in an annual growth rate of 0.77 percent.

In addition to the Reference Case projections, based as closely as possible on the system planning assumptions used by the NYISO for its system and reliability planning activities, electricity sector modeling was performed for alternative cases that include the unavailability of the Indian Point nuclear units due to expiration of operating licenses, higher and lower commodity prices of natural gas, and increased use of electric vehicles.

Reference Case Modeling Results

Generation Mix

Electricity system load is projected to grow by 7,517 GWh, or 4.6 percent, from 2012 to 2020. Looking out to 2030, system load is projected to grow by 21,724 GWh, or 13.3 percent, from 2012. Table 3 indicates that Reference Case load growth is projected to be more than met by increasing natural gas combined cycle generation: 11,074 GWh by 2020 and 26,647 by 2030 (compared to 2012). New renewable resources provide 4,317 GWh by 2020. Increasing run-time of existing coal units provides 1,921 GWh by 2020 and 3,045 GWh by 2030. Base load hydro and nuclear generation remain relatively unchanged from current levels. Imports of electricity from outside the State are projected to decrease by 6,248 GWh by 2020 and by 9,919 GWh by 2030 (compared to 2012).

Table 3 | New York State Electricity System Generation Mix (GWh) – Reference Case

SOURCE	2012	2020	2030
Natural Gas - Combined Cycle	40,100	51,174	66,747
Natural Gas - Combustion Turbine	1,105	1,951	3,126
Natural Gas - Steam	8,942	3,607	3,517
Oil - Steam	1,217	502	502
Coal	5,819	7,740	8,864
Nuclear	41,255	42,622	42,622
Hydro	26,730	27,830	27,750
Renewable	5,823	10,140	10,196
Other	1,863	1,887	1,887
Imports	32,442	26,194	22,523
Pumped Storage (losses)	(1,638)	(2,473)	(2,352)
SYSTEM ELECTRICITY REQUIREMENT	163,659	171,176	185,383

Notes: Based on IPM modeling results. Renewable includes wind, solar, biomass, landfill gas, and anaerobic digester gas. Other is primarily municipal solid waste.

Source: Based on IPM modeling results for the 2013 State Energy Plan Modeling Case.

Capacity Builds and Retirements

The Reference Case projects that by 2020 New York’s net generation capacity would increase by a cumulative 1,307 MW to meet forecast load growth. The projected net increase in generation capacity includes cumulative retirements of 2,765 MW (about 1,025 MW of coal and about 1,697 MW of oil/gas steam) units; nearly all are “firm” retirements identified by the NYISO, which are “hard-wired” as model inputs. Cumulative capacity additions by 2020 consist of about 337 MW of gas combined cycle; 1,226 MW of gas combustion turbines (about 500 MW is firm); 1,062 MW of wind, and about 168 MW of nuclear uprates (firm). Capacity additions and retirements that are not specified by the NYISO planning assumptions (i.e. “firm”), are IPM outputs based on the model’s internal economic comparison of the present value of annual unit operating costs to expected long-term energy and capacity revenues.⁴¹ By 2030, it is estimated that New York’s net generation capacity would increase by a cumulative 5,608 MW; this includes no additional retirements, and includes about 2,584 MW of new combined cycle capacity, and about 3,281 MW of new gas combustion turbine capacity.

Wholesale Energy and Capacity Prices

Throughout the past decade, wholesale electricity prices in New York have been closely correlated to the commodity cost of natural gas. As a result, wholesale electricity prices have generally increased when natural gas prices increased, and have decreased when natural gas prices decreased. With natural gas expected to provide an increasing proportion of electricity generation, future wholesale electricity prices are expected to be even more closely correlated to natural gas prices.

As shown in Table 4, it is estimated that from 2012 to 2020, New York’s average “firm power price,” which includes both wholesale energy and capacity price components, would increase by \$14.24/MWh, or about 31 percent in constant 2010 dollars. From 2012 to 2030, it is estimated

41. Because IPM is an economic planning model based on a 25-year optimization algorithm, existing power plants may be modified (e.g., repowered, uprated, emissions control technologies added, etc.) or retired over the planning period. Similarly, new power plants can be built based on long-term economic comparison with continued operation of existing plants. This methodology differs conceptually from the NYISO Reliability Needs Assessment (RNA) analysis, which assumes a predefined portfolio and configuration of generators that is assumed to be held constant over the planning period, whereby the need for additional capacity is determined based on successive calculations of loss-of-load probabilities. The SEP modeling work using IPM was closely coordinated with NYISO staff to ensure that the results, while based on different objectives, are based on the same system data and are consistent in their conclusions.

that the average firm power price would increase by \$25.46/MWh, or by 56 percent. The estimated firm power price changes over this period are largely correlated to the forecast change in the commodity price of natural gas, as natural gas-fired units are most frequently the marginal units that set the market clearing price of electricity.

Table 4 | New York State Wholesale Power Price Components – Reference Case

SOURCE	2012	2020	2030
Natural Gas Commodity Price (2010\$/MMBtu)	\$2.51	\$4.80	\$6.19
Wholesale Energy Price (2010\$/MWh)	\$39.51	\$48.42	\$59.08
Capacity Price (2010\$/MWh)	\$6.02	\$11.35	\$11.91
Firm Power Price: Energy plus Capacity (2010\$/MWh)	\$45.53	\$59.77	\$70.99

Note: Natural gas commodity price is at Henry Hub (Louisiana), and does not include the cost of pipeline transport to New York.

Source: Based on IPM modeling results for the 2013 State Energy Plan Modeling Case.

Emissions

The Reference Case projects that New York’s annual emissions of carbon dioxide (CO₂) from electricity generation would increase by about 8 percent from 2012 to 2020, and by about 33 percent from 2012 to 2030. New York’s annual emissions of nitrogen oxides (NO_x) are estimated to increase by about 18 percent from 2012 to 2020, and by about 27 percent from 2012 to 2030. Emissions of sulfur dioxide (SO₂) are estimated to decrease by about 16 percent from 2012 to 2020, and by about 8 percent from 2012 to 2030. Emissions of mercury (Hg) are estimated to decrease by about 62 percent from 2012 to 2030.⁴²

Alternative Case Modeling Results

Unavailability of Indian Point Nuclear Units

The unavailability of the Indian Point nuclear units due to license expiration in 2013 and 2015, respectively, is estimated to reduce nuclear generation by 13,999 GWh in 2020 (compared to 2012). Modeling

⁴². Emissions estimates for NO_x, SO₂, and Hg are based on approximation of impacts associated with the Cross-State Air Pollution Rule (CSAPR) and Mercury and Air Toxics Standards Rule. Emissions estimates for CO₂ do not include potential changes to the Regional Greenhouse Gas Initiative (RGGI) program that could be associated with the 2012 Program Review by the participating states.

results project that increased natural gas combined cycle generation could provide replacement generation for the Indian Point units, as well as to meet load growth. The unavailability of the Indian Point units is estimated to require 25,756 GWh of additional gas combined cycle generation in 2020 (63 percent more than in 2012), and 40,850 GWh in 2030 (99 percent more than in 2012). Compared to the Reference Case (in which the Indian Point units continue to be available), this is 31 percent more natural gas combined cycle generation in 2020, and 23 percent more in 2030.

Modeling results indicate that about 2,000 MW of additional natural gas combined cycle capacity would be needed by 2020 to replace the electricity generation that was previously provided by the Indian Point units. It is also estimated that about 1,370 MW of new combined cycle capacity would be needed by 2016 in the downstate region to maintain system reserve margins if the Indian Point units are unavailable after license expiration in 2013 and 2015, respectively.

Lower Natural Gas Prices

Natural gas commodity prices that are 30 percent lower (in 2020) than assumed in the Reference Case are estimated to result in increased use of natural gas for electricity generation. Compared to the Reference Case, natural gas-fired generation would increase by about 6 percent in 2020.

This amount of additional natural gas would displace nearly three-quarters of the coal-fired generation that is projected for 2020 in the Reference Case. Lower natural gas commodity prices would also result in CO₂ emissions being lower by 2.4 million tons, or about 7 percent and firm (energy plus capacity) power prices being lower by 20 percent.

Higher Natural Gas Prices

Natural gas commodity prices that are 30 percent higher (in 2020) than assumed in the Reference Case are estimated to result in decreased use of natural gas for electricity generation. Compared to the Reference Case, natural gas-fired generation would decrease by about 6 percent in 2020. About 1,882 additional GWh of coal-fired generation would be needed to meet system demand projected for 2020 in the Reference Case. Higher natural gas commodity prices would also result in CO₂ emissions being higher by a half million tons, or about 1 percent and firm (energy plus capacity) power prices being higher by 21 percent.

Plug-In Hybrid Electric Vehicles Case

The Plug-In Hybrid Electric Vehicles case assesses the impacts of increasing the penetration in the marketplace of this type of vehicle.⁴³ This is a relatively aggressive deployment case that assumes that approximately 8 percent of the new cars sold in 2020 would be electric cars, and that a typical electric car would use approximately 3 MWh per year. As a point of reference, the EIA Annual Energy Outlook, 2012 predicts that electric car sales in the Middle Atlantic region will amount to only 2 percent of sales in 2020, and that hybrid cars will grow from 4.5 percent of sales in 2010 to approximately 6 percent in 2020.⁴⁴

Comparing the Plug-In Hybrid Scenario to the Reference Case in 2030, gas-fired generation is higher by 1,432 GWh (2 percent) in 2030; cumulative capacity builds are 160 MW higher for natural gas combined cycle; CO₂ emissions in 2030 are higher by 0.6 million tons (1 percent); the firm power price in 2030, including energy and capacity, is virtually unchanged. A number of other studies have found that plug-in hybrid electric vehicles will have only minor impacts on generation and capacity requirements at similar EV penetration levels.

^{43.} The Plug-In Hybrid Vehicle case is based on a NYISO presentation given to the Environmental Advisory Council in 2011.

^{44.} U.S. Department of Energy. Energy Information Administration.



2

Natural Gas Report

North American (U.S.) Overview

The Natural Gas Report relies heavily on data and information supplied by the U.S. Energy Information Administration (EIA) and two reports it published: the Natural Gas Annual 2011 (NGA 2011) and the Annual Energy Outlook 2013 (AEO2013). The NGA 2011 is utilized primarily for historic data. The AEO2013 provides the national trends and forecasts as well as serving as the basis for New York trends and forecasts. Projections focus on the factors that shape U.S. energy markets in the long term under the assumption that

current laws and regulations remain generally unchanged throughout the projection period.

The AEO2013 Reference Case provides the basis for examination and discussion of energy market trends and serves as a starting point for analysis of potential changes in U.S. energy policies, rules, or regulations or potential technology breakthroughs.

Recovery from the recession of 2008-2009 is showing the slowest growth of any recovery since 1960. For this most recent recession, the expected five-year average annual growth rate in real GDP from 2009 to 2014 is 1.3 percentage points below the corresponding average for the three past recessions. The slower growth in the early years of the projection has implications for the long term with a lower economic growth rate leading to a slower recovery in employment and higher unemployment rates.

Most of the growth in natural gas production is a result of the application of recent technological advances and continued drilling in shale formations with high concentrations of natural gas liquids and crude oil, which have a higher value in energy equivalent terms than dry natural gas. With increased production, average annual wellhead prices for natural gas remain below \$5 per thousand cubic feet (2011 dollars) through 2025. The projected prices reflect continued industry success in tapping the nation's extensive shale gas resource. The resilience of drilling levels, despite low natural gas prices, is in part a result of high crude oil prices, which significantly improve the economics of natural gas plays that have high concentrations of crude oil, condensates, or natural gas liquids. Natural gas consumption is projected to rise from 25 trillion cubic feet (Tcf) in 2011 to 29 Tcf in 2035. The largest share of this demand growth nationally is for electricity generation. Demand for natural gas in electricity generation is projected to grow from 7.6 Tcf in 2011 to 9.4 Tcf in 2035. A portion of the growth is attributable to the retirement of 33 gigawatts of coal-fired capacity over the projection period.

New York State Overview

New York has approximately 4.7 million natural gas customers served by eleven local gas distribution companies (LDCs).¹ These LDCs are regulated by the Public Service Commission (PSC). Figure 17 illustrates the service areas of the New York LDCs.

The downstate market (geographically: Long Island, New York City, Westchester, Orange, and Rockland Counties) is served by National Grid NY (formerly Keyspan Energy Delivery of New York City), National Grid LI (formerly KeySpan Energy Delivery of Long Island) and Consolidated Edison Company of New York/Orange & Rockland Utilities, Inc. (Con Edison/O&R). These companies depend on common interstate pipeline companies², which connect either directly to production areas in the Gulf Coast region, Canada, and the Northeast, or to major storage areas.

The upstate market is served by Central Hudson Gas & Electric, Corning Natural Gas, National Fuel Gas Distribution Corporation, National Grid Upstate, New York State Electric & Gas Corporation, Rochester Gas and Electric Corporation, and St. Lawrence Gas. Most of the LDCs serving the upstate market depend on a common set of interstate pipeline companies.³

Interstate pipelines provide a transportation service, moving gas from producing and/or storage areas, for their customers such as gas utilities and electric generators. The interstate pipelines serving the Northeast are illustrated in Figure 18. Interstate pipeline companies do not sell the gas commodity; customers, such as the LDCs, purchase the natural gas from gas producers and gas marketers. The interstate pipelines are regulated by the Federal Energy Regulatory Commission (FERC).

LDCs deliver natural gas to their customers on either a firm or interruptible basis.⁴ Customers may also choose to purchase the commodity from the LDC or from another provider, as described in the following paragraph. Firm deliveries are generally provided to

1. EIA. Annual Report Data. December 29, 2011. The breakdown of customers by sector is 4.3 million residential customers and 0.4 million commercial, industrial, and electric generation customers.

2. Algonquin Gas Transmission (Algonquin), Iroquois Gas Transmission System (IGTS), TransCanada Pipeline Limited (TCPL), Tennessee Gas Pipeline Co. (Tennessee), Texas Eastern Transmission LP (Texas Eastern), Millennium Pipeline Company LLC (Millennium), and Transcontinental Gas Pipeline Corp. (TRANSCO).

3. Dominion Transmission Inc. (Dominion), Columbia Gas Transmission Corp. (Columbia), Empire State Pipeline Co. (Empire), Iroquois Gas Transmission System (IGTS), National Fuel Gas Supply Corporation (NFGS), Millennium Pipeline LLC (Millennium), and TransCanada Pipeline Limited (TCPL).

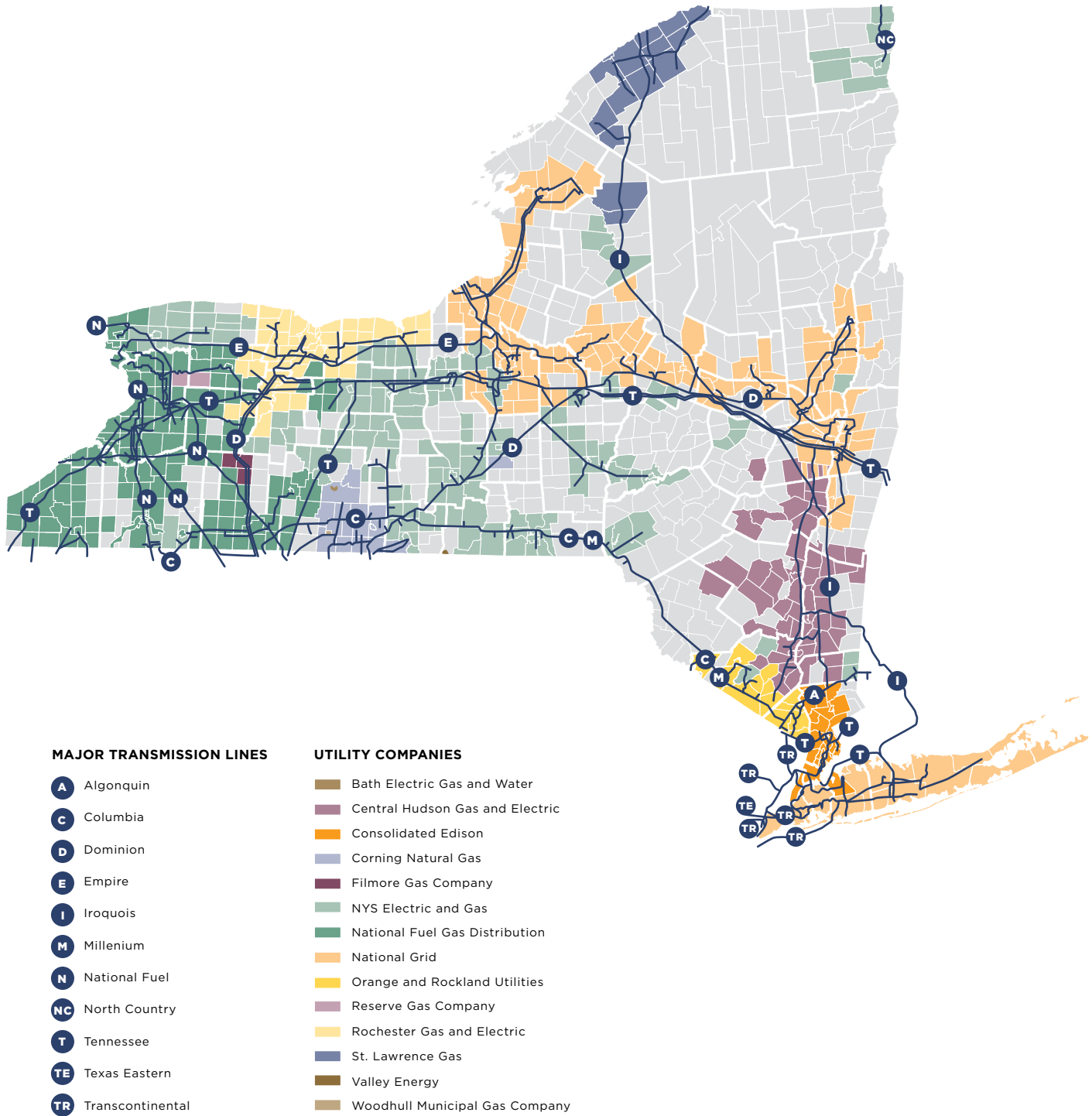
4. The same is true for interstate pipeline companies.

residential, and small commercial and industrial customers that do not have alternative fuel burning capability. Interruptible delivery service is not guaranteed and is used by larger customers, e.g., some apartment buildings, commercial, and industrial customers that have alternate fuel burning capability. Electric generators generally depend on interruptible delivery services whether or not they have dual fuel capability.⁵

Customers have the right to purchase natural gas from either the LDC or an Energy Service Company (ESCO). When customers opt to purchase gas supplies from the LDC, they are referred to as “sales customers.” Those who purchase the commodity from an ESCO are “transportation customers.” In this case, the LDC is simply providing the delivery service. Therefore, there are four possible combinations of delivery service and commodity service options: firm or interruptible utility provided gas, and firm or interruptible delivery service with gas provided by third parties. Approximately 20 percent of residential customers purchase gas from ESCOs, as do 33 percent of small commercial and industrial customers, 58 percent of larger industrial customers, and virtually all electricity generators. LDC rates have been unbundled into separate delivery and commodity charges to facilitate customer choice and competition among commodity suppliers. Natural gas supply purchased by LDCs is passed on to their “sales” customers at cost, without any markup or profit.

5. For reference, a residential customer in New York uses between 100 and 140 Dt per year, and about 1 Dt on a peak day. In contrast, a 350 MW combined cycle electric generating plant uses about 54,000 Dt per day, assuming an 100 percent capacity factor, and about 12,000,000 Dt per year, assuming a 60 percent annual capacity factor.

Figure 17 | New York State Gas Service Territories



Source: NYS DPS GIS

Figure 18 | Northeast Natural Gas Pipeline Systems



NORTHEAST NATURAL GAS PIPELINE SYSTEM

Algonquin Gas Transmission	Iroquois Gas Transmission	PNGTS
Columbia Gas Transmission	Maritimes & Northeast Pipeline	Tennessee Gas Pipeline
Dominion Gas Transmission	Millennium Pipeline	Texas Eastern Pipeline
Empire Pipeline	National Fuel Gas Supply	TransCanada
Granite State Gas Transmission	PNGTS/M&N Joint	Transco (Williams)

Source: Northeast Gas Association, Thomas Kiley. Pre-Winter Briefing Introduction. 2011

Production and Supply

U.S. Energy Information Administration (EIA) defines proved reserves as those volumes of oil and natural gas that geologic and engineering data demonstrate with reasonable certainty to be recoverable in future years from known reservoirs under existing economic and operating conditions.

Reserves estimates change from year to year as new discoveries are made, existing reserves are produced, and as prices and technologies change. Discoveries include new fields, identification of new reservoirs in old fields, and extensions. Extensions are reserve additions that result from additional drilling and exploration in previously discovered reservoirs. Extensions typically account for a large percentage of “discoveries” within a given year.

While actual discoveries of new fields and reservoirs are important indicators of new resources, they usually account for a small percentage of reserve additions in a given year.

North American Production and Supply History

The U.S. had “Proven Dry Natural Gas Reserves” of approximately 3,495 Tcf as of the end of 2010.⁶ This increased level continues a growing trend going back over ten years. While the level of increase has been gradual over most of that period, there was a significant increase of over 11 percent from 2008 to 2009. This most recent level represents the highest since 1971, despite the decline in natural gas prices relative to those used in developing the prior years’ numbers.

Production and Reserves

Since natural gas is a national market, developments nationwide regarding gas supply are critical to New York. The following are highlights of noteworthy aspects of U.S. natural gas supply.

Conventional Reserves

U.S. natural gas dry production totaled 25 Tcf in 2012, which was 25 percent higher than in 2007.⁷ About 98 percent of the natural gas produced in the U.S. comes from production areas in the lower 48 states.⁸ A breakdown by the highest producing states and areas in the lower 48 states is shown in Figure 19.

Higher natural gas prices resulted in increased drilling activity, particularly in areas that were formerly too expensive to develop. Higher prices have also contributed to the development of improved drilling and production technology that has allowed for the economic production of natural gas in deep water areas in the Gulf of Mexico and other large unconventional resources.

As shown in Figure 20, natural gas prices peaked in the summer of 2008 and dropped significantly during the following 12 months, which has resulted in a decline in drilling activity. Since the summer of 2009,

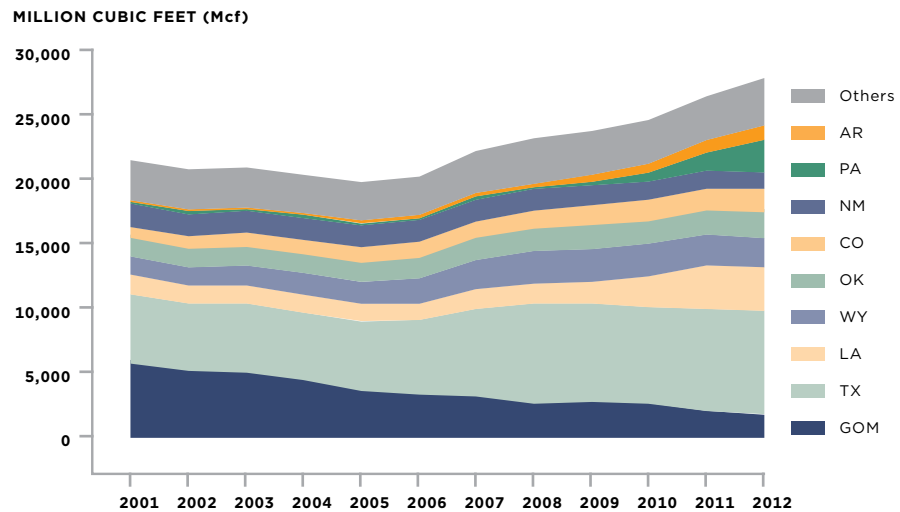
6. http://www.eia.gov/dnav/ng/ng_enr_sum_a_EPG0_R11_BCF_a.htm

7. Natural gas produced from a well may contain liquid hydrocarbons which are removed at a natural gas processing plant and the gas is then considered “dry” and is sent to pipelines for delivery to customers.

8. Natural gas production from Alaska currently accounts for less than 1 percent of the total U.S. dry natural gas production.

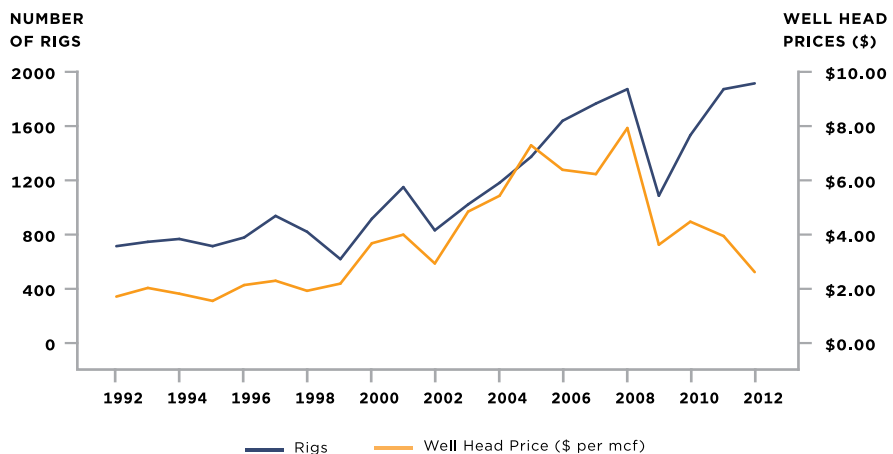
however, an increase in natural gas rigs has rebounded somewhat. This increase can be partially attributed to the increase in value of natural gas liquids being extracted from these wells. As the economy continues to improve, the demand and supply balance tightens, and natural gas prices increase, production is expected to respond adequately. Recent improvements in technology have reduced finding and development costs, lowered well completion times, and enhanced well productivity, increasing the natural gas production potential from domestic sources.⁹

Figure 19 | Annual Natural Gas Production by State



Source: U.S. EIA, *Natural Gas Annual*, 2012 data and EIA -914 natural gas production survey

Figure 20 | Natural Gas Rigs and Well Head Price



Source: EIA. *U.S. Natural Gas Rotary Rigs in Operation*, 2012.

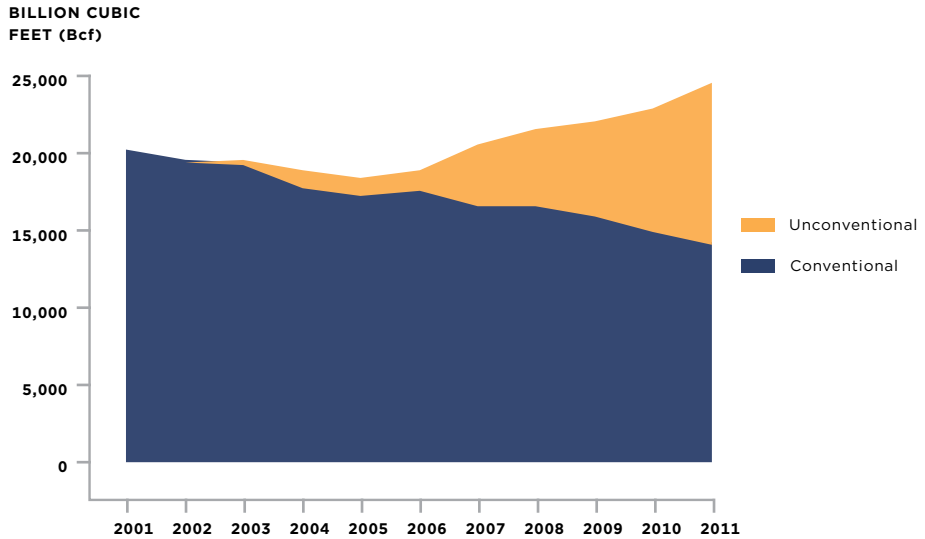
9. EIA. *Short Term Energy Outlook*. 2009. <http://eia.doe.gov/steo>

Unconventional Reserves

Application of new technologies can convert categories of previously uneconomic natural gas resources into proved reserves. EIA began reporting reserves data separately for coal-bed methane in 1990 and for shale gas in 2008. EIA does not currently report reserves estimates for tight gas, the third category of gas sometimes categorized as unconventional. As shown in Figure 21, the overall U.S. dry natural gas production has been increasing over the last five years. This is because in the past few years, there has been a significant shift in gas supplies from conventional or traditional supply areas and sources, to unconventional or new supply areas and sources. U.S. natural gas production from traditional, more mature and accessible natural gas supply basins, has steadily declined. However, this decline has been offset by increased drilling activities and by increased production from new unconventional gas supply areas.¹⁰ At the end of 2012, U.S. total natural gas production was about 69 billion cubic feet (Bcf)/day. Of that, the offshore Gulf of Mexico was about 4 Bcf/day and the rest (about 65 Bcf/day) was from the lower 48 states. In the lower 48 states, there are traditional natural gas wells, but in 2012 shale gas production was 34 percent of U.S. production, and in 2035 it is expected to be 49 percent of U.S. production.

The increased production from unconventional resources is primarily from tight sands, coal-bed methane, and shale formations. The Rocky Mountain Region is the fastest growing region for tight sands natural gas production and the predominate region for coal-bed methane natural gas production in the U.S. There are at least 21 shale gas basins located in over 20 states in the U.S. Currently, the most prolific shale producing areas in the country are in the southern U.S. and include the Barnett Shale area in Texas, the Haynesville Shale in Texas and Louisiana, the Woodford Shale in Oklahoma, and the Fayetteville Shale in Arkansas. In the Appalachian region, which extends into New York, the Marcellus Shale has developed into a major natural gas production area.

10. Unconventional natural gas is a widely used industry term and generally refers to gas that is more difficult and more expensive to extract, which usually involves new and developing production and well drilling technologies. Examples of what may currently be considered unconventional sources of natural gas are: deep natural gas – gas that is beyond conventional well drilling depths; tight sands natural gas; shale gas; coal-bed methane gas; geo-pressurized zone gas; and methane hydrate gas. As production from current unconventional sources matures and the technology used is more fully developed, the sources may evolve into being considered conventional.

Figure 21 | U.S. Dry Natural Gas Production

Source: EIA. *Natural Gas Gross Withdrawals and Production*. 2012. http://www.eia.gov/dnav/ng/ng_prod_sum_dcu_NUS_m.htm

Proven natural gas reserves for the U.S. totaled over 349 Tcf at the end of 2011, an increase of about 40 percent over 2007 levels.¹¹ The increase in reserves was the tenth year in a row that U.S. natural gas proven reserves have increased.

Tight Sands and Coalbed Methane¹²

Another form of unconventional natural gas is referred to as tight gas. This is gas that is present in a very tight formation underground, trapped in unusually impermeable, hard rock, or in a sandstone or limestone formation that is unusually impermeable and non-porous (tight sand). Several techniques exist that allow natural gas to be extracted from a tight formation, including fracturing and acidizing. However, these techniques are also very costly. Like all unconventional natural gas, the economic incentive must be there to incite companies to extract this costly gas instead of more easily obtainable, conventional natural gas. Tight gas makes up a significant portion of the nation's natural gas resource base, with the EIA estimating that, as of January 2009, 310 Tcf of

¹¹. The latest EIA proven reserves data is for 2011. Proven natural gas reserves are those which analysis of geologic and engineering data demonstrates with reasonable certainty to be recoverable from known reservoirs, under existing economic and operating conditions. Shale gas data started in 2007. http://www.eia.doe.gov/dnav/ng/ng_enr_dry_dcu_NUS_a.htm

¹². http://www.naturalgas.org/overview/unconventng_resource.asp

technically recoverable tight natural gas exists in the U.S. This represents over 17 percent of the total recoverable natural gas in the U.S., and represents an extremely important portion of natural gas resources.¹³

Many coal seams also contain natural gas, either within the seam itself or the surrounding rock. Coalbed methane does not migrate from shale, but is generated during the transformation of organic material to coal. This coalbed methane is trapped underground, and is generally not released into the atmosphere until coal mining activities unleash it. Historically, coalbed methane has been considered a nuisance in the coal mining industry. Once a mine is built, and coal is extracted, the methane contained in the seam usually leaks out into the coal mine itself. This poses a safety threat, as too high a concentration of methane in the mine creates dangerous conditions for coal miners. In the past, the methane that accumulated in a coal mine was intentionally vented into the atmosphere. Today, however, coalbed methane has become a popular unconventional form of natural gas. In April 2013, the Potential Gas Committee estimated that 158 Tcf of technically recoverable coalbed methane existed in the U.S.

Shale Production

Shale gas refers to natural gas that is trapped within shale formations. Shale reserves are fine-grained sedimentary rocks that can be rich sources of petroleum and natural gas. Over the past decade, the combination of horizontal drilling and hydraulic fracturing has allowed access to large volumes of shale gas that were previously uneconomical to produce. The production of natural gas from shale formations has rejuvenated the natural gas industry in the U.S. These shale plays are shown in Figure 22.

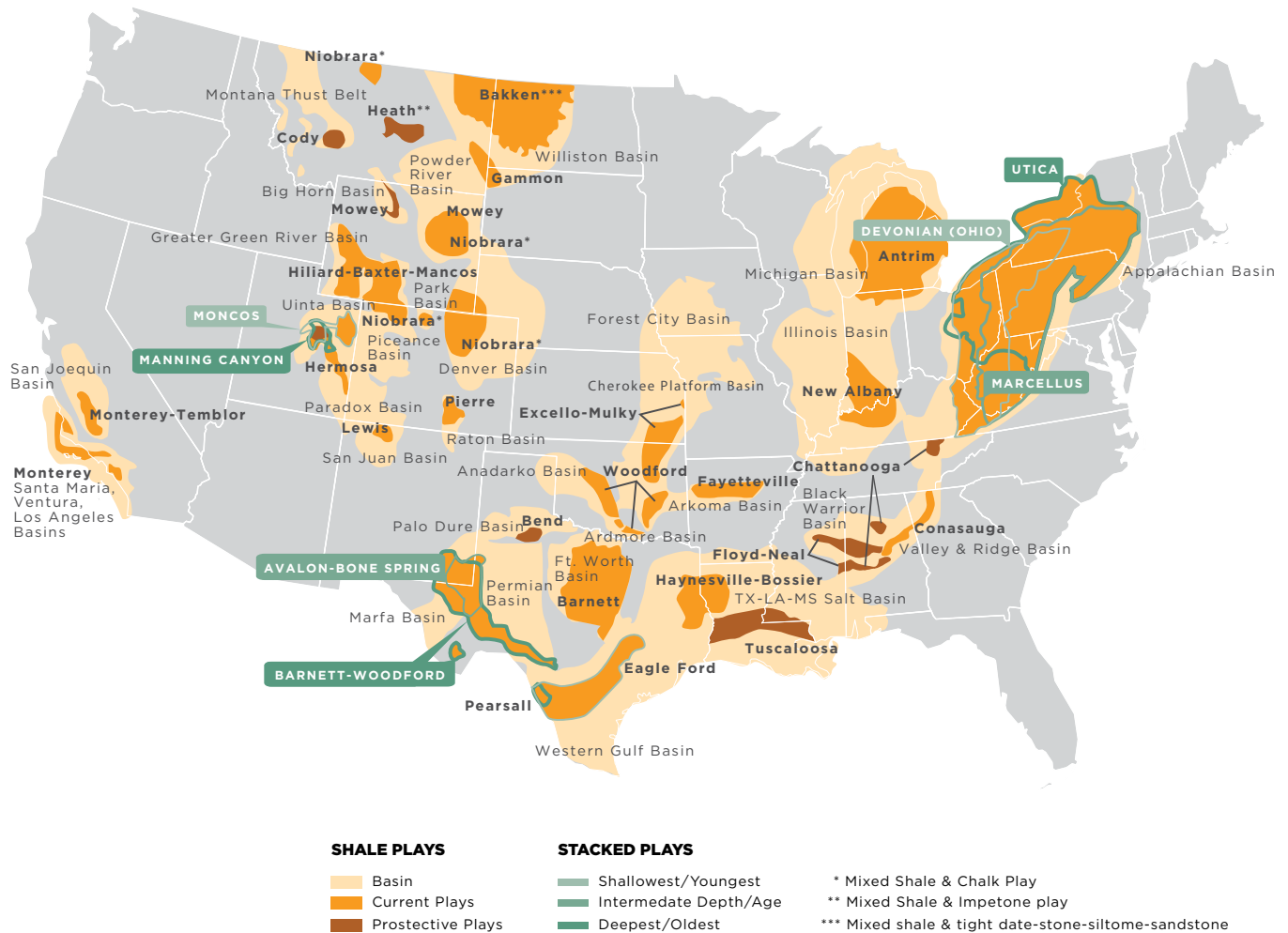
Additions associated with shale gas activity were instrumental in boosting overall wet gas proved reserves. Shale gas accounted for more than 90 percent of total net additions. Key shale states include Arkansas (the Fayetteville Shale), Louisiana (the Haynesville), Oklahoma (the Woodford), Pennsylvania (the Marcellus and Utica), Ohio (the Marcellus and Utica), and Texas (the Barnett and Haynesville/Bossier). Natural gas from shale represented 40 percent of U.S. gas reserves 334 Tcf in 2011.¹⁴

¹³. Energy Minerals Division of the American Association of Petroleum Geologists. http://emd.aapg.org/technical_areas/tightGas.cfm

¹⁴. http://www.eia.gov/dnav/ng/ng_enr_shalegas_a_EPG0_R5301_Bcf.a.htm

The profitability of natural gas liquids (NGLs) has, in recent years, led operators to focus drilling efforts on “wet” production areas where the NGLs are abundant. NGLs include fuels such as ethane, normal butane, isobutene, and propane. These wet areas can be found in portions of shale formations such as the Marcellus, Utica, and Eagle Ford.

Figure 22 | Gas Shale Plays in the U.S.



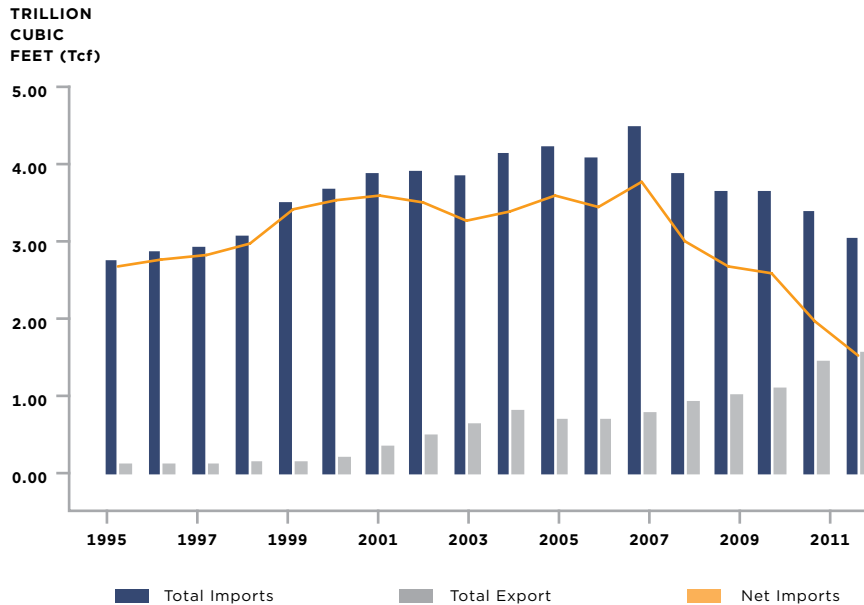
Source: EIA. *Shale Plays in Lower 48 States*. May 9, 2011

Imports and Exports of Natural Gas

Net imports of natural gas into the U.S. fell to 1.52 Tcf during 2012. This is 40 percent of the 2007 record level of 3.79 Tcf. Figure 23 details how continued growth in natural gas exports from the U.S. and falling imports of natural gas to the U.S. during 2012 accounted for the decline in net imports.

Domestic natural gas production was the primary driver in the declining level of net imports, as dry natural gas production in the U.S. continues to increase. With dry gas production at its highest level since 1973, increased domestic sources of natural gas helped maintain competitive prices and discouraged imports while encouraging exports.

Figure 23 | Natural Gas Imports and Exports



Source: EIA. *U.S. Department of Energy's Office of Fossil Energy*. 2011

Gross imports of natural gas declined 8 percent during 2011 as both liquified natural gas (LNG) and pipeline imports fell. In 2011, the U.S. imported 3,138 Bcf of natural gas, the lowest level since 1997, and the fifth consecutive year that natural gas imports to the U.S. declined.

Natural gas exports from the U.S. totaled 1,619 Bcf, increasing about 112 Bcf, or about 8 percent, during 2012. Pipeline exports accounted for 1,594 Bcf (98 percent) of the all exports from the U.S. during 2012 and LNG exports accounted for remainder.

Canadian Supply

In 2012, the U.S. imported approximately 3.2 Tcf of natural gas mainly from Canada along with some LNG from a number of countries.

Canada has been an important source of supply to meet U.S. natural gas

requirements. Imports from Canada totaled about 3 Tcf¹⁵ and account for about 98 percent of total imports.

Canada's production from its primary resource region, the Western Canadian Sedimentary Basin, has been relatively flat over the last ten years and is expected to decline over time. Moreover, Canada's natural gas consumption has been increasing for industrial and electric generation requirements. The combination of falling Canadian natural gas production and increasing demand is expected to result in decreased natural gas exports to the U.S. Potential new Canadian unconventional production from shale formations may mitigate declines in production.

Annual pipeline imports from Canada into New York are expected to continue to decline over the forecast period, as shown later in Figure 26. Natural gas supplies are projected to increase from the south and the west, as production from shale formations as well as the Rocky Mountains replaces declining imports from Canada.

Liquefied Natural Gas

Another source of the U.S. natural gas supply is from imported LNG. However in 2012, U.S. LNG imports continued to decline with only 175 Bcf received. This is 23 percent of the 2007 levels which were at 771 Bcf. The 2012 annual LNG imports represent less than 1 percent of total U.S. natural gas requirements. The principal reasons for the decline include low domestic natural gas prices that made it difficult to attract LNG cargo to the U.S. Of 12 active U.S. terminals, only Everett LNG in Massachusetts and Elba Island in Georgia received regular LNG cargo throughout the year, albeit with lower frequency than in past years. Both have long-term contracts. Figure 24 illustrates LNG price variations around the world.

15. The U.S. exported 1 Tcf to Canada in 2012 therefore; U.S. net Canadian imports for 2012 were 2 Tcf.

Figure 24 | World LNG Landed Price Estimates for 2012

Source: FERC. *Market Oversight*. 2012. <http://www.ferc.gov/market-oversight/othr-mkts/lng/othr-lng-wld-pr-est.pdf>

The U.S. domestic production in the lower 48 states has increased with the development of new supply basins, so the need for substantial increased volumes of imported LNG has diminished for the near term. It is anticipated that if natural gas production from Shale basins outstrips demand in the U.S., LNG may be exported from the continental U.S. to Asia or Europe. This could cause price volatility in the future and should be monitored.

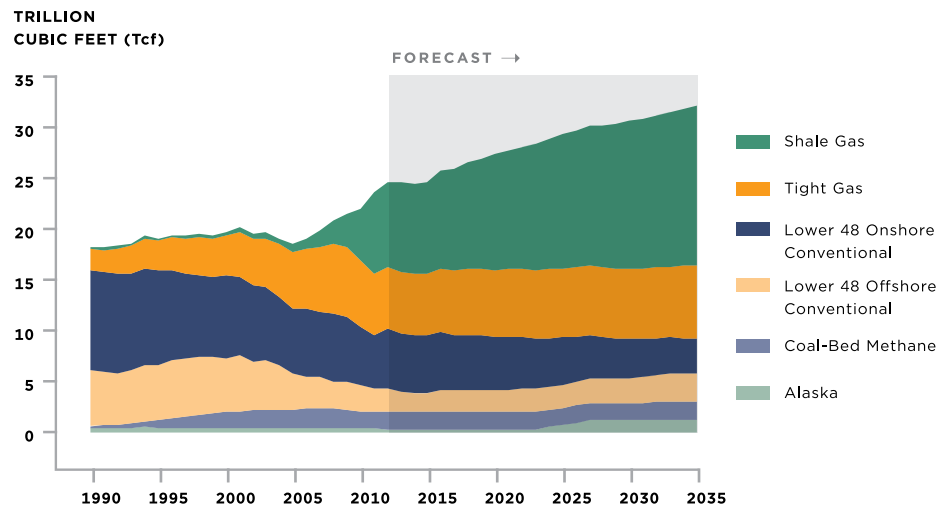
Alaskan Natural Gas Production

Alaska's North Slope has extensive hydrocarbon reserves, including natural gas. To date, 35 Tcf of natural gas have been discovered. These are considered to be marketable reserves, which could be developed at low cost with existing technology, if there was a market for this output. Currently, Alaskan gas is not marketed in the lower 48 states since there is no infrastructure to deliver gas produced in Alaskan fields to consumers in the rest of the U.S. A pipeline connecting Alaskan fields with the lower 48 consumers would allow the natural gas reserves that have already been identified to be marketed profitably, along with other undiscovered Alaskan gas resources. Increasing domestic supply could also reduce the prices paid by consumers for natural gas.

North American Production and Supply Forecast

Figure 25 illustrates natural gas production increases throughout the projection period. Much of this growth in natural gas production is a result of the application of recent technological advances and continued drilling in shale plays with high concentrations of natural gas liquids and crude oil, which have a higher value in energy equivalent terms than dry natural gas.

Figure 25 | U.S. Natural Gas Production, 1990-2035 (Tcf/year)

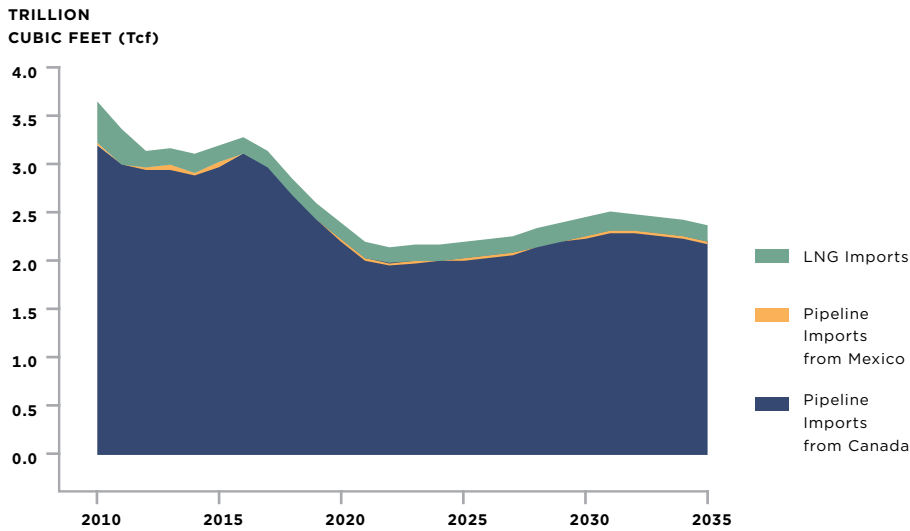


Source: EIA. *Annual Energy Outlook 2013 (AEO2013)*. June 2012.

Imported gas from Canada has decreased in recent years and that trend is predicted to continue. Net imports of natural gas into the U.S. fell 3 percent to 2 Tcf during 2012. Continued growth in natural gas exports from the U.S. and falling imports into the U.S. in 2020 accounted for the decline in net imports.

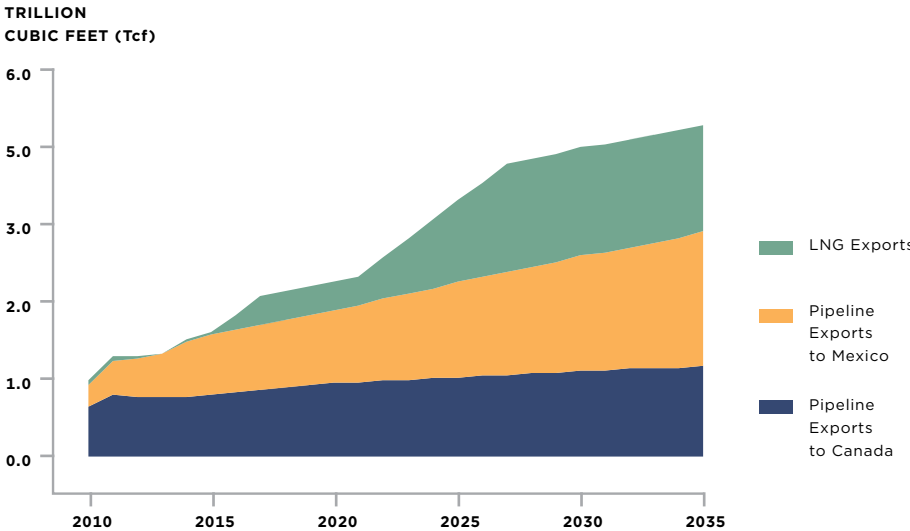
The increase in domestic natural gas production is a primary driver in the declining level of net imports, as dry natural gas production in the U.S. increased to 24.1 Tcf in 2012. Figure 26 and Figure 27 illustrate the impact of this production increase, to discourage imports and encourage more exporting.

Figure 26 | U.S. Natural Gas and LNG Imports (Tcf)



Source: EIA, *AEO2013*, April 2013

Figure 27 | U.S. Natural Gas and LNG Exports (Tcf)



Source: EIA, *AEO2013*, April 2013.

New York Production and Supply History

Approximately 97 percent of the natural gas supply required to meet the demands of New York natural gas customers is from natural gas supply production regions in other states. In the past these regions principally included the Gulf Coast and Canada. Today the mix includes supplies from the West and a growing proportion from the Marcellus Shale. This gas supply is brought to the New York market by interstate pipelines that move the gas from producing and storage areas to customers, such as LDCs and electric generators, who purchase the gas supplies from gas producers and marketers.

New York Production

Production of natural gas from wells in New York dates back to 1821 when the first commercial natural gas well in the U.S. was drilled in Fredonia. Currently, there are approximately 6,800 active natural gas wells in the State. For the 2012 calendar year, total reported State natural gas production was 26.4 Bcf, down 52 percent from the 2006 record production total of 55.2 Bcf.¹⁶ As in recent years, New York gas production in 2010 was primarily driven by wells in the Trenton-Black River formation. Additionally, steady production from the Medina, Herkimer, and Queenston formations represent gas production from traditional sources within New York. Gas from shale formations is excluded from the production mix, reflecting the prohibition of in-State high-volume hydraulic fracturing.¹⁷

Trenton-Black River Formations

The increase in New York natural gas production between 1998 and 2006 was primarily driven by prolific wells in the deep (7,000 to 11,800 feet) Trenton-Black River formation in the Finger Lakes region. The largest area of production from this formation is in Chemung and Steuben counties. Annual production from the formation has grown from about 1.6 Bcf in 1998 to over 40 Bcf between 2005 and 2007, dropping to 34.8 Bcf in 2008. In 2012, production from the Trenton-Black River producing wells has dropped to about 12.1 Bcf. In 2012, the Trenton-Black River production accounted for about 46 percent of the State's overall natural gas production from just 98 producing wells.

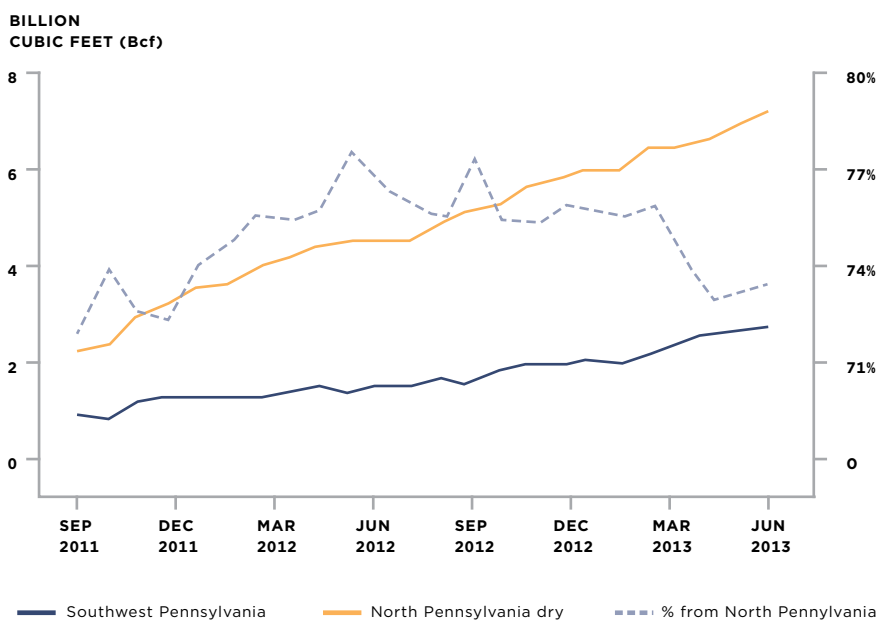
¹⁶. DEC online searchable database, annual well production search, <http://www.dec.ny.gov/energy/1524.html>

¹⁷. <http://www.dec.ny.gov/energy/75370.html>

Northeast Supply

Much of the growth in natural gas production is a result of the application of recent technological advances and continued drilling in shale plays with high concentrations of natural gas liquids and crude oil, which have a higher value in energy equivalent terms than dry natural gas. In the Northeastern U.S., natural gas production has grown rapidly since early 2009 as a result of increased drilling activity in the Marcellus Shale. The largest production gains have occurred in Northeastern Pennsylvania, with noticeable increases also in Southwestern Pennsylvania and West Virginia. Figure 28 illustrates the recent increase in Northeast gas production that can be available to New York.

Figure 28 | Pennsylvania Natural Gas Production Growth (Bcf/day)



Source: EIA *West Virginia, southwest Pennsylvania form an integrated natural gas production region*, August 23, 2013. <http://www.eia.gov/todayinenergy/detail.cfm?id=12671&src=Natural-b3>.

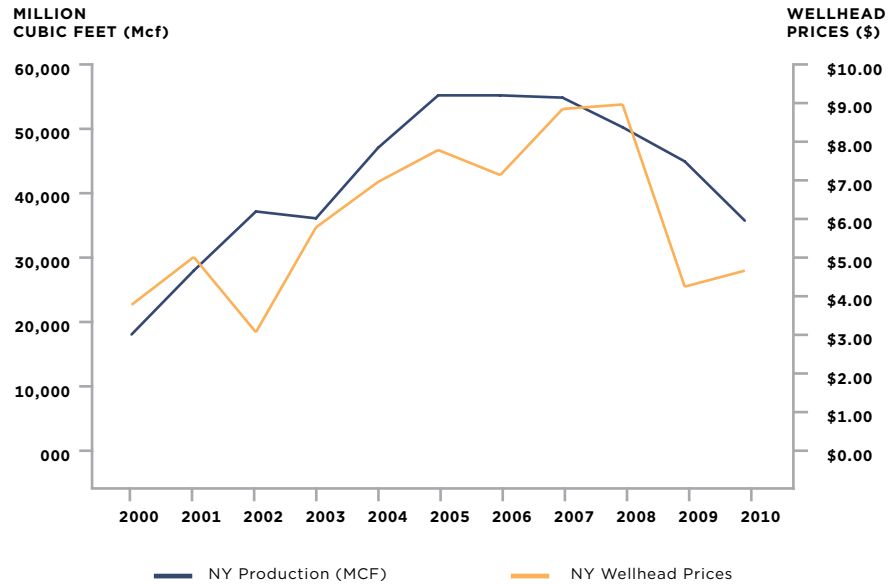
Highlights from Figure 28 show these trends:

- Production in Northern Pennsylvania passed 6 Bcf per day (Bcf/d), up from 2 Bcf/d in 2011.
- In Southwestern Pennsylvania, production is now approaching 3 Bcf/d, more than three times the level in 2011.
- While both areas continue to grow at a rapid pace, the wet Southwestern Pennsylvania is becoming a greater percentage of the total.

New York Supply

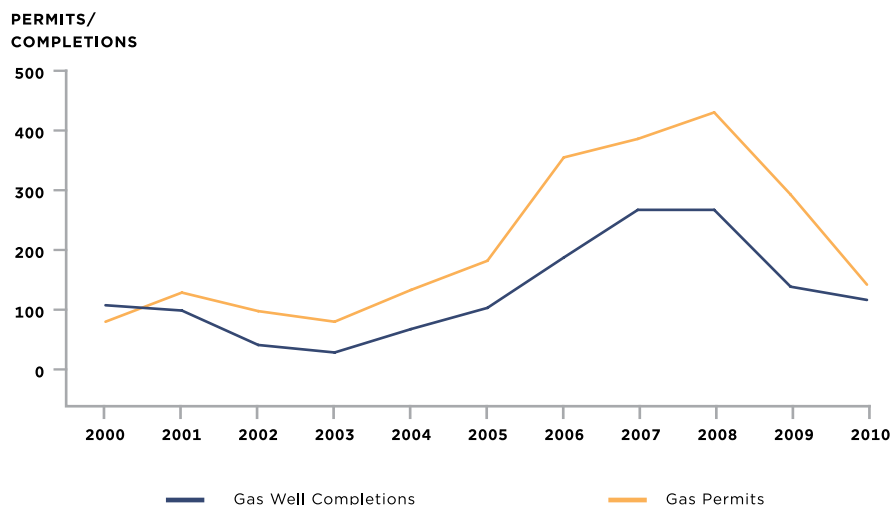
Figure 29 demonstrates the relationship between natural gas pricing and production in New York over the past decade. Generally, producers have increased drilling during periods of increasing prices and reduced drilling during periods of reduced prices. However, this is not true in all areas of the country. Those areas where drilling includes associated NGLs continue to experience strong growth in production even though the price of dry natural gas is down. This growth is due to the higher value of the associated NGLs.

Figure 29 | New York State Natural Gas Production, Annual (Mcf)



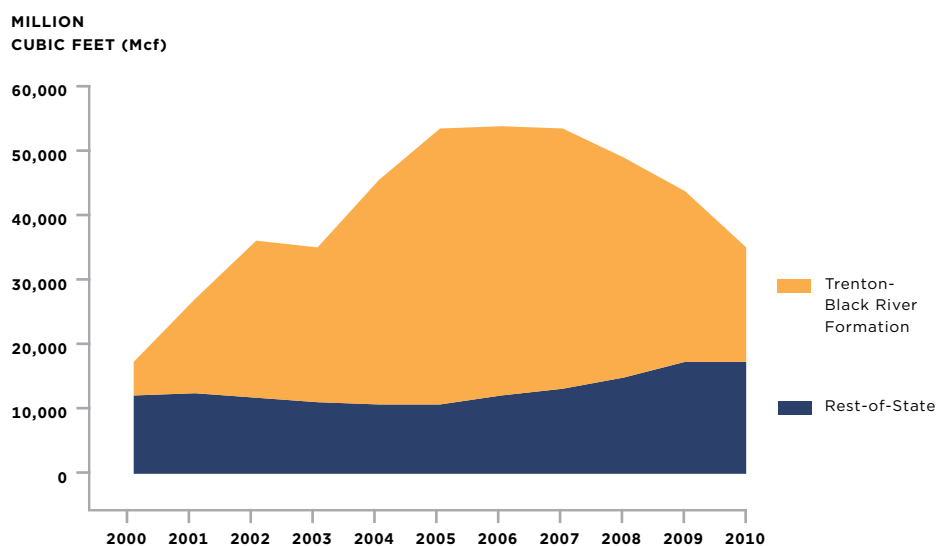
Source: DEC. *Annual Well Production Data: 2000 to 2010*. 2010.

Figure 30 demonstrates the change in gas permits sought and those brought to fruition are correlated very closely to the production statistics. As natural gas prices increase, the number of permits sought and those that are completed rise in relation to the price. Conversely, the number of permits sought and those brought to completion decline as natural gas prices decline.

Figure 30 | New York State Gas Well Permits and Completions

Source: DEC. *Annual Well Production Data: 2000 to 2010*. 2010.

Figure 31 shows that over the past decade the largest contributor to New York's natural gas production has come from development of the Trenton-Black River formation. In 2009, Trenton-Black River accounted for 60 percent of gas production in the State. However, 2009 was the first time in 11 years that no new Trenton-Black River Fields commenced production. Current Trenton-Black River production comes from 98 wells, with one well producing approximately 2.5 Bcf of the total.

Figure 31 | New York State Trenton-Black River Natural Gas Production, Annual (Mcf)

Source: DEC. *Annual Well Production Data: 2000 to 2009*. 2011.

The State's natural gas production is expected to decrease significantly over the forecast period, due largely to the projected decline in production from the Trenton-Black River wells and lack of new wells being drilled. Nevertheless, the supply demand surplus in New York will continue even with the current low price situation due to a shift to wet gas and associated gas from oil producing regions. Sufficient gas supplies should be available from outside the State as long as the interstate pipeline capacity exists to serve New York.

New York Pipeline Imports Forecast

The vast majority of New York's natural gas supply is brought in via pipeline from other states and Canada. The Transcontinental and Tennessee Gas Transmission pipelines from the Gulf Coast and the Iroquois pipeline from Canada link up with local gas distribution networks that supply the New York City metropolitan area and Long Island. Numerous other gas transmission systems branch in from Pennsylvania and Canada to feed other parts of the State. New York has moderate natural gas storage capacity, developed principally from depleted natural gas fields in the Appalachian Basin in western New York. These storage sites, along with those in Pennsylvania, Ohio, and West Virginia, are important for supplying the Northeast region, particularly during the peak demand winter season.

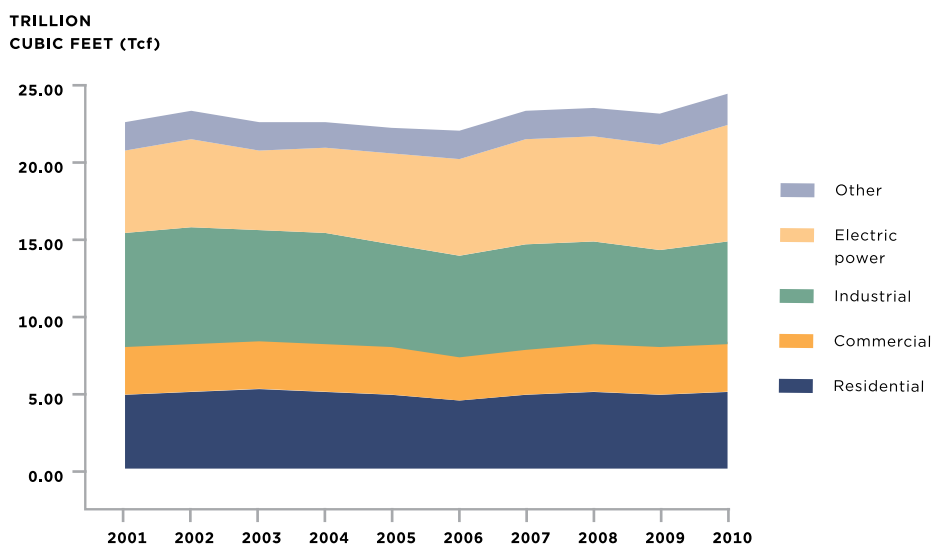
While new natural gas supplies appear abundant, the need to improve the capacity to transport this gas into New York will continue to need improvement. The different types of projects required and the status of current and future projects is discussed further in Section G, Infrastructure.

Demand

North American Demand History

Natural gas consumption comprises about 23 percent of the total energy consumption in the U.S. Natural gas is used for many purposes: home space and water heating, cooking, commercial and industrial space heating, commercial and industrial processes, as a raw material for the manufacture of fertilizer, plastics, and petrochemicals, as vehicle fuel, and for electric generation. Over 50 percent of the homes in the U.S. use natural gas as the primary heating fuel. In 2010, U.S. natural gas consumption totaled about 24.1 Tcf, which was a new record. Figure 32 presents U.S. historical natural gas demand by sector.

Figure 32 | U.S. Natural Gas Consumption by Sector, 2001 to 2010 (Tcf)



Source: EIA. *Natural Gas Consumption by End Use*. 2011. http://www.eia.gov/dnav/ng/ng_cons_sum_dcu_nus_a.htm

The residential sector represents about 5 Tcf or 20 percent of total U.S. natural gas consumption for 2010. Residential natural gas demand is largely a function of heating demand and is highly weather sensitive. Over 70 percent of annual residential consumption occurs during the five winter months (November through March).

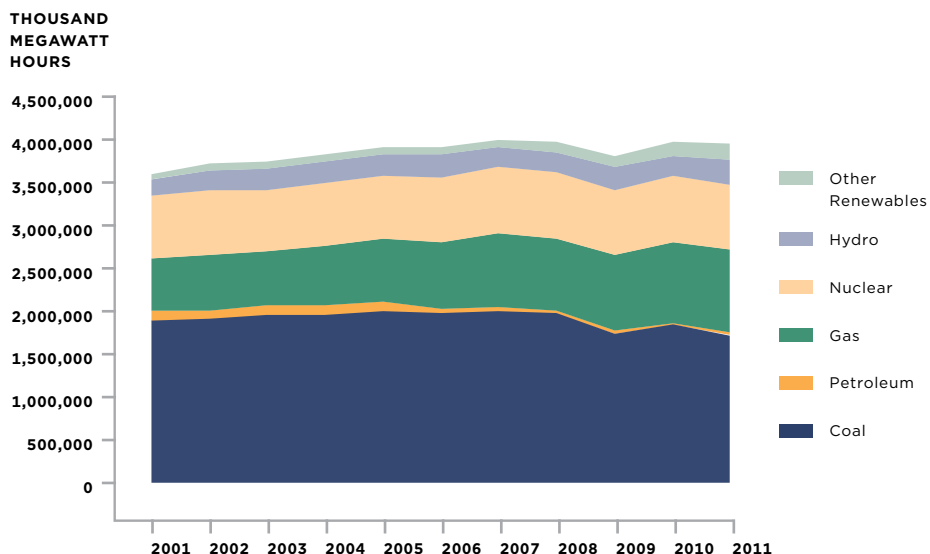
The commercial sector represents about 3.2 Tcf or 13 percent of total U.S. natural gas consumption for 2010. Demand in the commercial sector has been relatively flat over the past ten years. The industrial sector accounted for approximately 6.6 Tcf or 27 percent of total U.S. natural gas consumption in 2010.

Demand in the industrial sector has decreased about 10 percent in the last decade. Other uses of natural gas, including natural gas drilling operations, pipeline delivery, and transportation, accounted for about 2 Tcf of total natural gas consumption in 2010.¹⁸

Nationally, the electric generation sector consumed about 7.4 Tcf, accounting for about 31 percent of total U.S. natural gas demand for 2010. There has been significant growth in the use of natural gas for electric generation, and it has increased about 42 percent from 2000 levels (5.2 Tcf).

Figure 33 shows changes in the fuels used to produce electric generation over the last ten years. Natural gas-fired generation continues to increase, displacing a large amount of coal-fired generation. Generation from natural gas-fired plants grew to more than 24 percent from 18 percent, while coal generation, as a percentage of total output, declined steadily to 44 percent in 2011 from about 51 percent in 2001.

18. “Other” uses include: 1.3 Tcf of natural gas consumed in natural gas drilling and processing operations; 0.6 Tcf of consumption for pipeline and distribution use; and 0.03 trillion cubic feet for vehicle fuel.

Figure 33 | U.S. Electric Generation by Fuel Use, 2001 to 2011 (Percent of Total)

Source: EIA. *Electric Power Monthly*. April 2012.

Low natural gas prices in 2011 helped push the proportion of coal generation down during the year, ending at 39 percent of total U.S. generation in December. Over roughly the last decade, the largest volume of natural gas-fired combined cycle generation construction occurred from 2000 to 2005. Their capacity factors have been growing steadily since that time, from the low 30 percent range to nearly 40 percent. In addition to advantageous fuel costs, the increase in natural gas-fired generation is based in lower construction costs, shorter construction or conversion timetables, and more flexible operations with fewer environmental restrictions. Coal plant construction, however, has not come to a halt. Coal still maintains a fuel-cost advantage for large base-load plants in certain locations, particularly where delivered coal costs may be low.

North American Demand Forecast

In the AEO2012 Reference Case, natural gas consumption rises from 24.5 Tcf in 2011 to 26.6 Tcf in 2035, about the same level as in the AEO2011 Reference Case. The largest share of the growth is for electricity generation. Demand for natural gas in electricity generation grows from 7.5 Tcf (24 percent share) in 2011 to 9.0 Tcf (27 percent share) in 2035. A portion of the growth is attributable to the retirement of 33 gigawatts of coal-fired capacity over the projection period. Over the next 25 years, the projected coal share of overall electricity generation falls to 39 percent, well below the 49 percent share seen as recently as 2008 (Figure 33), because of slow growth in electricity demand, continued competition from both natural gas and renewable plants, and the need to comply with new environmental regulations.

New York Demand History

In 2010, New York used approximately 1,198 Bcf of natural gas¹⁹, making it the fourth largest gas consuming state in the nation. This usage accounts for about five percent of U.S. demand. The breakdown of this gas consumption by sector is residential 390 Bcf (33 percent), commercial and industrial 363 Bcf (30 percent), and electric generation 425 Bcf (35 percent).²⁰

New York's 4.3 million residential customers used about 390 Bcf of natural gas or 33 percent of total statewide gas use. The State's 377,000 commercial customers used about 277 Bcf or 23 percent of total natural gas use. Natural gas consumption in the residential and commercial sectors in New York represents a larger proportion of the total consumption than U.S. consumption for those sectors (20 and 13 percent, respectively). The primary use of natural gas in New York for residential and small commercial customers is for space heating and is highly weather sensitive.

The State's natural gas market is winter peaking with over 70 percent of residential and 60 percent of commercial natural gas consumption occurring in the five winter months (November through March). Figure 35 presents New York historical natural gas demand by sector.

19. U.S. Energy Information Administration –Natural Gas Consumption by End Use 2010.

20. Other uses, i.e., pipeline and distribution use and vehicle fuel, account for roughly 19 Bcf of demand

Although the total number of residential and commercial natural gas customers has increased, particularly in the downstate market area, overall statewide gas consumption has remained relatively flat for these sectors. This can be attributed to decreased customer usage due to conservation measures and increased efficiency for new natural gas appliances.²¹

Natural gas use in New York's industrial sector accounts for about 75 Bcf or 6 percent of total consumption in the State. Industrial consumption has decreased over the historic period due to both the industrial manufacturing capacity leaving the State and the continued movement away from energy intensive manufacturing processes towards less energy intensive processes. New York's industrial sector natural gas use is a much smaller percentage of overall State natural gas demand than that of the national industrial use (27 percent) to total national gas demand.

In 2010, the electric generation sector used about 425 Bcf of natural gas or 35 percent of the State's total natural gas consumption. Consumption of natural gas for electric generation has fluctuated during the historic period 2000 through 2010²². Much of this fluctuation can be attributed to economic fuel switching by older, dual-fuel oil/gas steam plants and peak demand weather related variances. Natural gas has become and will continue to be the fuel of choice for new and replacement generation in New York for the next several years due to its economic, operational, and environmental advantages. In general, natural gas-fired generation plants have lower capital costs, are cleaner burning, are more energy-efficient, and have a greater degree of operational flexibility than other fossil fueled alternatives. In New York, from April 2006 through October 2011, approximately 3,700 megawatts (MW) of new generation capacity has been added and 2,500 MW of generation capacity has been retired for a net gain of 1,200 MW of new generation capacity.²³ Natural gas represents the greatest level of additions with

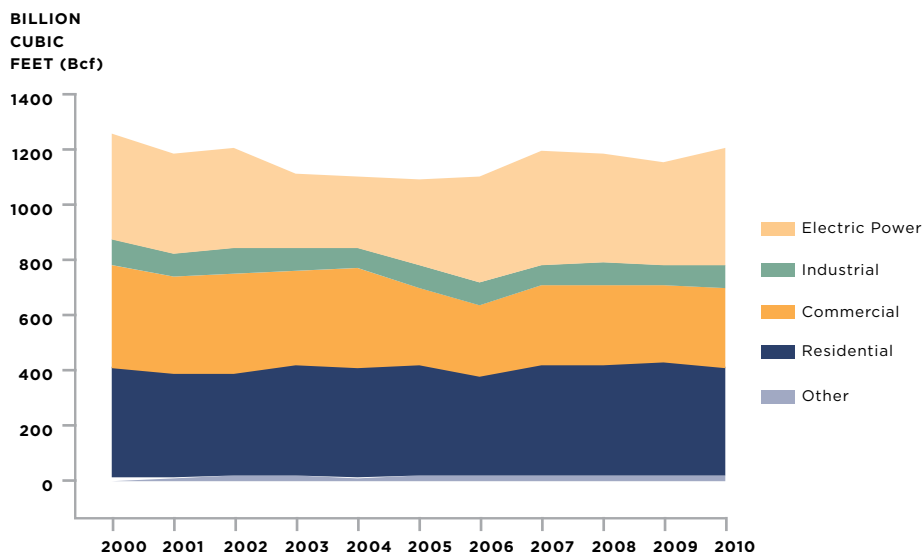
21. Note: historic consumption has not been normalized for weather.

22. Electric generation consumption of natural gas was much higher in 2010 than 2009, probably due to a warmer summer.

23. The fuel sources for the new added capacity include natural gas, wind, water, methane, and solar. Following gas, wind generation represents the second largest category of additions with 34 percent of the total new additions. There were no new coal or oil fired generating units added to the mix during this period. Of the total units retired, approximately 85 percent were coal or oil fired generation.

approximately 63 percent of the new additions. About 36 percent of electricity generated in New York was fueled by natural gas in 2010.²⁴

Figure 34 | New York State Natural Gas Consumption by Sector (Bcf)

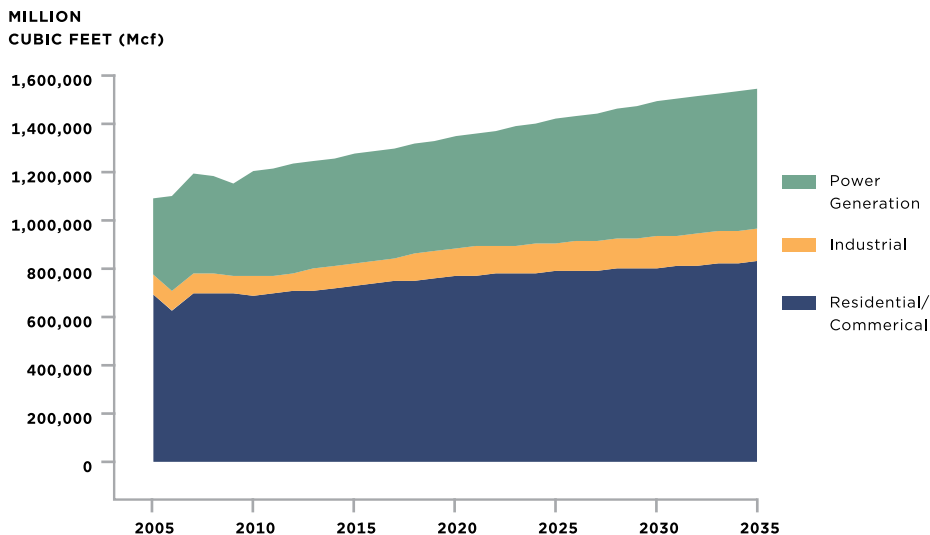


Source: EIA. *Natural Gas Consumption by End Use: 2000 to 2010*. 2012. http://www.eia.gov/dnav/ng/ng_cons_sum_dcu_sny_a.htm

New York Demand Forecast

From 2011 to 2035, State annual gas demand is expected to grow by about 185 Bcf (21 percent) to about 1.48 Tcf. The EIA Annual Energy Outlook for 2012 forecasts residential consumption to increase at an average of 0.3 percent during this period. Consumption of natural gas for Commercial purposes is expected to average 1 percent per year. Industrial Consumption is expected to average 1.5 percent per year over this period. Finally, based on electricity sector modeling performed for the State Energy Plan (see Electricity section of Volume 2: Sources), from 2012 to 2030, New York's total natural gas use in the electricity sector is projected to increase from 420 trillion Btu to 554 trillion Btu, a total increase of 32 percent. This indicates power generation fueled by natural gas is expected to increase at an average 1.6 percent annual rate over this period.

24. EIA Net Generation by State by Type of Producer by Energy Source 1990-2010. http://www.eia.gov/cneaf/electricity/epa/epa_sprdshts.html

Figure 35 | New York State Gas Consumption Forecast (Mcf)

Source: EIA. *AEO2012*. June 2012.

About 80 percent of the growth in New York gas demand, as shown in Figures 36, 37, and 38, is concentrated in the capacity constrained New York City and Long Island regions.

The following are forecasts of natural gas demand in New York based on State data in the EIA Annual Outlook 2012 and from annual filings by the 11 major LDCs located in New York.²⁵ The analyses included in this write-up evaluate changes in normal annual, design winter, and design day requirements based on the LDCs filings used to support their 2011-2012 winter supply plans. In addition, these company filings include a 5-year forecast of their requirements. Department of Public Service (DPS) Gas Policy staff used this company provided data to complete a forecast through 2035.

Normalized Demand Requirements

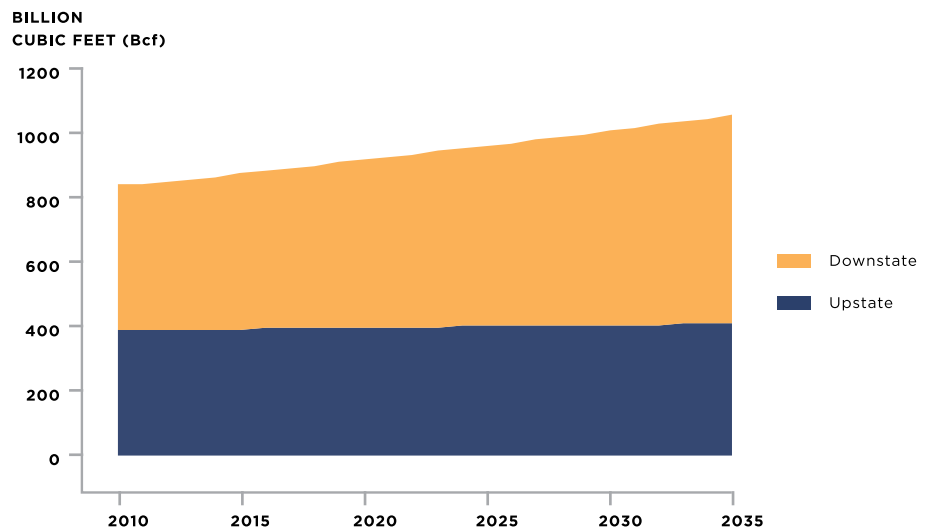
Figure 37 provides a forecast of upstate and downstate normal annual send out for the period 2010 to 2035. This chart shows that based on variables known at the time these filings were prepared that, the upstate

25. There are four LDCs included in the Downstate analyses, including: Consolidated Edison, Orange and Rockland, National Grid-NY, and National Grid-LI. The Upstate analyses include seven companies: Central Hudson, Corning, National Fuel Gas, National Grid – Upstate, New York State Gas and Electric, Rochester Gas and Electric, and St. Lawrence Gas.

LDCs were forecasting flat growth through the conclusion of the winter of 2015 to 2016. These data carried forward present overall flat growth upstate through 2035. This forecast indicates that in general there will be little need for additions to upstate capacity necessary to support annual growth. The one exception is in the Capital District area where constraints on both the Dominion Transmission and Tennessee Gas pipelines threaten expanded use of natural gas for all customer sectors.

However, downstate the data provide a different picture. Growth downstate is projected to average approximately 1.5 percent annually. These projections are consistent with the EIA Annual Energy Outlook 2012 reference data for New England. If these growth rates materialize normal annual requirements would increase from 434 Bcf in 2010 to 466 Bcf through the conclusion of the 2015 to 2016 winter. These projections taken through the conclusion of the winter of 2035 to 2036 would increase the downstate annual requirements from 434 Bcf in 2010 to 625 Bcf or approximately 44 percent over this 25 year period. Given the current tightness in capacity in the downstate markets, this annual growth rate of 1.5 percent will likely require ongoing additions to capacity holdings by the downstate LDCs. Changes in growth to these forecasts will have capacity implications, especially changes that result in increases in annual requirements. Such increases to projected growth downstate will result in the need for additional vigilance in identifying the need and for sourcing capacity to serve additional requirements.

Figure 36 | New York Regional Demand - Normal Annual Requirements (Bcf)



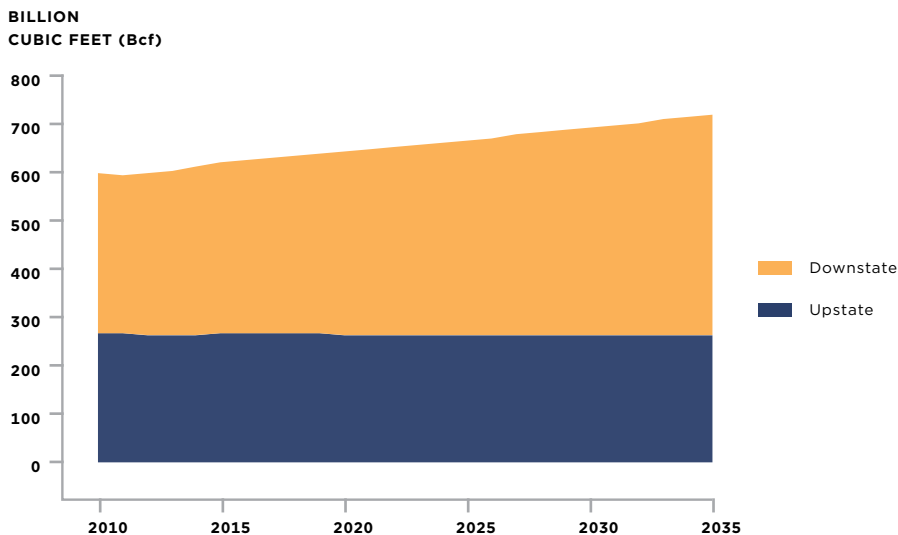
Source: PSC. *Case 11-G-0380: Report on New York State Natural Gas Supply Readiness for the 2011-2012 Winter Season*. October 2011.

Reliability Demand Requirements

Reliability demand requirements are essential to any effort at capacity planning. Specifically, both design winter and design day requirements are needed to identify the need for pipeline and storage capacity.

Design Winter Requirements

Figure 37 provides a forecast of upstate and downstate design winter requirements for the period 2010 to 2035. This chart shows that based on the known variables, at the time these filings were prepared, the upstate LDCs were forecasting flat to slightly negative growth in upstate design winter needs. These forecasts reflect expected low growth over the forecast period combined with energy efficiency, conservation, and changes to the weather forecasts by National Oceanic and Atmospheric Administration (NOAA) that reflect warmer weather and a resulting lower number of heating degree days (HDDs). All these variables contributed to flat growth in the upstate design winter analysis. As with the discussion of normalized annual volumes, the downstate picture is different in that downstate LDCs are forecasting growth in design winter demand. For the period 2010 through the winter period ending 2015 to 2016, the downstate companies project annual growth in excess of 1.25 percent annually for a total growth in excess of 6 percent. For the period 2010 to 2035 the total growth in design winter requirements are in excess of 36 percent growth. As discussed above, there are number of variables that are also dampening the forecast in design winter growth (i.e., energy efficiency, conservation, warmer weather). If these variables do not materialize fully, it is likely that these changes could place further demands on the already tight capacity demands that exist in the downstate LDC service areas. As a result, a portion of the needed capacity forecast to serve the normal annual send out that is associated with an increase in design winter may require capacity additions to storage.

Figure 37 | New York Regional Demand – Design Winter Requirements (Bcf)

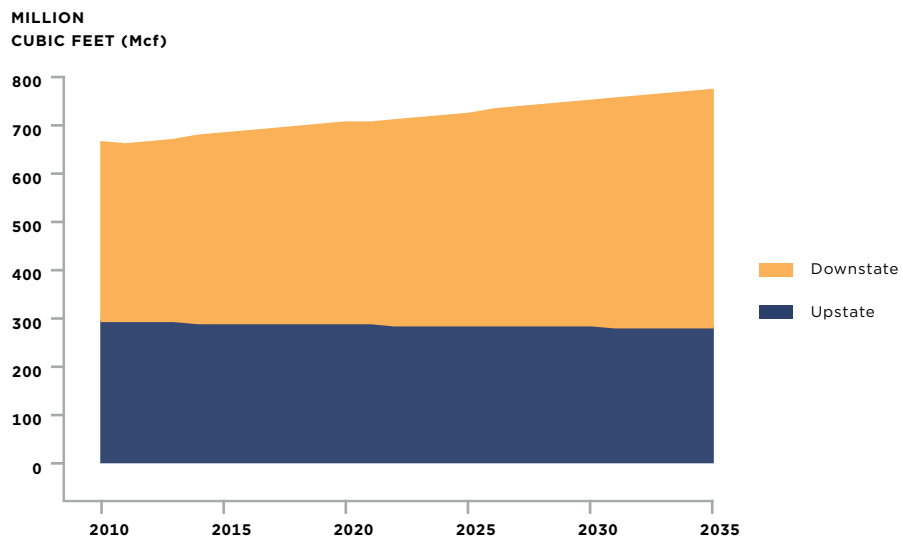
Source: PSC, *Case 11-G-0380: Report on New York State Natural Gas Supply Readiness for the 2011-2012 Winter Season*, October 2011.

Design Day Requirements

Figure 38 provides a forecast of upstate and downstate design day requirements for the period 2010 to 2035. This chart shows that based on the known variables, at the time these filings were prepared, the upstate LDCs were forecasting slightly negative growth in upstate design day requirements of about 1 percent for the period 2010 through the winter of 2015 to 2016. These same requirements forecast for the period 2010 to 2035 show a 4 percent reduction in the requirements to serve a peak day for the upstate companies. Similar to the variables affecting design winter, the reduction in design day requirements for this period result from expected lower growth combined with energy efficiency, conservation, and changes to the weather forecasts by NOAA that reflect warmer weather and a resulting lower number of HDDs. These variables contributed to negative growth in the upstate design day requirements. The downstate picture is different in that downstate LDCs are forecasting growth in design day requirements. For the period 2010 through the winter period ending 2015 to 2016, the downstate LDCs project annual growth in excess of 1 percent annually for an increase in growth in design day requirements of close to 6 percent. For the period 2010 to 2035 the total growth in design day send out is forecast to be in excess of 25 percent growth. There are a number of variables that are contributing to a lower forecast in design day growth (i.e., energy efficiency, conservation, warmer weather) in the upstate service areas, which are also included in

the downstate projections. However, if these variables do not materialize fully, there is some potential that these changes could contribute to growth and further demands on the already tight capacity demands that exist in the downstate LDC service areas. Together with the design winter analysis, the design day analysis should be utilized to select the mix for future additions between pipeline transportation, storage service, and peaking assets.

Figure 38 | New York Regional Demand – Design Day Requirements (Mcf)



Source: PSC, *Case 11-G-0380: Report on New York State Natural Gas Supply Readiness for the 2011-2012 Winter Season*, October 2011

Power Generation Requirements

Relatively low natural gas prices spur increased use in the electric power sectors nationally, particularly over the next 15 years. Although natural gas also continues to capture a growing share of total electricity generation, natural gas consumption by power plants does not increase as sharply as generation because new plants are very efficient. After accounting for 36 percent of total New York generation in 2010, the natural gas share of generation should rise through 2035. The amount and the extent of this increased share cannot be determined without additional information regarding electric generation retirements, refueling of operations as well as what new generation is brought on line. In addition, most generators utilize interruptible gas service and do not require dedicated pipeline capacity.

Infrastructure

U.S. natural gas pipeline capacity investment slowed in 2012 after several years of robust growth. Limited capacity additions were concentrated in the northeast U.S., mainly focused on removing bottlenecks for fast-growing Marcellus Shale gas production. More than half of new pipeline projects in the U.S. that entered commercial service in 2012 were in the Northeast. Excluding gathering, storage, and distribution lines, project sponsors in the U.S. added 4.5 bcf/d of new pipeline capacity and 367 miles of pipe totaling \$1.8 billion in capital expenditures in 2012.²⁶

26. EIA "Today in Energy", March 25, 2013; <http://www.eia.gov/todayinenergy/detail.cfm?id=10511>

Pipeline Siting

Planning, regulatory approval, and construction of new pipeline facilities is difficult and can take many years, particularly in the Northeast. For example, the Millennium pipeline project's application was first filed with FERC in December 1997. The project experienced significant delays due to major issues involving routing and environmental concerns. The project was eventually constructed and put in service in December 2008, over 11 years after it first filed its FERC application. Several projects are either now under construction or planned to improve gas deliverability in specifically constrained areas of New York.

National Grid has identified needs to add delivery capacity into its Capital District service area. This is directly related to the inability of marketers not required to participate in the mandatory assignment of capacity program to attain firm primary capacity at the Albany East Gate. Tennessee Gas pipeline is expanding its capacity through Albany into New England and it may be possible to increase the capacity received from its Albany gate, but the FERC transmission rates on Tennessee are considerably higher than DTI's so it is not the first choice of the commercial and industrial customers needing the service. In addition, there are certain constraints within the distribution system around Albany that must be considered in planning interstate pipeline capacity additions.

Pipeline Expansions for New York and the Northeast

Recently Completed Pipeline Projects

Over the past four years, several natural gas pipeline infrastructure projects were completed in the region. Six of the projects provide additional pipeline capacity directly into the New York market. The newly constructed Millennium pipeline in conjunction with the Empire Connector, Ramapo Expansion, Market Access Expansion, and the 08/09 Expansion projects have provided New York with a significant amount of new natural gas pipeline capacity. The Millennium pipeline originates in the Corning area, where it interconnects with the new Empire Connector pipeline, and terminates at an interconnection with the Algonquin pipeline in the Ramapo area. The Millennium pipeline was put in service in 2008 and has added a total of 525 millions of cubic feet per day (MMcfd) of incremental capacity to access Canadian supplies, through the Empire Connector, and storage services along both the Millennium and Empire pipelines. The Millennium pipeline serves markets along its route through the lower Hudson Valley, and provides incremental capacity of 300 MMcfd to New York City and Long Island

markets through the newly expanded Algonquin (Ramapo Expansion) and Iroquois (Market Access and 08/09 projects) Pipelines. Construction of pipeline capacity upstream of Corning to interconnect with the Millennium pipeline would enable new supplies from the west to reach New York markets.

Additional projects were completed that allow better access to the new shale supply basins in Ohio, West Virginia, and Pennsylvania. Although these projects did not add new capacity directly in New York, the accessibility to the new source of supply has added flexibility and improved the ability of a more diverse supply for New York customers.

Marcellus Shale and Other Proposed Pipeline Projects

The level of pipeline construction in the Northeast will continue to increase in the next few years. These pipeline expansions will provide access to supplies from shale areas, providing significant sources of additional supply to the market area. Some of the planned projects are competing for the same market, and not all of these projects will be constructed and put into service. The projects that are ultimately certified and constructed will enhance the State's access to supplies to meet future loads and will be critical to ensuring reliable, competitively priced supplies to New York in the future. Tables 5A, 5B, and 5C is a list of the major projects planned in the Northeast.

Table 5A | Planned Northeast Pipeline Projects

PROJECT	PIPELINE	DESCRIPTION	STATUS/ EST. IN SERVICE
Team 2014	Spectra/ Texas Eastern	Construction of over 30 miles of new pipe and added compression will supply 600 Mcf per day of Marcellus natural gas supply and deliver it into Northeast markets.	FERC Pre-filing 2012; Est. In-Service 2014
Constitution Pipeline	Williams Partners	Construction of new 120-miles of pipe to connect Williams Partners' gathering system in Susquehanna County, PA, to the Iroquois Gas Transmission and Tennessee Gas Pipeline systems in Schoharie County, NY. Williams Partners will own 75 percent of Constitution Pipeline and Cabot will own the remaining 25 percent. The new pipeline will initially be designed to transport at least 500,000 dekatherms (Dth) per day, but will be expandable to meet growing demand for takeaway capacity in northeast Pennsylvania.	FERC Filing Jun. 2013; Est. In-Service Late 2015

Table 5B | Planned Northeast Pipeline Projects

PROJECT	PIPELINE	DESCRIPTION	STATUS/ EST. IN SERVICE
AIM	Spectra/ Algonquin	Multiple supply and expansion projects to increase flows from Tetco and Millennium Pipelines into northeast (New England) markets. This aggregation of projects will allow supplies from the Appalachian basin to flow into the Northeast helping to meet the increasing demand from home heating and electric generation up to 433,000 Dth per day.	FERC Pre-filing 2012; Est. In-Service 2016
NYMARC	Iroquois	Addition of 66 miles of 36 inch diameter pipe to connect millennium Pipeline at Minisink, NY and Tennessee Pipeline at Wantage Township, NJ with Iroquois at Pleasant Valley, NY. Initial plans are for 500 to 2,000 MDth/d	Open Season Completed 2010
NYMARC Penn	Iroquois	Addition of 135 miles of 36 inch diameter pipe to connect directly with North PA production areas as well as Millennium Pipeline with Iroquois at Pleasant Valley, NY. Initial plans are for 900 to 2,000 MDth/d.	TBD
Northeast Upgrade	Kinder Morgan/ Tennessee	Construct additional firm transportation capacity of 636,000 Dth per day of natural gas to be transported along Tennessee's 300 Line in Pennsylvania and delivered to growing markets in the Northeast. This includes upgrade to the existing 24-inch diameter 300 Line by constructing five, 30-inch diameter pipeline loops and modifying four existing compression stations. These loops will close out the remaining un-looped segments of Tennessee's existing 300 Line east of Bradford County, Pennsylvania, into New Jersey. Upon completion, this project along with the company's 300 Line Project, will add about 1 Bcf per day of new firm transportation capacity to key Northeast markets.	FERC Approved May 2012; Est. In Service November 2013
Leidy South East	Williams- Transco	This is designed to increase the Transco pipeline's capacity by 525,000 Dth of natural gas per day. The proposal would involve the construction of approximately 30 miles of additional pipe segments in Pennsylvania and New Jersey, in addition to modifying some existing pipeline facilities (adding 525,000 Dth/d of incremental firm transportation capacity).	FERC Pre-Filing Jan. 2013; Est. In-Service Dec. 2015
TBD	Kinder Morgan/ Tennessee	Expansion of service into New England through Albany on the 200 line.	Scoping in progress

Table 5C| Planned Northeast Pipeline Projects

PROJECT	PIPELINE	DESCRIPTION	STATUS/ EST. IN SERVICE
Tuscarora Lateral	National Fuel Gas Supply/ Empire	Construction by Empire of approximately 18 miles of 16- or 20-inch diameter natural gas pipeline and interconnection facilities, beginning at National Fuel's existing Tuscarora Compressor Station in the Town of Tuscarora, New York, and ending at the Empire Tioga County Extension Pipeline in the Town of Caton, New York, or in Jackson Township, Pennsylvania. In addition Empire will add a new measuring and regulating station at Tuscarora, New York. The construction by National Fuel of additional compression facilities and related upgrades at its existing Tuscarora Compressor Station. These new facilities will provide New York markets with access to load balancing storage services and new economic gas supplies.	Pre-Filing 2013; Est. in-service Nov. 2015

Source: NYS Department of Public Service Infrastructure Project Database, derived from FERC Office of Energy Projects, Monthly Energy Infrastructure Updates and pipeline company informational postings.

Midstream and Gathering Systems

In addition to the mainline projects, additional investment is planned to provide both trunkline and gathering services from the Marcellus Shale producing areas to northeast markets (Table 6). These projects will collect gas from a variety of shale gas producing areas and deliver gas to existing pipeline systems capable of reaching existing market areas.

Williams Partners, LP is becoming a dominant player in northeastern Pennsylvania. In addition to purchasing Laser Northeast, it has expanded its Springview system to access major transportation routes to New York City and New England. Its Susquehanna Supply Hub in northeast Pennsylvania is a major natural gas supply hub being built to serve natural gas producers in northeastern Pennsylvania. The system currently has a gathering inlet capacity of approximately 1 Bcf/d and is connected to three major interstate gas pipeline systems. The Ohio Valley Midstream system in northern West Virginia, southwestern Pennsylvania and eastern Ohio is situated in the NGL-rich heart of the Marcellus Shale. Current Williams' assets in this area include a gathering system and a processing facility. In addition, construction is underway on fractionation and additional processing facilities, and there are plans to construct NGL pipelines. By 2015, Williams Partners expects to be gathering 5 Bcf/d in the Marcellus Shale.

Table 6 | Midstream Pipelines and Gathering System Projects

PROJECT	COMPANY	DESCRIPTION	STATUS/ EST. IN SERVICE
Laser Northeast Expansion	DMP New York, Inc.	Construct approximately 51,857 feet of 16-inch diameter, coated steel natural gas transmission pipeline and a gas compressor station in the Town of Windsor, Broome County, New York. The expansion will transport natural gas from nine existing natural gas wells operated by Alta Resources LLC (Alta) in Susquehanna County, PA, and nine additional wells yet to be drilled by Alta in the same area.	Expansion In-Service Winter 2012
Bluestone Pipeline	Bluestone Gas Corporation of New York	Natural gas gathering system with dehydration and compression facilities in the Town of Sanford, Broome County, where approximately 0.5 miles of station piping, dehydration, an interconnection with Millennium Pipeline, and future compression facilities will be installed (the "Sanford Station"). The system includes approximately 9.0 miles of 20 inch steel pipeline in Broome County, New York from the Sanford Station to a point where the pipeline will cross into Susquehanna County, PA.	In-Service May 2013
Springview Gathering System	Williams, Co.	Susquehanna Gathering System in County, PA., connecting Marcellus wells with the Transco interstate pipeline. Initial delivery capacity of approximately 300 MMcf/d expected 4Q 2011 in-service; expansions in 2012 will increase capacity to 625 MMcf/d	Initial In-Service January 2012 Expansions In-Service 2012-13

Source: NYS Department of Public Service Infrastructure Project Database, derived from FERC Office of Energy Projects, Monthly Energy Infrastructure Updates and pipeline company informational postings.

New Pipeline Delivery Points into New York City and the Capital District

Both National Grid and Consolidated Edison have identified a need to add delivery capacity into their respective New York City and Capital District territories. In addition, the distribution system's ability to absorb additional interstate pipeline deliveries at a particular point must be considered in planning interstate pipeline capacity additions. Consolidated Edison has identified a need to add delivery capacity in lower Manhattan as the optimal point. National Grid has identified a need to add delivery capacity in the Jamaica Bay (Rockaway Peninsula) area as

well as upstate at Canajoharie and the Albany East Gate of the Dominion pipeline. These projects are shown in Table 7.

Texas Eastern Transmission's (TETCO) proposal to extend its system from its existing Goethals delivery point in Staten Island to a new delivery point in lower Manhattan was selected by Consolidated Edison. The pipeline received commitments from Consolidated Edison and a group of producers for a sufficient level of capacity to make the lower Manhattan project economical. This project was completed in November 2013. Transco proposed a new delivery pipeline lateral from its offshore pipeline in the Lower New York City Bay to an interconnection with National Grid facilities on the Rockaway Peninsula.²⁷

New delivery points at those New York City market locations (Table 7) would significantly relieve existing capacity constraints, increase the reliability of the gas system and reduce both the volatility of spot market gas prices in the downstate market and the delivered price of natural gas into that market. Additional pipeline capacity into the downstate region would provide a direct benefit to not only the natural gas ratepayers but also to electric ratepayers. Therefore, mechanisms for having all beneficiaries share the cost of these expensive pipeline capacity additions should be explored.

National Grid has identified needs to add delivery capacity into its Capital District service area. This is directly related to the inability of marketers not required to participate in the mandatory assignment of capacity program to attain firm primary capacity at the Albany East Gate. Tennessee Gas Pipeline is expanding its capacity through Albany into New England and it may be possible to increase the capacity received from its Albany gate, but the FERC transmission rates on Tennessee are considerably higher than Dominion Transmission Incorporated's (DTI) so it is not the first choice of the commercial and industrial customers needing the service. In addition, there are certain constraints within the distribution system around Albany that must be considered in planning interstate pipeline capacity additions.

27. FERC. Pre-filing Docket PF09-8. 2009. <http://www.ferc.gov/industries/gas/indus-act/pre-filing/fy-2009.pdf>

Table 7 | Planned Pipeline Projects into New York City and Capital District.

PROJECT	COMPANY	DESCRIPTION	STATUS/ EST. IN SERVICE
Rockaway Delivery Lateral	Williams-Transco	Pipeline from Transco's offshore system in the Lower NY Bay to interconnect with National Grid on the Rockaway Peninsula and South Brooklyn. Capacity of 647 MMcfd.	FERC Pre-filing 2012; Est. In-Service November 2014
NJ - NY Expansion	Spectra-Texas Eastern	Pipeline from Texas Eastern's facilities near the existing NY delivery station at Goethals into NJ and crossing the Hudson River to interconnect with Consolidated Edison in lower Manhattan. Capacity of 800 MMcfd.	FERC approved July 2012; In-Service as of November 2013
New Market (TBD)	Dominion Transmission	Construction is proposed for incremental firm transportation service to Iroquois Gas Transmission at Canajoharie and Niagara Mohawk's West Schenectady delivery point. Current scope is for facilities to allow for 200,000 dt/d of total project deliveries with 160,000 dt/d delivered to Iroquois at Canajoharie and 40,000 dt/d delivered to West Schenectady (Albany East Gate).	Open Season June 2013; Est. in Service November 2016

Source: NYS Department of Public Service Infrastructure Project Database, derived from FERC Office of Energy Projects, Monthly Energy Infrastructure Updates and pipeline company informational postings.

Storage

Natural Gas storage is essential in meeting customer demands. The natural gas demand cycle is highly weather related, while supplies tend to be relatively stable. In order to ensure sufficient natural gas supplies to meet customer requirements, gas is injected into underground natural gas storage facilities during lower demand periods, typically April through October, and withdrawn from storage during the higher demand winter season. However, with the recent trend towards natural gas-fired electric generation, demand for natural gas during the summer months is now increasing. Natural gas storage also serves as insurance against unforeseen incidents, such as natural disasters (hurricanes), or other incidents that may affect the production or delivery of natural gas.

National

LDCs access interstate pipeline and independently owned storage facilities located at different points along the interstate pipeline systems in the natural gas production and market areas. Generally, the regulation of existing storage facilities and certification of new facilities fall under FERC jurisdiction. There are over 400 natural gas storage facilities in the U.S. with a total working gas storage design capacity of approximately 4.6 Tcf of natural gas.

Northeast U.S. (New York Market Area Storage)

Natural gas storage plays a significant role in meeting the weather sensitive gas supply needs. For many states in this region, local distribution companies are legally required to purchase and store working gas to ensure sufficient inventories to meet increased winter demand. As a result, working gas storage capacity generally tends to be full in the East by the end of October, regardless of weather and market conditions. The region consistently fills close to or above 90 percent of its working gas storage capacity by the end of October.

Approximately 35 to 40 percent of New York LDCs winter gas requirements are met through gas withdrawn from storage facilities, primarily depleted gas wells, located in Pennsylvania and western New York.²⁸ Generally, using storage facilities that are close to market is an economic way to meet seasonal demands. The alternative would be to build additional pipeline capacity all the way back to the gas production areas. In addition, some LDCs have peaking supplies such as LNG or propane²⁹ plants located within their service territories that are critical to meeting gas demand on peak winter days.

²⁸. The storage fields in Pennsylvania and New York have total working gas storage capacity of about 432 billion cubic feet and 126 billion cubic feet respectively.

²⁹. The last propane plant operating in New York was decommissioned in 2011.

Northeast Storage Capacity Expansions

Storage capacity rose in most regions in the last few years, reflecting a mix of different types of storage such as aquifer, depleted gas field, and salt dome storage.³⁰ In the East, design capacity remained unchanged over the last year at 2,300 Bcf. In comparison, the total design capacity and demonstrated maximum working gas capacity in the lower 48 states rose 91 Bcf and 77 Bcf, respectively over the last year. Table 8 lists some planned storage projects in New York.

Table 8 | Planned Storage Projects

PROJECT	COMPANY	DESCRIPTION	STATUS/ EST. IN SERVICE
Stagecoach Storage Facility North and South Project	Central NY Oil & Gas	Increase the throughput capacity of the North Lateral to approximately 560 MMcf/d, and that of the South lateral to approximately 728 MMcf/d.	Proposal under development 2013
Stagecoach Storage Facility Marc I Project	Central NY Oil & Gas	Proposed 39 mile, 30-inch bi-directional gas pipeline that will provide transport capacity between Tennessee 300 Line and Transco's Leidy Line.	Proposal under development 2013
Alleghany Storage	Dominion	This proposal provides natural gas storage and transportation services in Ohio, West Virginia, Pennsylvania, and Maryland. The project will provide 125,000 Dth per day of storage service and 125,000 dekatherms per day of transportation service to customers.	FERC Approved December 2012; Est. In-Service November 2014
Seneca Storage	Arlington Storage Company	Expand storage capacity by adding 0.75 Bcf of space.	Proposal under review FERC and NYS 2013

Source: NYS Department of Public Service Infrastructure Project Database, derived from FERC Office of Energy Projects, Monthly Energy Infrastructure Updates and pipeline company informational postings.

30. EIA: Underground Natural Gas Working Storage Capacity , July 24, 2013.

Prices

The natural gas market price paid by customers is composed of three major components: the wellhead price paid to the producer, interstate gas pipeline transportation costs, and the local distribution company's delivery charge.

U.S. Price History

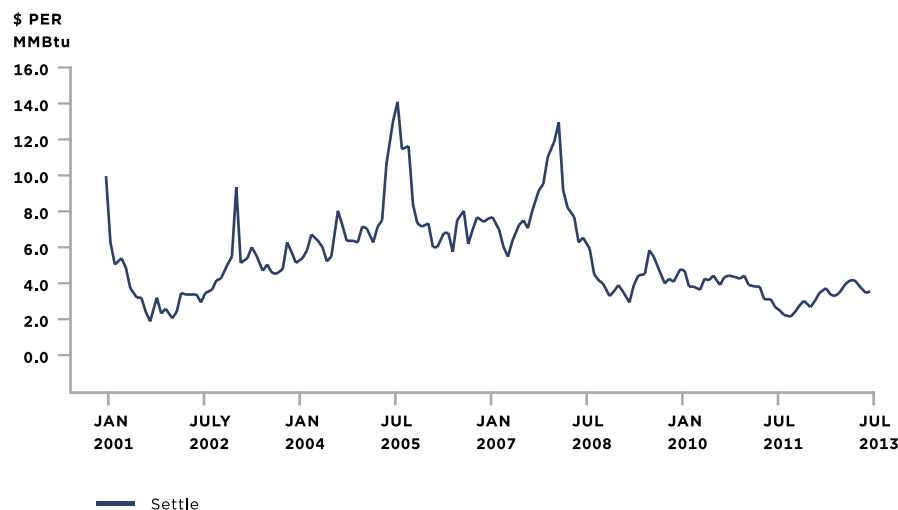
Henry Hub is the largest centralized point for natural gas spot and futures trading in the U.S. The New York Mercantile Exchange (NYMEX) uses the Henry Hub as the point of delivery for its natural gas futures contract. The NYMEX gas futures contract began trading on April 3, 1990 and is currently traded 72 months into the future. NYMEX deliveries at the Henry Hub are treated in the same way as cash-market transactions. Many natural gas marketers also use the Henry Hub as their physical contract delivery point or their price benchmark for spot trades of natural gas.

As shown in Figure 39, natural gas commodity prices showed a high degree of volatility from 2001 through 2009, but have stabilized recently. Natural gas commodity prices ranged from approximately \$2 per one million BTU (MMBtu) in mid 2001 to peak as high as \$12 to \$14 per MMBtu in 2005 and 2008.³¹ The NYMEX gas commodity price through most of 2013 was in the \$3 to \$4 per MMBtu range. There are several

³¹ Based on New York Mercantile Exchange (NYMEX) data with gas prices on the NYMEX quoted for delivery at the Henry Hub. The Henry Hub is a major interconnection point, or transportation hub, on the U.S. natural gas pipeline system located in Louisiana, interconnecting with nine interstate and four intrastate pipelines. Price differentials, or basis, between the Henry Hub and city gate delivery points reflect pipeline transportation services.

interrelated reasons for these recent changes, including decreased nationwide economic/industrial gas demand and a general widening in the national gas supply/demand balance. Hurricane seasonal damage to production facilities and the increased participation by non-commercial entities in the natural gas financial markets have also been less of an impact recently than in previous years.³²

Figure 39 | U.S. Commodity Prices, NYMEX Monthly Closing Price (2001-2013)



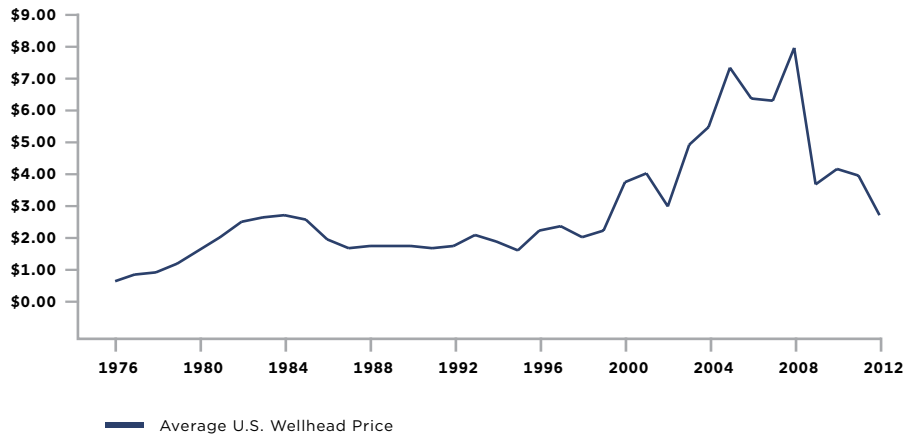
Source: New York Mercantile Exchange (NYMEX) data

³². Natural gas is traded as the value of a commodity and natural gas prices are determined through the interaction of two types of markets for natural gas; the physical market, which involves the purchase and sale of physical quantities of natural gas; and the financial market, which involves the purchase and sale of derivatives and financial instruments in which the buyer and seller seldom take physical delivery of the natural gas.

Wellhead Prices

The U.S. natural gas market (Figure 40) has undergone significant changes since the deregulation of natural gas wellhead prices in 1989. It has evolved into a highly price transparent market, arguably the most price transparent commodity market in the world. This evolution has been driven by market forces, technology, and governmental oversight.³³

Figure 40 | Average U.S. Wellhead Prices (1996 to 2012)



Source EIA. *Natural Gas Wellhead Prices: 1976 to 2012*. September 2013. http://www.eia.gov/dnav/ng/ng_pri_sum_dcu_nus_m.htm

Production Costs

Natural gas production costs, especially break-even analyses, can be a very confusing topic. To explain some of the typical costs experienced by natural gas producers, one must understand the stages a producer must go through from the wellhead to the buyer and roughly what each step costs in terms of per thousand cubic feet (Mcf) of gas. With this information you can have an idea of the breakeven price is of an average natural gas producer. Analyze these costs by field and some interesting comparisons may develop.

Despite low prices, Northeast production continues growing at a stronger pace than the rest of the country primarily due to additional pipeline expansions and a well backlog in the region. These scenarios indicate that for production to remain flat, Northeast growth will have to be offset by declines in less-economic basins. The historic supply basins

³³. Albrecht, William P. *Price Transparency in the U.S. Natural Gas Market*. July 14, 2009

that led the initial production decline are also the most likely to continue declining.

Based on recent pricing and operating costs, the average rates of return for producers are poorest in the Haynesville, Arkoma/Woodford, and Fayetteville shale basins. The dry portion of the Marcellus Shale region also is experiencing weak operating returns, but the well backlog in that area is so large that output is likely to continue to grow as scheduled capacity additions enter service. This gas also requires only a minimum amount of processing (usually water removal only). In addition, returns in the wet portion of the Marcellus are still healthy due to the higher prices associated with wet by-products, suggesting that long-term growth will be supported by wet-gas development.³⁴

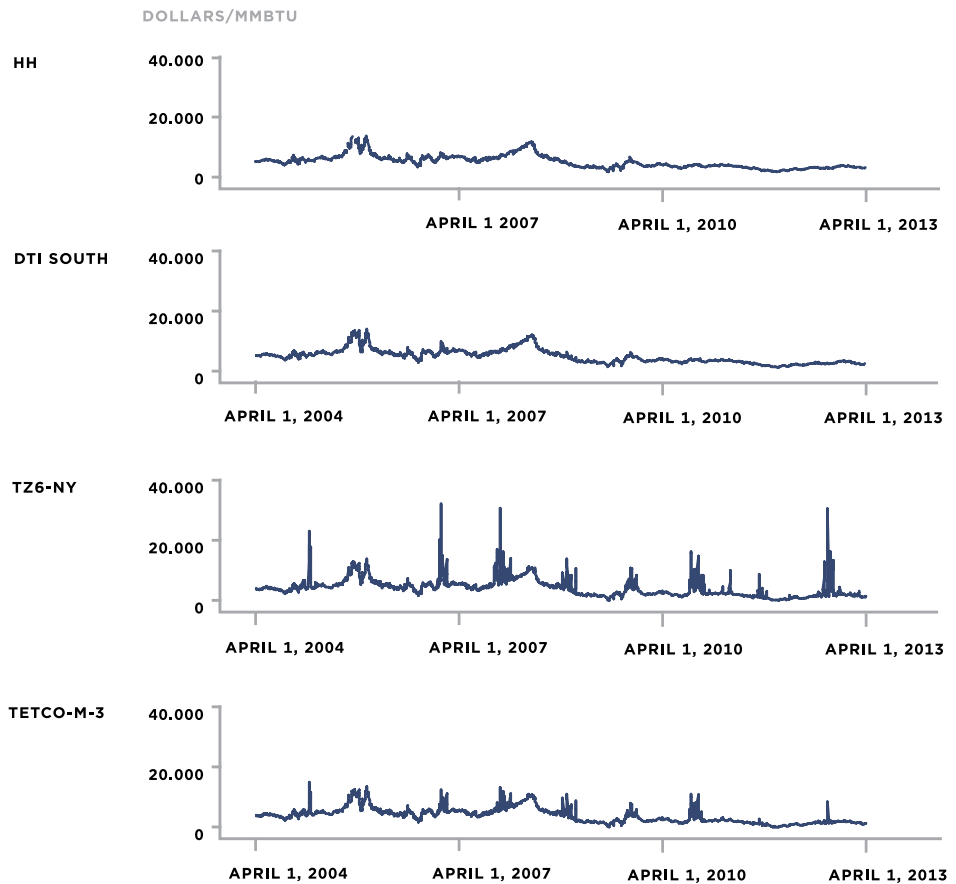
Henry Hub and Representative Market Prices

Wholesale spot natural gas prices in most areas of the U.S. fell in 2012 from the previous year. Prices at the Henry Hub fell over 30 percent to under \$3 per million Btu in 2012, the lowest annual average price since 2004. Strong gains in domestic natural gas production as well as much warmer winter weather nationally contributed to low average spot natural gas prices. A return to more normal weather in 2013 forced prices higher with Henry Hub spot prices increasing to the \$3.50 per million Btu level.

Transportation differentials, also called basis spreads (the difference between a regional price and the Henry Hub price), narrowed considerably for Northeast market locations in the last few years as shown in Figure 41. In fact, the Dominion Transmission Inc. South Point Index (DTI South), traded at a level lower than Henry Hub for a good part of the year. This occurred primarily due to issues in take-away natural gas pipeline capacity and expanded Marcellus Shale regional production. Prices continue to drop during periods of high supply and low demand. In New York, basis spreads continue to trend higher than Henry Hub due to increased demand and on-going pipeline restrictions into New York City and New England.

34. Bentek Energy, LLC. *Gas Tank Full: Henry Hub Will Re-Test Price Floor*. Market Alert. May 10, 2012.

Figure 41 | Henry Hub Spot Price Compared to Market Area Indices (2004 to 2013)
(Dollars/MMBtu)



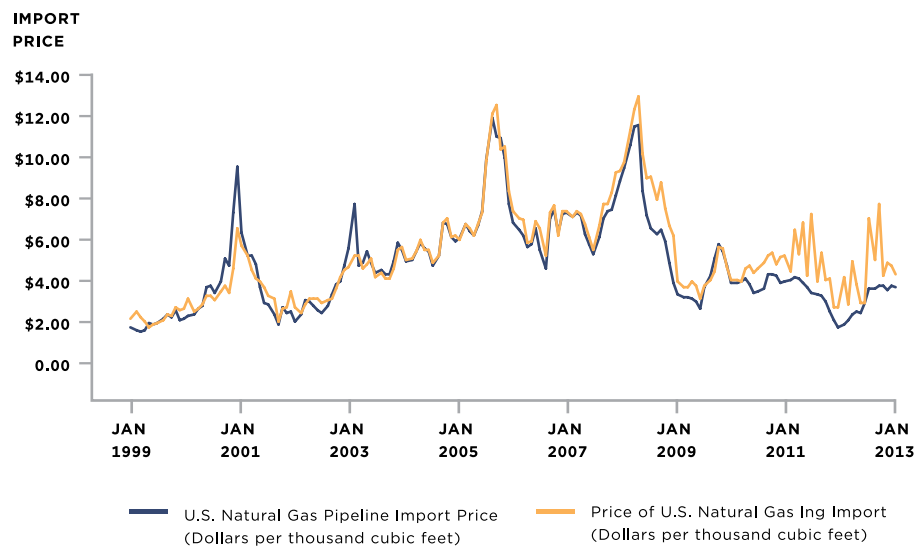
Source: NYS Department of Public Service: Natural Gas Price Database.

The combination of increased availability of shale gas and improved take away capacity from this supply basin has led to a general reduction in price volatility to the Northeast. The May 2012 futures price for delivery of natural gas at Henry Hub in Louisiana hit a low of \$1.91 per MMBtu on April 19, 2012. The NYMEX settle price for May 2012 delivery was \$2.13 per MMBtu. Since then, natural gas prices have rebounded off of the lowest prices seen in over a decade to reach \$4.15 per MMBtu closing price for May and June 2013 delivery. Although the implied volatility of the front month futures contract has increased since early April, historical volatility moved lower. This gap has recently narrowed but continued pressure for higher price volatility does not appear to exist.

The price drops have also had an expected impact on natural gas imports. The differential between the cost of continuing to acquire Canadian supplies or LNG shipments and supplies from the new unconventional sources is driving the reduction in both actual and net imports (Figure 42).

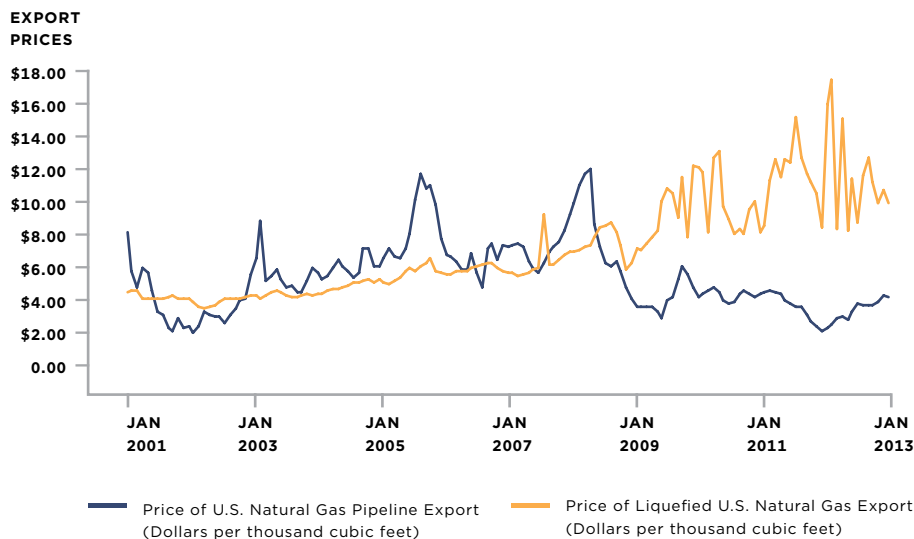
Likewise, this price differential is creating more opportunities for natural gas exporting (Figure 43). This can be seen in both the applications for infrastructure projects that will add transport of supplies to Canada and the new interest in establishing LNG liquefaction facilities to ship North American gas overseas.

Figure 42 | Average Natural Gas Import Prices (1999 to 2013)



Source: EIA. *Natural Gas Price Data*. September 2013. http://www.eia.gov/dnav/ng/ng_pri_sum_dcu_nus_m.htm

Figure 43 | Average U.S. Natural Gas Export Prices (2001 to 2013)



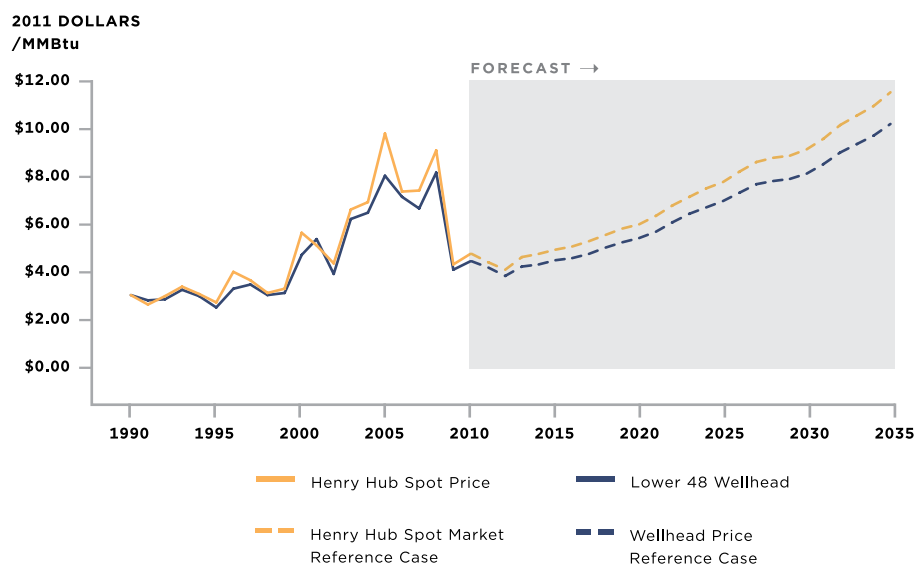
Source: EIA. *Natural Gas Price Data*. September 2013. http://www.eia.gov/dnav/ng/ng_pri_sum_dcu_nus_m.htm

U.S. Price Forecast

With increased production, average annual wellhead prices for natural gas remain below \$6 per MMBtu (2010 dollars) through 2023 in the AEO2013 Reference Case. The projected prices reflect continued industry success in tapping the nation's extensive shale gas resource. The resilience of drilling levels, despite low natural gas prices, is in part a result of high crude oil prices, which significantly improve the economics of natural gas plays that have high concentrations of crude oil, condensates, or natural gas liquids. The AEO2013 Reference Case shows the significant long-term potential for liquids supply worldwide that will continue to impact natural gas prices.

As displayed in Figure 44, natural gas commodity prices at the Henry Hub (constant 2011 dollars per MMBtu) are projected to increase at an average annual rate of 3.2 percent from 2012 to 2020, increasing from \$3.69 per MMBtu in 2012 to \$6.49 per MMBtu in 2020. While this projected change represents a sustained upward trend, the projected price for 2030 does not surpass the price levels that were reached in 2008. The increase materializes as the numbers of tight gas and shale gas wells drilled increase to meet growing domestic demand for natural gas and offset declines in natural gas production from other sources.

Figure 44 | U.S. Natural Gas Wellhead and Henry Hub Spot Price Forecast (2011 Dollars/MMBtu)

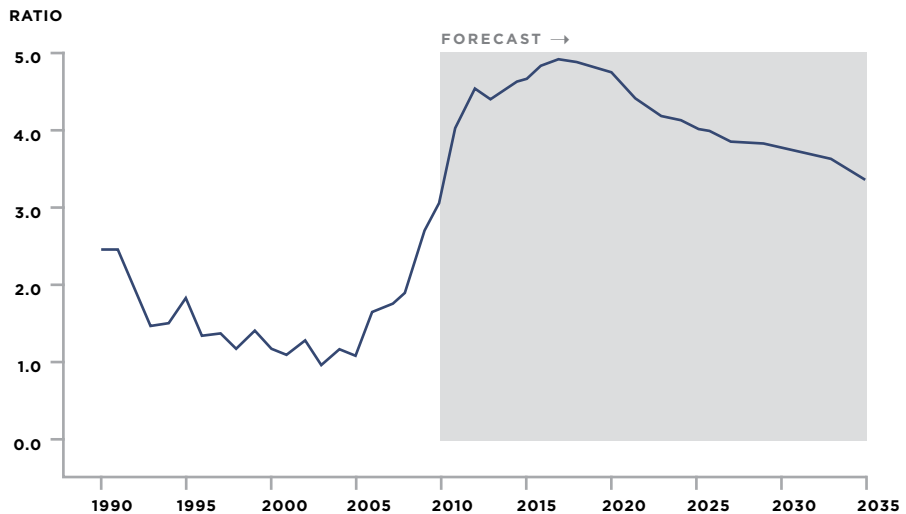


Source: Source: EIA: AEO2012, June 2013; and *Natural Gas Price Data*. http://www.eia.gov/dnav/ng/ng_pri_sum_dcu_nus_m.htm

Shale gas will continue to have enormous potential. To satisfy demand, the Reference Case projects the number of natural gas wells completed in the lower 48 states. As a result, the average wellhead price for natural gas increases by an average of 3.7 percent per year, to \$10.01 per million Btu in 2035 (2010 dollars). Henry Hub prices increase by 3.9 percent per year, to \$11.48 per million Btu in 2035. Nonetheless, the Henry Hub price and average wellhead prices do not pass \$6.00 per million Btu until after 2020.

As discussed, the price disparity between crude oil and natural gas is shifting drilling investment to natural gas liquids-rich shale deposits. Unlike crude oil prices, natural gas prices did not return to the higher levels recorded before the 2007-2009 recession (Figure 45). Some supply factors may continue to relate both, but they do not track directly as they once did. The shift in drilling toward basins with high concentrations of liquids occurs as producers look for a higher return on exploration and production investments. Additional drilling in non-rich liquid areas may continue as lease arrangements and/or economics dictate, but high prices for propane, ethane, and other natural gas liquids will continue to dictate where drilling occurs until natural gas prices increase.

Figure 45 | Ratio of crude oil to Henry Hub Spot Price (1990 to 2035)

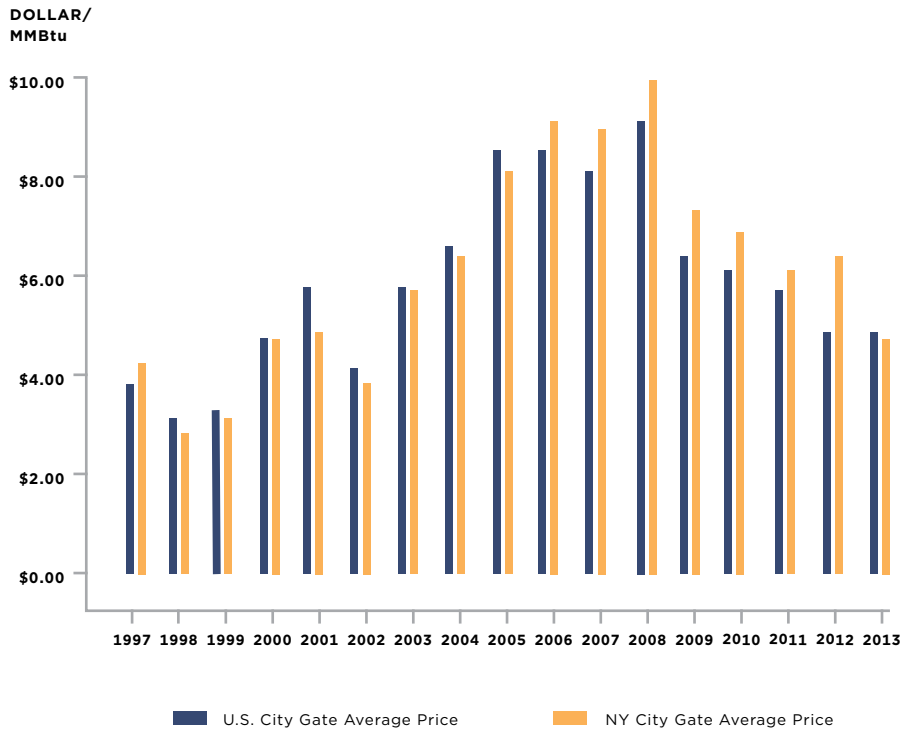


Source: EIA: *AEO2012*. June 2012; and *Natural Gas Price Data*. http://www.eia.gov/dnav/ng/ng_pri_sum_dcu_nus_m.htm.

New York Price History

Retail prices include the commodity cost of natural gas, and the pipeline and LDC delivery charges. Since the commodity price makes up a significant portion of the customer's delivered price, retail prices have exhibited a similar pattern of growth and volatility.

Figure 46 | U.S. and New York Average City Gate Prices (Dollar/MMBtu)



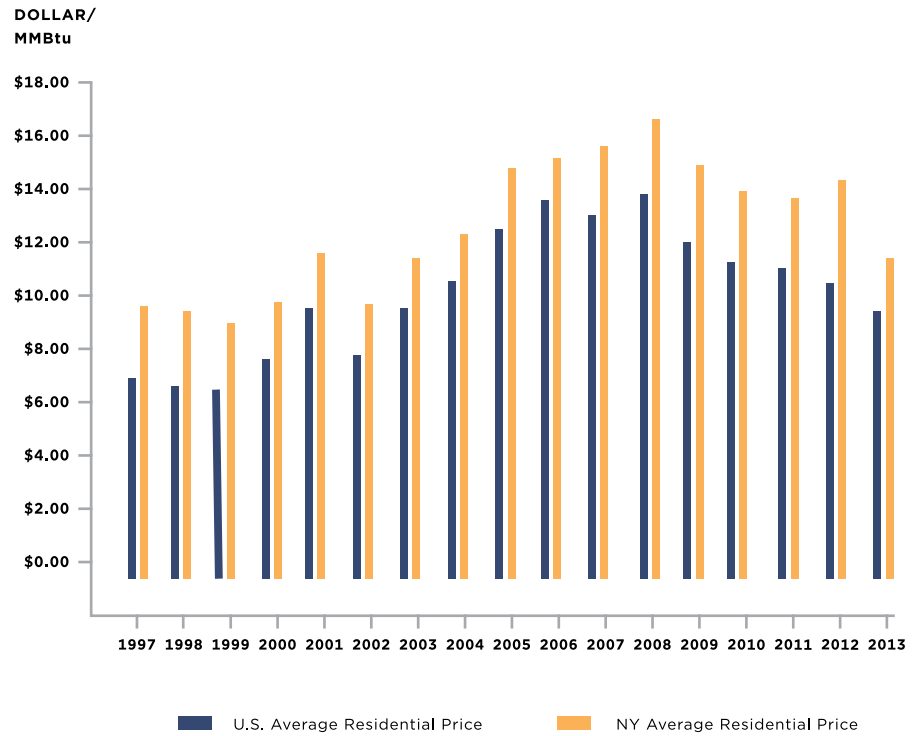
Source: EIA. *Natural Gas Prices*. July 2013. http://www.eia.gov/dnav/ng/ng_pri_sum_dcunus_m.htm.

The average delivered price of natural gas to the city gates in New York was about \$2.92 per MMBtu in January 1999, climbing to \$10.07 per MMBtu in August 2008, and decreasing to about \$7.35 per MMBtu in March 2009. By the end of 2011 it settled at \$6.04. Figure 46 shows the comparison of national and New York average annual city gate prices by year.

As shown in Figure 47, Figure 48, Figure 49, and Figure 50, in recent years, New York's average delivered price to customers has been approximately \$1.00 per MMBtu higher than the national averages.

The average delivered price of natural gas to residential customers in New York was about \$9.12 per MMBtu in January 1999, climbing to \$16.78 per MMBtu in August 2008, and decreasing to about \$15.05 per MMBtu in March 2009. By the end of 2011 it settled at \$13.64. Figure 47 shows the comparison of national and New York average annual residential prices by year.

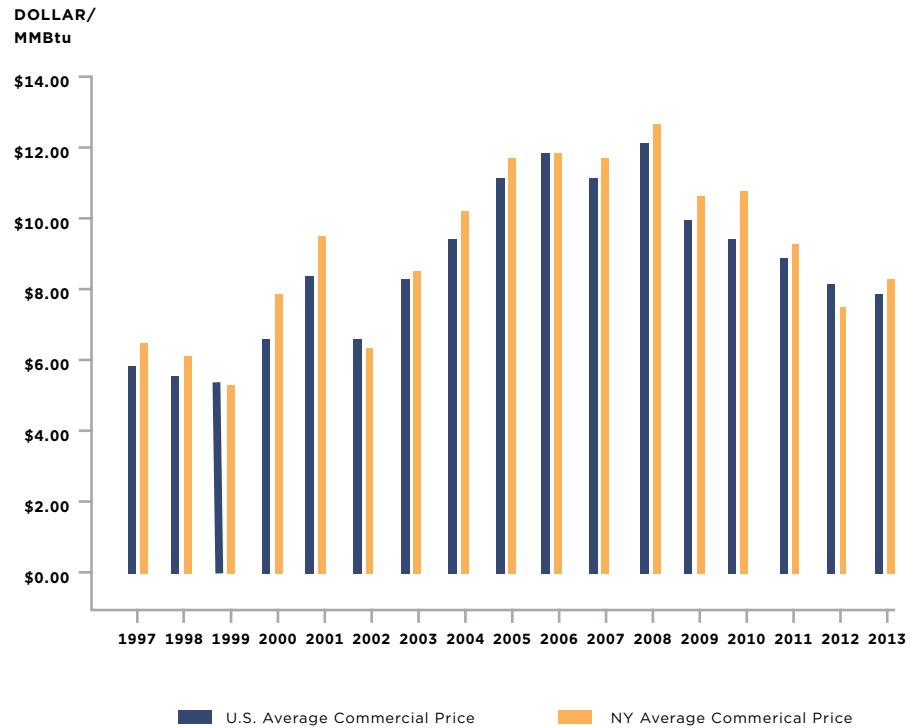
Figure 47 | U.S. and New York Residential Prices (Dollar/MMBtu)



Source: EIA. *Natural Gas Prices*. July 2013. http://www.eia.gov/dnav/ng/ng_pri_sum_dcunus_m.htm.

The average delivered price of natural gas to commercial customers in New York was about \$5.15 per MMBtu in January 1999, climbing to \$12.86 per MMBtu in August 2008, and decreasing to about \$10.72 per MMBtu in March 2009. By the end of 2011 it settled at \$9.37. Figure 48 shows the comparison of national and New York average annual commercial prices by year.

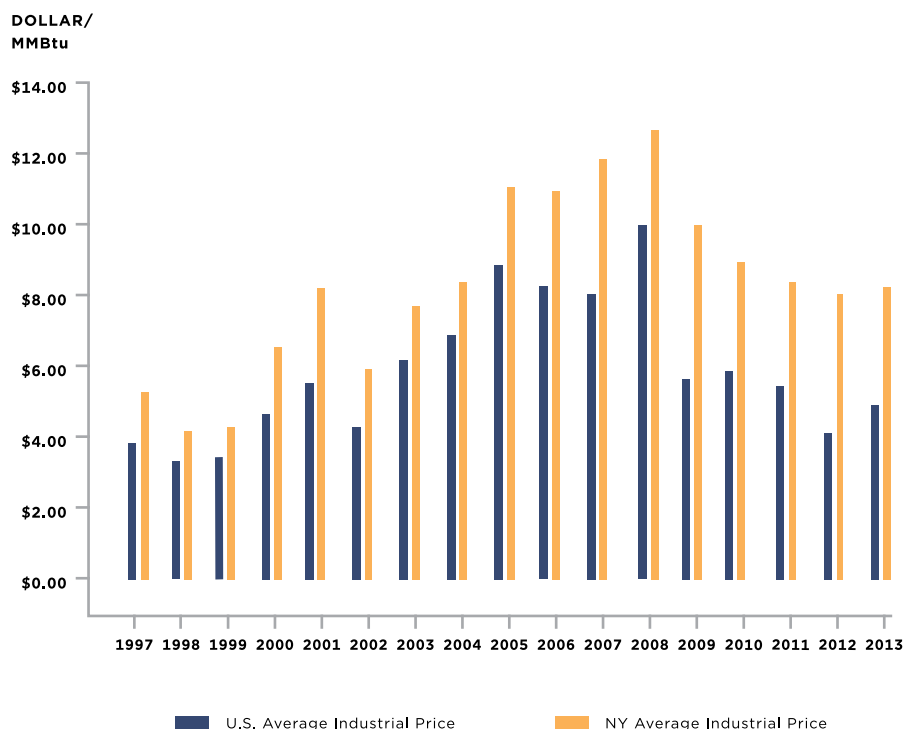
Figure 48 | U.S. and New York Commercial Prices (Dollar/MMBtu)



Source: EIA. *Natural Gas Prices*. July 2013. http://www.eia.gov/dnav/ng/ng_pri_sum_dcunus_m.htm.

The average delivered price of natural gas to industrial customers in New York was about \$3.90 per MMBtu in January 1999, climbing to \$12.30 per MMBtu in August 2008, and decreasing to about \$9.52 per MMBtu in March 2009. By the end of 2010 it settled at \$8.55. Figure 49 shows the comparison of national and New York average annual industrial prices by year.

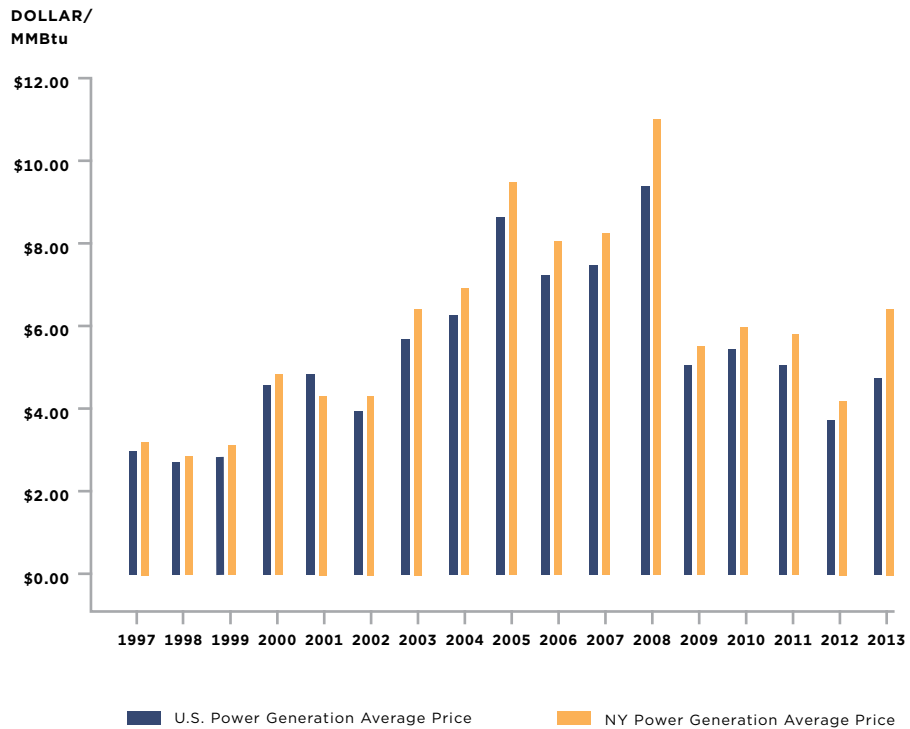
Figure 49 | U.S. and New York Industrial Prices (Dollar/MMBtu)



Source: EIA. *Natural Gas Prices*. July 2013. http://www.eia.gov/dnav/ng/ng_pri_sum_dcunus_m.htm.

The average delivered price of natural gas to power generation customers in New York was about \$2.88 per MMBtu in January 1999, climbing to \$24.85 per MMBtu in August 2008, and decreasing to about \$5.26 per MMBtu in March 2009. By the end of 2011 it settled at \$5.54. Figure 50 shows the comparison of national and New York average annual power generation prices by year.

Figure 50 | U.S. and New York Power Generation Prices (Dollar/MMBtu)



Source: EIA. *Natural Gas Prices*. July 2013. http://www.eia.gov/dnav/ng/ng_pri_sum_dcunus_m.htm.

Because of the historically volatile nature of gas prices, the PSC expects LDCs to diversify the pricing of their gas purchases in order to ameliorate price volatility. The PSC issued a Gas Purchasing Policy Statement in 1998, which outlined the purchasing options that a diversified supply portfolio might include.³⁵ Among these options are a blend of short and long-term fixed price purchases, spot acquisitions, use of physical and financial hedges, and contracts that provide flexibility in the amount of gas taken. The policy is intended to mitigate the effect of price volatility on customers' bills. However, the policy also acknowledges that market price fluctuations cannot be predicted with great accuracy and therefore the weighted average price of a sufficiently diversified gas supply portfolio may turn out to be lower or higher than the prevailing market price. The PSC stated that excessive reliance on any one gas pricing mechanism or strategy does not appear to reflect the best management of the gas portfolio and any LDC without a diversified gas purchasing strategy will have to meet a heavy burden to demonstrate that its approach is reasonable.

New York Price Forecast

Projections follow data provided by the EIA in AEO2012. These forecasts focus on the factors that shape U.S. energy markets in the long term, under the assumption that current laws and regulations remain generally unchanged throughout the projection period.

With increased national production, average annual wellhead prices for natural gas remain below \$5 per MMBtu (2010 dollars) nationally through 2023 in the AEO2012 Reference Case. The resilience of drilling levels, despite low natural gas prices, is in part a result of high crude oil prices, which significantly improve the economics of natural gas plays that have high concentrations of crude oil, condensates, or natural gas liquids. Projected prices reflect continued industry success in tapping the nation's extensive shale gas resource. With its nearness to the Marcellus Shale basin, New York should participate in prices lower than those experienced from 2000 through 2010 and more similar to those of the last few years.

35. NYPSC: Case 97-G-0600. Request for Gas Distribution Companies to Reduce Gas Cost Volatility and Provide for Alternate Gas Purchasing Mechanisms, Statement of Policy on Gas Purchasing Practices; Issued and Effective on April 28, 1998.

Tables 9A and 9B shows forecasts of New York retail natural gas prices for selected years from 2012 through 2030. Projections are based on data provided by the EIA in AEO2012. From 2012 to 2030, residential natural gas prices are projected to increase at an average annual rate of 0.7 percent (constant 2011 dollars). Over the same period, commercial and industrial retail natural gas prices are projected to increase at average annual rates of 1.1 percent and 1.6 percent, respectively.

Table 9A | New York State Retail Natural Gas Price Forecasts, (2011 Dollars/MMbtu)

YEAR	INDUSTRIAL	COMMERCIAL	RESIDENTIAL
2012	\$7.26	\$9.26	\$13.04
2015	\$7.91	\$9.79	\$13.52
2020	\$8.18	\$10.00	\$13.72
2025	\$9.14	\$10.78	\$14.43
2030	\$9.74	\$11.27	\$14.88

Sources: NYSDERDA. 1997-2011 *Patterns & Trends*. 2013. Forecast based on EIA's *Annual Energy Outlook*, 2012.

Table 9B | New York State Retail Natural Gas Price Forecasts, (2011 Dollars/MMbtu) - Average Annual Growth Rates

YEAR	INDUSTRIAL	COMMERCIAL	RESIDENTIAL
2012-20	1.5%	1.0%	0.6%
2020-30	1.8%	1.2%	0.8%
2012-30	1.6%	1.1%	0.7%

Sources: NYSDERDA. 1997-2011 *Patterns & Trends*. 2013. Forecast based on EIA's *Annual Energy Outlook*, 2012.

Markets

North American Markets

Natural Gas Fired Power Generation

Demand for natural gas in electricity generation is expected to grow from 7.5 Tcf (24 percent share) in 2011 to 9.0 Tcf (27 percent share) in 2035. A portion of the growth is attributable to the retirement of 33 gigawatts of coal-fired capacity over the projection period. Over the next 25 years, the projected coal share of overall electricity generation falls to 39 percent, well below the 49 percent share seen as recently as 2008 (Figure 34), because of slow growth in electricity demand, continued competition from both natural gas and renewable plants, and the need to comply with new environmental regulations.

LNG Exports

It is anticipated that if natural gas production from Shale basins outstrips demand in the U.S., LNG may be exported from the continental U.S. to Asia or Europe. This could cause price volatility in the future and should be monitored.

New York Markets

The historic rate of conversion across New York has been relatively flat during the last five years (2006 to 2010), with slow but steady increases in the non-residential conversion rate. The residential rate of conversion appears to have had its high in 2008, with a slight decline since that time. In many areas of the State, there is no option for natural gas since there is no distribution system. In some cases, due to location, additional interstate pipeline capacity would also be necessary, even in areas where sufficient capacity exists for current customer demand. In some service territories, the cost of line (mains and services) may also be too expensive for potential new customers to manage, even if an energy cost savings would be realized.

Since natural gas is cleaner than other fossil fuels used for home heating, and under current market conditions costs a third as much, and since New York is well-located geographically to take advantage of existing and newly developed lower cost natural gas supplies located outside the State, the PSC is reviewing regulations and policies that may unduly constrain the availability of natural gas and other factors influencing customer conversions. Consumers may enjoy significant savings in household fuel expenses by using natural gas which in turn could benefit the State's economy to the extent that households redeploy those savings. In addition, New York's location, relatively close to these new sources of supply, could provide the State a competitive advantage in attracting and retaining employers concerned about costs of, and access to, a reliable source of energy. This review is conducted in support of the Governor's Power NY agenda and The Energy Highway initiative, designed to ensure that New York's energy grid is the most advanced in the nation and promotes increased business investment in the State.

Generic Gas Requirements for Power Generation

The heat rate for the capability to use gas as a replacement fuel in electric generation is about 7 Dth per MWh. The volume of gas needed on an annual basis would reflect 7 Dth per MWh or 14,000 Dth per MWh, for example as a replacement for 2,000 MW. This requirement is then multiplied by the number of hours per year (8,760 hours per year) for a plant that would run 100 percent of the time. Still, it is unlikely that a new gas fired plant would run 100 percent of the time. When maintenance activities and other variables for a gas fired facility are considered, it is more likely that a dispatch rate of up to 85 percent is more realistic.

Coal or Oil Plant Conversions

Overall, there is not a lot of coal fired generation in New York for conversion from coal to gas. There are some plants in the western part of the State that use coal, and several plant owners have proposed conversion to natural gas. In addition, there is a plant toward New York City that is using coal, but that plant also has a scrubber in-place and looks like it will be around for the foreseeable future.

Danskhammer - Units 3 & 4 - represent some potential for conversion from coal to gas. These two units represent about 375MW of capacity. Again, based on the discussion above, if this were to happen and these facilities were replaced with modern gas fired generating capability, @ 7 Dth per MWH = $400 * 7$ or $2800 \text{ Dth} * 8760 \text{ hours} = 24,528,000 \text{ Dths}$ @ 80-85 percent = 19,622,400 to 20,848,800 Dths.

Overall, there is also not a lot of oil fired generation in New York that is expected to be retired or closed. Much of what existed has already converted to natural gas. In New York City there are some oil fired generation assets located on barges. There are also some New York City facilities that may be looking at conversion in the near term. In addition, there may be some limited Consolidated Edison steam generating facilities that could convert to natural gas, but final decisions have not been made at this point in time.

Indian Point Conversion

If the Indian Point Nuclear Generating facilities cease operations, retrofitting with natural gas might be an option. Indian Point represents approximately 2,000 MW of electric generation capacity. If this capacity were replaced with modern gas fired generating capability, the result, as discussed above would be 14,000 Dth per hour times 8,760 hours = 122,640,000 Dth per year if the plant were dispatched 100 percent of the time. Based on the 85 percent dispatch rate assumptions, the additional volumes of gas needed, on an annual basis to replace 2000 MW of nuclear generating capacity entirely with new natural gas fired capacity would be between 98,112,000 and 104,244,000 Dths.

New Gas-Fired Generation

There are several potential new gas fired generating plants under consideration:

- AP Dutchess/Cricket Valley, 1000 MW, Dover, NY recieved a Certificate of Public Convenience and Necessity (CPCN) from the PSC in February 2013. The developer has contacted the NYISO to have this project included as part of the capacity planning process (potential decision/ approval for Sep 2012), and if/when it receives NYISO and DPS CPCN approvals, it could be constructed in 18 to 24 months depending on PSC Article VII approvals for both gas and electric transmission access.
- Wawayanda, Orange County is also under PSC Article X consideration. No action has been taken to date.
- Bowline – Haverstraw NY – This plant had previously received approvals for a 750 MW gas-fired facility at this project location. No action had been taken, so if the owners desired to reinstitute this project, the process would need to start anew.

Environmental Conversions

On April 20, 2011, in order to improve air quality in New York City, the New York City DEP passed a rule governing the emissions from #4 and #6 fuel oil consumed in heat and hot water boilers/burners.³⁶ The use of #6 heating oil will be phased out by 2015 and #4 oil users will have until 2030 to convert to cleaner fuels. This rule raises the possibility of approximately 7,100 potential conversions to natural gas within the Consolidated Edison (ConEd) gas franchise area and another 1,200 potential conversions in the National Grid – NY franchise area.

The design day requirements forecast can be used to provide perspective on the impact of this market segment converting to natural gas. Still, a reduced conversion rate is possible, which would reflect assumptions around the number of the customers moving to burn #2 fuel oil instead of gas, the number of customers switching to some form of interruptible service not firm service, and other customers that would have switched to gas without the pending regulatory action and therefore are already incorporated into the distribution companies' existing plans.

The five year design day forecasts of the companies identify annual increases in send-out of 108.0 MDt/day in the ConEd territory and 16.8 MDt/day for the Brooklyn Union service territory. The adjusted incremental send-out including the full impact of #4 and #6 conversions is an incremental 680 MDt/day in ConEd's territory and 186 MDt/day in National Grid's territory.

A rapid conversion e.g., one year of all #4 and #6 oil customers to gas, would far exceed current plans. Even a longer term conversion, including a reduction associated with alternate fuels demonstrates a significant increase over non-conversion forecasts. The wholesale conversion of this market segment to gas in both territories will require significant infrastructure to support the gas network and customer connections, including system and customer reinforcements along with main extensions, services, and meter connections. Additional upstream transmission projects, in addition to those already planned would need to be developed to ensure adequate supplies to the New York Facilities System (NYFS).

³⁶. The City Record, Volume CXXXVIII Number 77, April 21, 2011, Proposed Amendments to Chapter 2 of Title 15 of the Rules of the City of New York Pertaining to Emissions from the Use of #4 and #6 Fuel Oil in Heat and Hot Water Boilers and Burners.

Alternate Fuel Source Conversions

Requests for conversion to natural gas have been happening throughout New York. As a consumer's heating equipment fails, choices need to be made about replacement of the system. The economic and environmentally advantageous choice among fossil fuels is natural gas. Residential consumers are generally not converting fuels without the failure of their furnace/boiler.

Natural Gas Vehicles (NGVs)³⁷

Environmental and energy security concerns related to petroleum use for transportation fuels, together with recent growth in U.S. proved reserves and technically recoverable natural gas resources, have sparked renewed interest in policy proposals aimed at stimulating increased use of natural gas as a vehicle fuel.

The interest in natural gas as an alternative transportation fuel stems mainly from its clean-burning qualities, its domestic resource base, and its commercial availability. Because of the gaseous nature of this fuel, it must be stored onboard a vehicle in either a compressed gaseous or liquefied state. These two forms of natural gas are considered alternative fuels under the Energy Policy Act of 1992.

Compressed Natural Gas (CNG)

To provide adequate driving range, CNG must be stored onboard a vehicle in tanks at high pressure—up to 3,600 pounds per square inch. A CNG-powered vehicle gets about the same fuel economy as a conventional gasoline vehicle on a gasoline gallon equivalent (GGE) basis. A GGE is the amount of alternative fuel that contains the same amount of energy as a gallon of gasoline. A GGE equals about 5.7 lb (2.6 kg) of CNG. CNG fuel systems typically are used to power mostly localized or regional fleets and light-duty vehicles.

Liquefied Natural Gas (LNG)

To store more energy onboard a vehicle in a smaller volume, natural gas can be liquefied. To produce LNG, natural gas is purified and condensed into liquid by cooling to -260°F (-162°C). At atmospheric pressure, LNG occupies only 1/600 the volume of natural gas in vapor form. A GGE equals about 1.5 gallons of LNG. Because it must be kept at such cold

37. U.S. Energy Information Administration / Annual Energy Outlook 2010, pp. 33 – 38.

temperatures, LNG is stored in double-wall, vacuum-insulated pressure vessels. LNG fuel systems typically are only used with heavy-duty vehicles.

NGV Market Analysis

Historically, natural gas has played a limited role as a transportation fuel in the U.S. In 2008, natural gas accounted for 0.2 percent of the fuel used by all highway vehicles and 0.2 percent of the fuel used by heavy trucks – the market that many observers believe to be the most attractive for increasing the use of natural gas. Because there are currently relatively few heavy vehicles that use natural gas for fuel, there has been limited development of a natural gas fueling infrastructure. As of May 2012, there are 1,047 fueling stations for CNG and 53 fuel stations for LNG in the U.S. Just over half are privately owned and are used for central refueling. Further, they are not distributed evenly: 22 percent (227) of the CNG facilities and 68 percent (36) of the LNG facilities are in California. Unless more natural gas vehicles enter the market, there will be little incentive to build more natural gas fueling infrastructure nationally or in local or regional corridors.

Despite the price advantage that natural gas has had over diesel fuel in recent years (an advantage that is projected to increase over time in the AEO2012 Reference Case and shown in Figure 52), other factors – including higher vehicle costs, lower operating range, and limited fueling infrastructure – have severely limited market acceptance and penetration of natural gas vehicles.

As of 2010, trucks powered by natural gas made up only 0.4 percent of the heavy truck fleet, or about 40,000 of the 9.0 million registered heavy trucks. Although their share grows in the Reference Case projections, high incremental costs keep the fleet of HDNGVs relatively small, at 2.4 percent (300,000 vehicles) of the total stock of 12.5 million heavy trucks on the road in 2035.

In 2010, U.S. freight trucks used more than 2.2 million barrels of petroleum-based diesel fuel per day. In the AEO2012 Reference Case, they are projected to use 2.3 million barrels per day in 2035. Petroleum-based diesel use by freight trucks in 2010 accounted for 17 percent of total petroleum consumption (excluding biofuels and other non-petroleum-based products) in the transportation sector (12.8 million barrels per day) and 12 percent of the U.S. total for all sectors (18.3 million barrels per day). In the Reference Case, oil use by freight trucks grows to 19 percent of total transportation use (12.1 million barrels per day) and 14 percent of the U.S. total (17.2 million barrels per day) by 2035.

CNG Activities

There are approximately 3,500 CNG vehicles currently registered in New York. Most of these are medium- and heavy-duty fleet vehicles. Public transportation, refuse hauling, and delivery vehicle markets have seen the highest levels of interest. The low cost of natural gas is shortening payback periods for vehicle purchases but CNG vehicles still carry a cost premium above diesel trucks (\$25,000 to \$60,000).

New York has about 100 CNG fueling stations, but about two-thirds of these are private and not open to outside fleets. Fast-fill CNG stations can be very expensive to install, from \$500,000 to \$2 million per site.

A federal effort was launched late in 2011, to have states enter into a Memorandum of Understanding to:

- Incentivize automobile manufacturers to develop a large fleet of functional and affordable CNG vehicles thru potential state procurements
- Develop and expand CNG fueling infrastructure

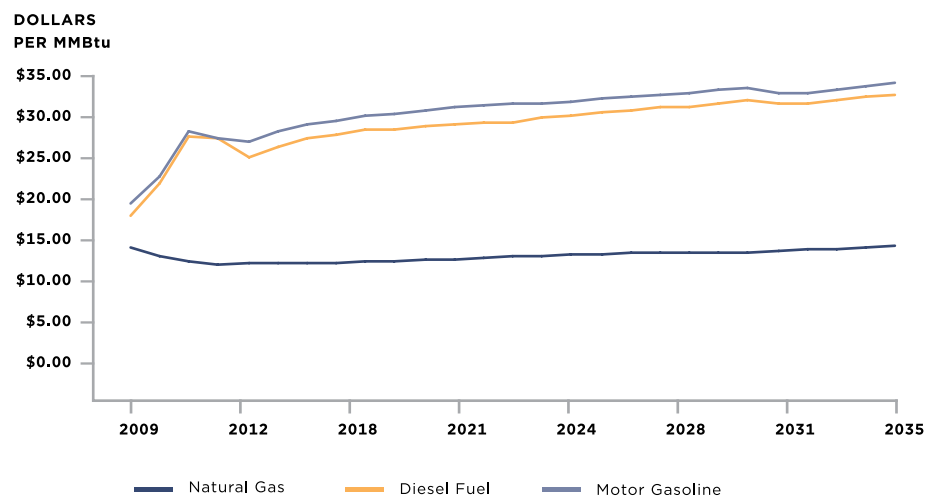
LNG Activities

The LNG vehicle market is growing primarily in California, but remains small throughout the rest of the country. LNG vehicles have longer ranges than CNG vehicles (500-600 miles, compared to 300 miles). Interest in LNG is increasing among long-haul trucking companies, but LNG infrastructure needs to be improved across the country and LNG trucks are significantly more expensive than diesel trucks.

New LNG storage facilities are currently not permitted in New York, and there are no LNG trucks known to be registered in the State. In June 2012, Shell Oil Company announced an agreement with TravelCenters of America (TA) to sell LNG to heavy duty road customers in the U.S. through TA's network of full service fueling centers. It has an active campaign to open up the LNG transportation market particularly in the northeast U.S. Several of these stations are targeted for New York, specifically near the NYS Thruway and other major transportation

routes. There is clearly much interest in expanding this market in view of the growing natural gas supply.^{38, 39}

Figure 51 | Average National Transportation Energy Prices



*Prices include estimated motor vehicle fuel taxes and estimated dispensing costs or charges.

Source: EIA. *AEO2012*. June 2012.

Advocates of expanding the use of natural gas as a transportation fuel⁴⁰ suggest the following approach as options for federal, State, and local governments:

- Encourage the purchase and use of natural gas vehicles (NGVs), with an emphasis on fleet vehicles
- Promote expansion of NGVs in public transportation, government fleets, and other taxpayer-funded vehicles as well as other related programs
- Promote the production of NGVs by original equipment manufacturers
- Encourage the certified conversion or repowering of gasoline and diesel vehicles to natural gas
- Incentivize installation of natural gas fuel pumps at service stations and commercial facilities

38. *Natural Gas Fuel Option*; Shell Oil Company News Release, June 7, 2012; <http://www.shell.us/aboutshell/us-media-center/news-and-press-releases/2012/06072012-natural-gas.html>

39. DEC issued a Notice of Proposed Rule Making in the State Register on Wednesday, September 11, 2013. The purpose of this rule (LNG rule: 6 NYCRR Part 570) is to allow the locating of LNG facilities in certain areas of the state.

40. NGV America. *Natural Gas Vehicles for America*. Government Policy.

- Encourage the installation of natural gas home refueling appliances
- Encourage government support of natural gas vehicle research and development.

Other CNG/LNG Utilization Markets

CNG and possibly LNG in the future can also be used to open up additional markets to natural gas. Natural gas delivery companies, virtually unheard of only a few years ago, are creating a niche market in the Northeast, where many industrial and institutional customers are far removed from gas pipeline service. The market for delivered CNG and LNG in New England, New York and lower Canada is said to be between 5 and 12 Bcf/year, or no more than around 30,000 Mcf/d — a small fraction of overall gas demand of about 25 Tcf/year. But suppliers and customers alike expect this niche market to continue growing given the demand for relatively low-cost gas in regions currently served only by more expensive fuels such as oil and propane.⁴¹

CNG can now be delivered in New York in pressurized trucks. The use of transport vehicles allows gas to be delivered to remote locations not near pipelines. The trucks themselves can be utilized as storage containers for large scale operations with only loading and unloading equipment required at the supplier and customer locations.

⁴¹. Gas Daily. *CNG startups target end-users far from pipelines*. Platts Company, McGraw-Hill Financial. August 23, 2013.



3

Petroleum Report

New York is a major consumer of petroleum fuels, including motor gasoline, home heating oil, diesel fuel, propane, and residual fuel oil. The quantities and composition of these fuels broadly affects the economy and environment of the State. New York has little indigenous supply and no refining capacity, and is supplied by an established regional system that draws from a global supply chain of refined products from U.S. and foreign sources. This report describes numerous aspects of the supply and demand of refined

petroleum fuels, critical Mid-Atlantic infrastructure and transportation components, price impacts, and market fundamentals. It also describes important developments in the industry, including the introduction of biofuels as significant blending components for various fuels at the national and State level.

From an energy supply perspective, petroleum products provided 32.5 percent of New York total energy in 2011.¹ Petroleum fuels such as gasoline, diesel fuel, and jet fuel supply 92 percent of all energy used in the transportation sector. Other fuels such as heating oil, kerosene, propane, and residual fuel provide the residential, commercial, and industrial sectors with the energy required to heat and power operations. These fuels are used by the electric sector for primary electric generation and as crucial alternative back-up fuels, helping to maintain electric reliability, particularly in the downstate region.

New York State is the fifth largest petroleum fuel market in the U.S., exceeded only by Texas, California, Louisiana, and Florida.² In 2011, total statewide expenditures on all petroleum fuels by all economic sectors equaled \$32.9 billion, or 50.9 percent of all energy expenditures in the State.³ The transportation sector accounted for \$26.3 billion or 79.9 percent of the statewide petroleum expenditure total.

To meet New York demand for fuel, numerous multi-national, national, and independent energy companies supply refined petroleum products through an extensive distribution system. The Port of New York/New Jersey, with large petroleum storage terminals located on both sides of the harbor, is an important component of this system. These deep-water terminals receive a steady flow of refined petroleum products and crude oil from domestic and foreign sources. New York also receives petroleum products from several pipeline systems that connect terminals located throughout the State to major refining centers along the U.S. Gulf and East Coasts. Crude oil is delivered into the Port of New York/New Jersey area and by train to Albany, NY, and used by refineries in the Mid-Atlantic region to produce refined products for the Northeastern U.S. Once refined fuels arrive at these terminal facilities or are produced at

1. NYSDERDA. *Patterns and Trends: New York State Energy Profiles (1997-2011)*. June 2013. <http://www.nyserda.ny.gov/patterns-and-trends>

2. U.S. Energy Information Administration (EIA). State Energy Data System. Table C2. Data for year 2011. http://www.eia.gov/state/seds/sep_sum/html/pdf/sum_use_tot.pdf

3. NYSDERDA. *Patterns and Trends: New York State Energy Profiles (1997-2011)*. June 2013. <http://www.nyserda.ny.gov/patterns-and-trends>

the regional refineries, they are distributed by pipeline, barge, and truck transport to smaller coastal and inland terminals for further distribution.

As a result of emerging renewable fuel requirements, ethanol and biodiesel are becoming increasingly important fuel supply components. These biofuels have upstream production characteristics and transportation pathways that are often distinct from petroleum fuels. To achieve a final end product, petroleum and renewable fuels must arrive at a final location to be combined into a finished product before delivery to New York end users can occur.

There are several emerging issues in the petroleum sector that will affect the State. In early 2012, the dynamics of the international crude oil markets and the economics of refining converged to potentially force the closure of an important northeast regional refinery. As a result, New York, as well as the East Coast suppliers, will need to secure additional refined products from U.S. Gulf Coast producers and international markets. Concurrently, emerging fuel standards and specifications are moving the U.S., New York, and regional markets, including New York City, towards the use of clean fuels and increased use of alternative or renewable biofuels for transportation and heating. As the use of ethanol in gasoline increases, the underlying infrastructure that produces, transports, stores, and blends it with petroleum products becomes more important. During the initial introduction period, increased use of ultra low sulfur distillates (ULSD) for transportation and heating applications may challenge the petroleum industry's capacity to provide sufficient supply, particularly during periods of peak demand.

This report concludes that, while supplies are adequate for the near term, New York may experience challenges in obtaining sufficient supply of certain fuels during periods of high demand, depending on the evolution of the regional market. Although already implemented for transportation purposes, the transition towards ULSD for heating will require changes and enhancements to petroleum distribution infrastructure components and facilities. In addition, the federal requirement for increased use of bio-blends, as well as regional phase-outs of residual fuel for heating purposes, i.e. New York City, will place

additional demands on existing petroleum fuels infrastructure.^{4, 5} Finally, the closure of almost 200,000 barrels per day (b/d) of refining capacity in the Northeast in 2012 will make New York and the region more reliant on Gulf Coast shipments and international imports into northeastern ports, including the Port of New York/New Jersey. As the composition of fuel types evolve, demand patterns, supply sources, storage capacity, and infrastructure component capability will need to be monitored and reassessed on a regular basis.

New York State Overview

Historic and Current Demand

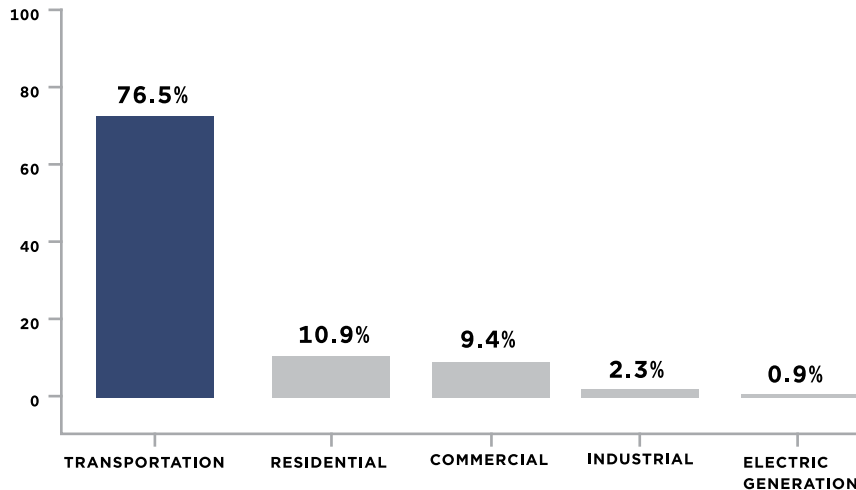
New York is the fifth largest petroleum fuel market in the U.S. The State's demand for petroleum products peaked in 1973 at 505.5 million barrels (mmbbl). Since then, total demand in New York has declined, and by 2011 stood at 216.4 mmbbl, a drop of 57.2 percent from the 1973 peak. While the economic sector declines for petroleum fuels in residential, commercial, industrial, and electric generation have been significant, transportation sector use has remained relatively constant. The petroleum fuel with the largest reduction over the period has been residual fuel. Significant environmental and economic factors in the industrial, commercial, and electric generation sectors have caused a shift away from residual fuel toward natural gas.

At New York peak petroleum use in 1973, the transportation sector made up 41.7 percent of total petroleum demand. As shown in Figure 52, by 2011 the transportation sector comprised 76.5 percent of total petroleum demand, a gain of 34.8 percentage points. The use of all distillate fuels and gasoline in 2011 accounted for 85.9 percent of all petroleum products consumed in the State.⁶ Residential demand, in the form of home heating oil, propane, and kerosene, is the second largest consuming economic sector of petroleum products in the State.

4. Energy Policy Act of 2005 (EPACT05) established the first renewable fuel standard (RFS) in the U.S. The Energy Independence and Security Act (EISA) of 2007, created RFS2.

5. New York City, PlaNYC: *Air Quality*. 2011. http://nytelecom.vo.llnwd.net/o15/agencies/planyc2030/pdf/planyc_2011_air_quality.pdf

6. EIA. State Energy Data System. 2013

Figure 52 | New York State Petroleum Use by Sector 2011

Source: EIA. *State Energy Data System*. 2013.

New York State Petroleum Infrastructure and Distribution Network

Meeting New York State's current and future petroleum demands requires both an adequate supply of refined products and an efficient distribution network to transport the various fuels from refining centers and terminals to end users statewide. However, the reliability and efficiency of the petroleum distribution system is challenged continually by changing circumstances, including periodic extreme weather events, evolving fuel specification, strict environmental requirements, land-use issues, aging infrastructure, and adequate financing to make the necessary investments to maintain and expand facilities as necessary.

The petroleum supply and distribution industry in New York has evolved in response to changing demand patterns, new fuel specifications and types, sources of supply, and market evolution. As domestic sources of crude oil and refined products became less plentiful, the Port of New York/New Jersey developed into a ready entry point for petroleum products. As tanker shipments of petroleum products from foreign sources and distant Gulf Coast refineries increased, many terminal companies established large supply operations along the New York and New Jersey sides of the Port. Today, these primary oil storage facilities act as vital mechanisms to redirecting bulk deliveries of imported and domestic refined products and biofuels to end users across the State and throughout the Northeast.

Over the years, a diverse distribution network has developed to transport petroleum products into and throughout the State. Several

pipeline systems connect New York consumers to the major refining centers located along the U.S. Gulf and East Coast. Waterways, consisting of coastal channels, rivers, and canals, allow barges and tankers to move supplies of refined products to secondary terminals and end users statewide. These water routes also provide an alternative means to ship fuels from domestic refineries located outside the State. Highway transport vehicles deliver supplies from New Jersey, Pennsylvania, and Canada across the southern and northern regions of the State. Rail shipments, while not as common as other modes of petroleum fuel transportation, are growing in importance as propane, ethanol, and even crude oil shipments into the State increase. In recent years federal requirements mandating the use of ethanol in gasoline has increased the use of railcars to move large volumes of ethanol to gasoline terminal and distribution areas such as the Port of Albany and Port of New York/New Jersey. Refined products, including gasoline with ethanol, are often placed in interim locations and major regional terminal centers for later truck or barge distribution to retail outlets and end users.

A State as highly populated and geographically diverse as New York requires several different supply systems to meet petroleum fuel end user demands. A summary of regional supply pathways follows and is illustrated in Figure 54.

Downstate New York

The Port of New York/New Jersey serves as a central petroleum fuels distribution center for the Long Island, New York City, and Hudson River Valley regions. The Harbor area is the largest and most important petroleum product distribution hub in the Northeast. It features regional refining capacity, deep-draft marine import facilities, extensive terminal storage capacity, and is the terminus point for the Colonial Pipeline, a major Gulf Coast sourced pipeline. Many of the petroleum products that are either refined locally, brought from the Gulf Coast, or delivered to the Harbor via ocean-going tankers from foreign sources, are redistributed to smaller inland terminals that serve local demand. Within the downstate market, regional refineries and pipeline deliveries of Gulf Coast petroleum products each make up between 30-40 percent of supply in recent years.

Originating in the U.S. Gulf Coast, the 5,519 mile Colonial Pipeline system transports fuels mainly from refineries in Texas, Louisiana, Mississippi, and Alabama to 267 marketing terminals serving the Southern and Eastern U.S. It delivers an estimated 900,000 b/d of petroleum products into the Mid-Atlantic region. Colonial has nine

small capacity connector pipelines within the New York Harbor region that deliver to 23 terminals in New Jersey and New York, the majority of which have water access and truck loading capability. Two of the Colonial pipelines connect to the Buckeye Pipeline large capacity tank farm and distribution center at Linden, NJ. Buckeye receives product from Colonial, the IMTT terminal, Harbor Pipeline, marine distribution terminals, and New Jersey refineries. In the downstate market, the Buckeye East Line moves fuel from New Jersey to petroleum terminal locations east of the Hudson River including, New York City, Eastern Nassau County on Long Island, and direct pipeline flows of jet fuel to the New York City airports.

Central New York

The Central region of the State, which includes the cities of Binghamton, Utica, Rome, and Syracuse, is supplied primarily by bulk-storage facilities connected to two different regional pipeline systems, the Buckeye West Line and the Sunoco Logistics Pipeline System. These pipelines deliver petroleum products into the region from Mid-Atlantic refineries, Port of New York/New Jersey, and from the U.S. Gulf Coast. Buckeye serves Upstate New York via its Macungie, PA North pipeline with deliveries into Buffalo, Waterloo, Syracuse, Rochester, Vestal, Utica, and other locations. Sunoco Logistics operates two pipelines that originate in Montello, PA, and terminate in Buffalo and Syracuse, NY. The Sunoco Logistics pipelines are supplied by Philadelphia area refineries, the Colonial, Harbor, Laurel, and Buckeye pipelines, and marine imports at Eagle Point, NJ. Terminal facilities connected to these pipelines are located near the Binghamton, Utica, Rome, and Syracuse areas.

Trucking activity and rail transport brings additional volumes into the region from Pennsylvania, New Jersey, Ontario, and Eastern Canadian refineries located in Quebec. Additionally, the Enterprise TE Products Pipeline system (Enterprise TE), a propane only pipeline originating in the U.S. Gulf Coast region, transports propane across Upstate New York to four truck terminals at Watkins Glen, Harford Mills, Oneonta, and Selkirk, NY for further distribution throughout New York and New England.

Eastern New York State and North Country Regions

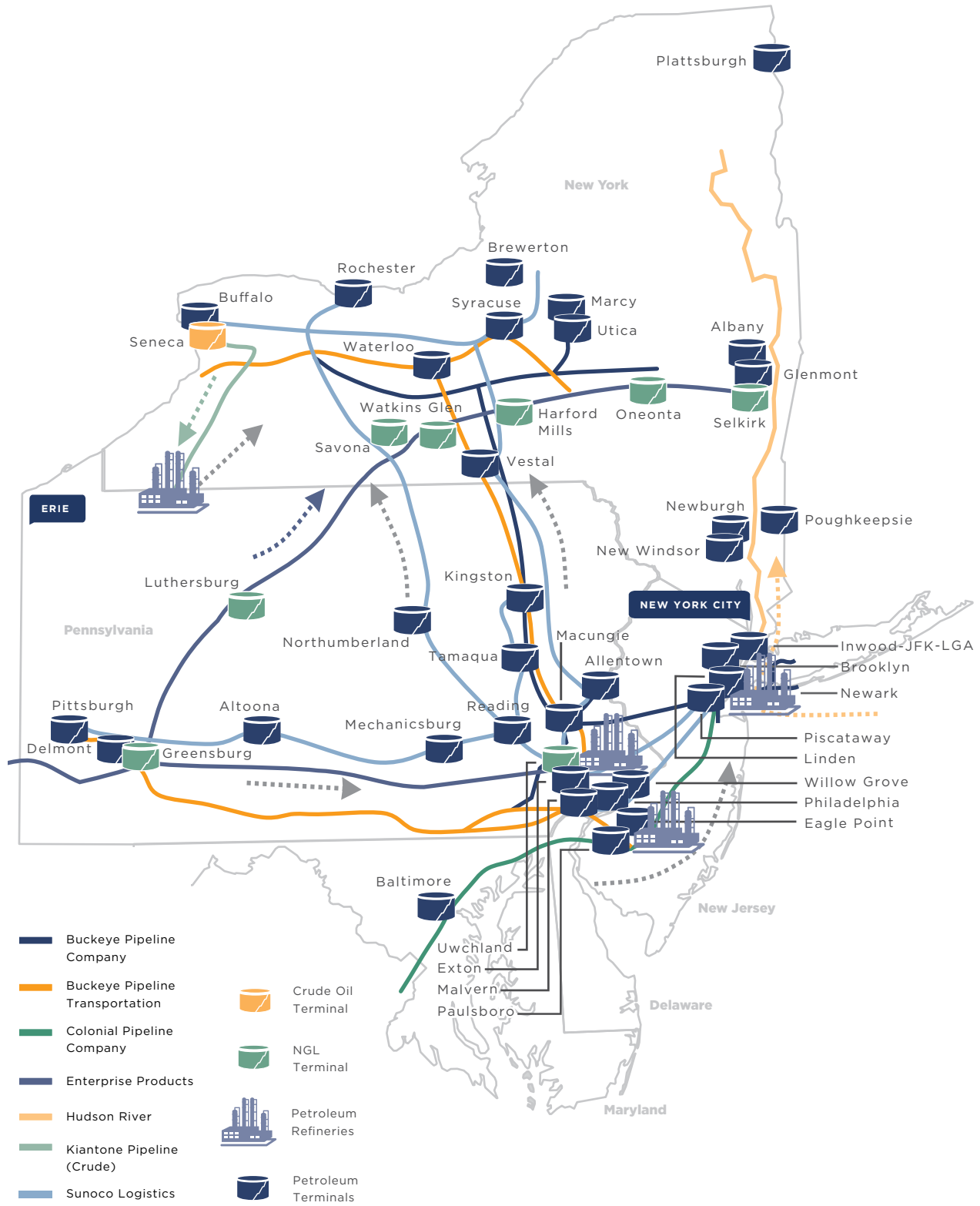
Consumers in Eastern New York and the expansive North Country region receive petroleum fuel supplies from several distribution areas. The Port of New York/New Jersey provides fuel to Upstate and Eastern New York and parts of Western New England markets via the Hudson River. Fuels are transported by barge to storage facilities along the Hudson

River, including Newburgh, Kingston, Catskill, and the large capacity facilities at the Port of Albany/Rensselaer. Supplies are also sourced from Central New York pipelines and Eastern Canadian refineries in Quebec. In addition, truck transport delivers product from the Port of New York/New Jersey to the surrounding region for wholesale storage and retail sales. These regions are particularly dependent on trucking operations to move fuels from supply terminals to distant, inland market areas.

Western New York

Western New York markets are served by the same Buckeye and Sunoco Logistics pipelines that transit through the Central Region. Large volumes are supplied by refineries located in Sarnia, Canada, and by several small locally significant refineries in Western Pennsylvania. Delivery points along these pipelines include locations in the Rochester and Buffalo areas. Distribution facilities in the Buffalo area also receive barge and rail delivery of petroleum fuels from Mid-Western sources. Finally, extensive truck transport activities play a vital role in distribution to end users in this region.

Figure 53 | Northeast Petroleum Supply Infrastructure



Source: ICF. *Draft Transportation Fuels Infrastructure Study*. 2012.

East Coast Refinery Capacity

Refineries along the East Coast, principally in the New Jersey, Philadelphia, and Delaware region, provide a portion of New York's petroleum products supply. Through the 1990's, the cumulative capacity of these plants was approximately 1.6 b/d. Due to closures in recent years of several Northeast refineries, including Eagle Point, Marcus Hook, and Port Reading, capacity has declined. Industry has adapted to these closures by converting some of these refining facilities into large refined product import terminals and expanding pipeline capacity to increase fuel flow from the U.S. Gulf Coast region.

Statewide/Regional Fuel Specific Storage Capacity

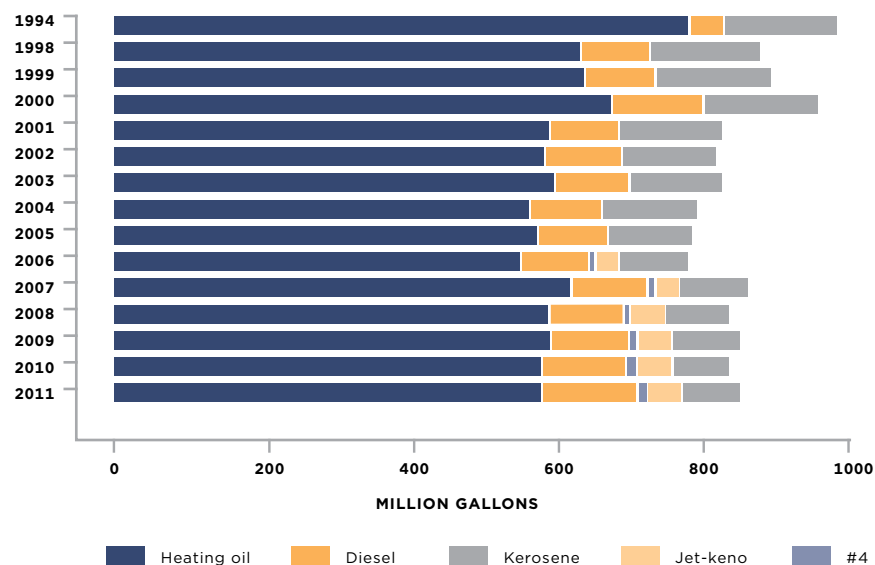
Adequate storage capacity helps ensure continuous supply of petroleum products during periods when short-term demand surpasses delivery capacity. Storage occurs at the primary (large bulk storage facilities), secondary (wholesalers and retailers), and tertiary levels (customer tanks). There are numerous challenges associated with maintaining storage capacity. Petroleum storage terminal facilities face many of the same environmental, land use, and economic pressures that affect the refining sector. Operators note the high costs associated with meeting environmental regulations, insurance costs, carrying costs associated with holding large volumes of high priced petroleum products, and the lack of market incentives including lower fuel demand as a result of efficiency improvements and fuel type substitution to build new facilities as impediments to adding storage capacity in the State. Despite these challenges, beginning in 2007, the amount of New York's storage capacity dedicated to distillate fuels has grown. In certain parts of the State, including Long Island, the petroleum distribution industry has responded to market signals and added tank capacity to meet demand.

From 1994 to 2011, total New York storage capacity for all fuels declined from 2.74 billion gallons to 2.273 billion gallons, a decline of 467 million gallons (mmgals), or 17 percent.⁷ Since 2004 however, the total capacity has held relatively steady at approximately 2.3 billion gallons. Within this range, individual fuel storage capacities have changed as the distribution industry makes adjustments in response to consumer demand and changing fuel types including the addition of biofuels, specifications, and blends.

7. Department of Environmental Conservation (DEC). Major Oil Storage Facility data file.

Statewide distillate fuel storage capacity, which includes volumes of #2 home heating oil, kerosene, diesel fuel, #4 fuel, and jet-kerosene, is shown in Figure 53.⁸ These fuels are presented together because terminal operators often have to convert tanks to hold one fuel or another, depending on demand or as market events dictate. The total State storage capacity for all these fuels declined from 993 mmgals in 1994 to 863 mmgals in 2011, a reduction of 130 mmgals, or 13.1 percent.⁹ Over the same period however, statewide demand for these fuels decreased by only 5.8 percent.¹⁰ This indicates that, while terminal capacity is being used more efficiently to meet normal everyday demand, there may be less capacity available to meet atypical demand surges by the heating and electric generation sectors prime consumers of these fuel types during periods of colder than normal temperatures. This may create marketplace supply uncertainty and contribute to greater short-term price volatility. In effect, consumers are becoming more dependent on the ability of the petroleum transport industry (tugboats, barges, pipelines, tankers, and trucks) to resupply the remaining terminals and distribute various fuels during peak demand periods.¹¹

Figure 54 | New York State Distillate Storage Capacity



Source: DEC. *Major Oil Storage Facility and Petroleum Bulk Storage Aggregated Data*. 2012.

8. Storage capacity for #4 fuel equals approximately 7 mmgals, and while included, is too small to see on the chart.

9. DEC. Major Oil Storage Facility data file.

10. NYSDERDA. *Patterns and Trends: New York State Energy Profiles (1997-2011)*. June 2013. <http://www.nysderda.ny.gov/patterns-and-trends>

11. For a more complete analysis of the State's distillate and residual fuel storage capacity, see ICF Consulting LLC (prepared for NYSDERDA). *Petroleum Infrastructure Study*. 2006.

Of all the distillate fuels, home heating oil has the highest annual demand. It is used primarily by the residential sector for heating and hot water, but may also be used by the electric generation sector as a secondary backup fuel by dual-fueled facilities and peaking turbines. In New York, operational storage capacity for home heating oil declined from 794 mmgals in 1994 to 590 mmgals by 2011, a slight increase from its recent low of 558 mmgals in 2006. Even with this recent increase, there is an overall reduction in capacity of 204 mmgals, or 25.7 percent, from the 1994 peak. Part of this decline may be attributed to reduced consumer demand for heating oil, as residential sector conversions to natural gas and propane occur.

Kerosene is an important fuel used to meet heating needs and as a blending agent to prevent cold temperature gelling in both transportation sector diesel fuel and home heating oil. This fuel can also be used as a secondary backup fuel by many dual-fueled electricity generating facilities that use natural gas as their primary fuel and by peaking turbines. Statewide storage capacity of kerosene has fallen from 150.5 mmgals in 1994 to 80.1 mmgals in 2011, a decrease of 70.4 mmgals, or 46.8 percent. Part of the decline is attributable to the reclassification of jet fuel capacities.

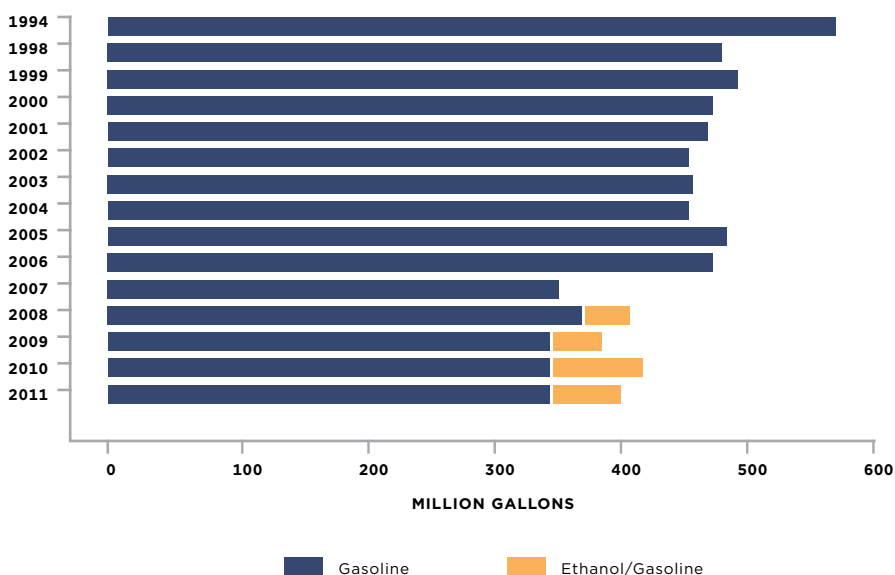
Diesel fuel is used primarily by the transportation sector, although it also may be used for heating application and for electric generation. Like gasoline, diesel fuel has steady, every day supply/demand fundamentals, unlike heating fuels, which are subject to sharp weather-driven seasonal demand spikes. As such, diesel fuel requires less storage capacity to maintain adequate supply because with a more consistent and predictable demand pattern fuel supply, companies are able to provide a more steady and defined volume of fuel on a daily basis and not have to prepare for unanticipated demand surges. In New York, diesel fuel storage capacity increased steadily from 49 mmgals in 1994 to 127 mmgals by 2000, a gain of 78 mmgals, or 159 percent. A significant decline in capacity occurred in 2001, as the total statewide volume decreased to 99 mmgals, a fall of 28 mmgals, or 22 percent. Since 2001, capacity totals have regained previous losses, and in 2011, equaled 134.9 mmgals; a new capacity peak.

Jet fuel capacities have only been available from the Department of Environmental Conservation (DEC) data files since 2006. Prior to that year, these capacities were included in one of the other distillate fuel categories. In 2011, total State capacity equaled 51 mmgals, 16 mmgals, or 45.4 percent, more than in 2006, the initial year of data availability. Most of the jet fuel storage capacity is located at airport facilities, particularly the large downstate airports. Only a limited number of petroleum

distribution terminals have any jet fuel capacity, and that capacity is generally dedicated to local airport service. Jet fuel also may be used as a backup fuel to natural gas by the electric generation sector.

As shown in Figure 55, statewide motor gasoline storage capacities fell from 571 mmgals in 1994 to 340 mmgal in 2011, a drop of 231 mmgals, or 40.5 percent. Enhancing gasoline storage capacity is the addition of 60 mmgals of ethanol and ethanol blended gasoline capacity in 2011. Ethanol is required to be blended into the reformulated gasoline (RFG) used in the downstate area. Additionally, ethanol may be blended on an optional basis by distributors in the upstate area. By 2013 the use of ethanol blended gasoline was almost universal throughout the upstate area. It is expected that additional ethanol storage capacity will be added in the coming years; however, it is not known if this will include new tanks or the conversion of existing gasoline tanks for ethanol storage.

Figure 55 | New York State Gasoline and Ethanol Storage Capacity



Source: DEC. *Major Oil Storage Facility and Petroleum Bulk Storage Aggregated Data*. 2012.

Residual fuel oil, commonly referred to as #6 fuel oil, is a fuel primarily used by the electricity generation sector and in large industrial, commercial, and residential building boilers. Statewide storage capacity for residual fuel oil declined from a 1994 peak of 981 mmgals to 727

mmgals in 2011, a reduction of 254 mmgals, or 25.9 percent.¹² From the 1960s to the late 1970s, New York's electric generation sector was dominated by residual fuel powered capacity. By the 1970s, concern about environmental emissions and oil dependency stimulated the conversion of generation capacity away from residual fuel to natural gas. In response to lower demand, the terminal industry has eliminated large amounts of residual fuel storage capacity. In 2012, New York City announced a plan to gradually eliminate the use of residual fuel in the commercial and large residential building sectors. This long term effort is expected to result in lower storage capacity in future years.

Crude Oil Production

New York's first commercial oil well began production in 1865, and Statewide production peaked in 1882 at 6.8 million barrels per year. This initial oil boom was short-lived and by 1893, production had fallen to one million barrels per year. New York's second oil boom occurred with the advent of water flooding, the first enhanced oil recovery technique. This technique led to a second peak of 5.4 million barrels in 1943. The Bass Island Trend in Chautauqua County, brought on line in 1981, was the last major oil discovery in the State.

According to the U.S. Energy Information Administration (EIA), New York ranked 27th out of 31 oil producing states in 2011. New York's oil production comes from two distinct regions: from the historic areas of Allegany, Cattaraugus, and Steuben counties, and from the Bass Island Trend in Chautauqua County. Oil production in 2012 totaled 394,000 barrels,¹³ approximately 0.2 percent of annual statewide petroleum product demand. While the 2012 production total is 7.7 percent less than the 1991 peak of 427,000 barrels, it is 174 percent greater than the 2003 low of 144,000 barrels.

Crude oil exploration and production activities, whether in New York or elsewhere, are dependent on the market price of oil for support. In recent years, sharply higher crude oil prices have stimulated exploration activities in the State. Between 1990 and 2003, U.S. domestic crude oil prices averaged \$20.69/oil barrel (bbl), an insufficient level to support extensive exploration efforts in the State.¹⁴ By 2003, crude oil production

12. DEC. *Major Oil Storage Facility and Petroleum Bulk Storage aggregated data*. 2012.

13. DEC. *2012 Oil and Natural Gas Production Data*. 2013. <http://www.dec.ny.gov/energy/36159.html>

14. EIA. *Domestic Refinery Acquisition Cost (RAC) presented as U.S. crude oil price*. 2013.

in New York had dropped to a low of 144,000 barrels per year. By 2012, the average price for U.S. domestic crude oil had increased to \$100.72/bbl, a gain of \$70.90/bbl or 238 percent from the 2003 level of \$29.82/bbl, helping to stimulate exploration activities in the State. From the 2003 production low point, significant crude oil price increases acted to stimulated new interest in New York's historic oil fields. The long decline of the State's crude production volumes reversed in 2004 and continued to trend higher through 2012. From its historic low in 2003 to its current level in 2012, State production grew to 394,000 barrels per year, a gain of 250,000 barrels or 174 percent.

Petroleum Share of New York Economic Sector Demand

Petroleum fuels are vital to New York's economy and are the second largest source of energy consumed in the State. New York annual demand for petroleum products peaked in 1973 at 505.5 mmbbl.¹⁵ From 1981 through 2010; demand has varied between 228.9 mmbbl and 322.5 mmbbl. In 2011, total demand was 216.4 mmbbl, down 12.5 mmbbl (5.5 percent) from the prior year demand of 228.9 mmbbl.

In 2011, petroleum fuels accounted for 32.5 percent of New York's total energy demand, well below the 66.8 percent record high recorded in 1972.¹⁶ While the total petroleum share of energy demand continues to decrease gradually, a review of each economic sector indicates that petroleum continues to dominate the transportation sector as a source of energy. Transportation sector petroleum share has been near 98 percent for the past four decades and as of 2011 equaled 92 percent.

On a historical basis, petroleum fuel demand in the electric sector has posted the sharpest decline, falling from approximately 48 percent in 1975 to 0.7 percent by 2011. Beginning in the mid-1970s, the electricity sector steadily turned to natural gas and nuclear power to satisfy the State's increased electricity demand. Even with the trend to natural gas powered generation and expanded output from nuclear facilities, petroleum products continue to support a number of large base-load generating units as key alternative fuels during periods of peak natural gas demand. Residual fuel and distillates, such as diesel, kerosene, jet

15. EIA. *State Energy Data System. New York State Consumption*. 2013. http://www.eia.gov/state/seds/sep_use/total/csv/use_NY.csv

16. EIA. *State Energy Data System. New York State Consumption*. 2013. http://www.eia.gov/state/seds/sep_use/total/csv/use_NY.csv

fuel, and home heating oil, power electricity generation peaking units and provide essential backup fuel capability at dual-fueled interruptible natural gas powered electric generation facilities. Dual-fuel equipment allows end-users the option to switch between natural gas and distillate or residual fuels when the price for one fuel offers an economic advantage or if natural gas is unavailable due to regulatory fuel supply service class requirements. As a result, if sufficient fuel switching occurs, petroleum use may increase or decrease from year to year. A limited amount of dual-fuel capability exists in large apartment buildings in the residential sector, and in both the commercial and industrial sectors.

In the residential sector, demand for all petroleum fuels, including home heating oil, kerosene, and propane fuel, declined as higher prices and environmental considerations encouraged homeowners to convert to natural gas, increase home insulation, lower thermostats, and purchase high-efficiency furnaces. The total of all petroleum fuels' share of energy supply to the residential sector has fallen from 49 percent in 1962 to 17.2 percent by 2011.¹⁷ Similar end-user sentiment in the commercial sector has reduced petroleum's share of total energy supply. In the industrial sector, petroleum's percentage of total energy use increased from 1995 to 2011. In 2011, petroleum's share of energy supply in the industrial sector amounted to 14.1 percent.

Distillate Fuel Focus

Distillate Fuel Demand

New York is a major user of distillate fuel, consuming 60.3 mmbbl in 2011 or 4.2 percent of total U.S. distillate fuel demand.¹⁸ In 2011, New York accounted for 13.7 percent of Petroleum Administration for Defense District 1 (PADD 1) total distillate consumption.¹⁹ The three principle distillate fuels; heating oil, kerosene, and diesel, are used in each economic sector and represent almost 30 percent of total petroleum fuel used in New York in 2011.²⁰ The transportation and residential sectors accounted for the greatest share in the consumption of distillate fuel in

17. EIA. *State Energy Data System. New York State Consumption*. 2013. http://www.eia.gov/state/seds/sep_use/total/csv/use_NY.csv

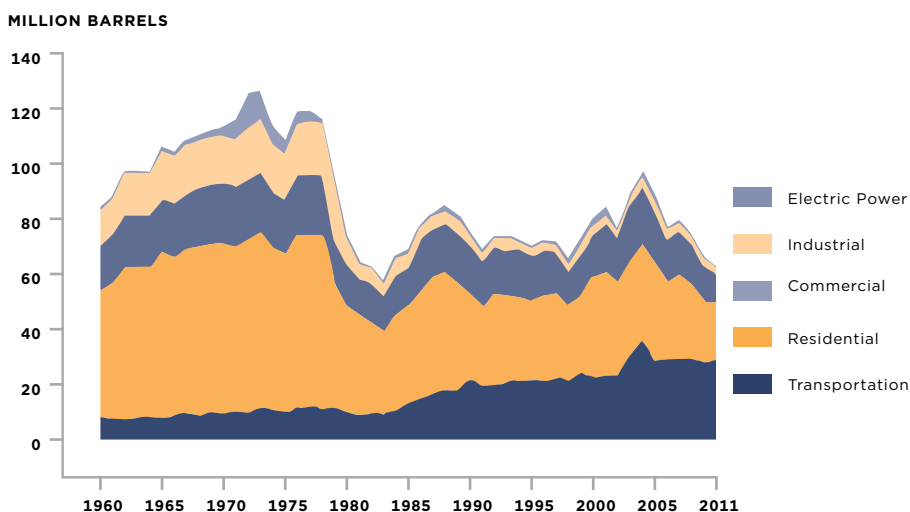
18. EIA. *State Energy Data System. New York State Consumption*. 2013. http://www.eia.gov/state/seds/sep_use/total/csv/use_NY.csv

19. EIA. *Petroleum Navigator*, 2013. http://www.eia.gov/dnav/pet/pet_cons_821dsta_dcu_SNY_a.htm

20. EIA. *State Energy Data System. New York State Consumption*. 2013. http://www.eia.gov/state/seds/sep_use/total/csv/use_NY.csv

the State in 2011, 47.2 percent and 30.5 percent, respectively. Home heating oil use in the residential sector is particularly important in New York with an estimated 2.0 million households, roughly 28 percent of the State's housing stock, using home heating oil and kerosene to heat.²¹ The State uses more home heating oil in the residential sector than any other state in the nation. Although overall use of distillate fuel is declining, the use of diesel fuel in the transportation sector is growing. As shown in Figure 56, total transportation use of diesel in 2011 equaled 28.5 mmbbl, up from 23.0 mmbbl in 2000 and 21.7 mmbbl in 1990. Within the electric generation and industrial sectors, use of distillate has fallen sharply from the peak periods in the 1970s as natural gas use has increased. Commercial demand is relatively flat while residential use is slowly declining.

Figure 56 | Total Annual Distillate Fuel Demand by Sector in New York State



Source: EIA. *State Energy Data System*. 2013.

Distillate Fuel Supply

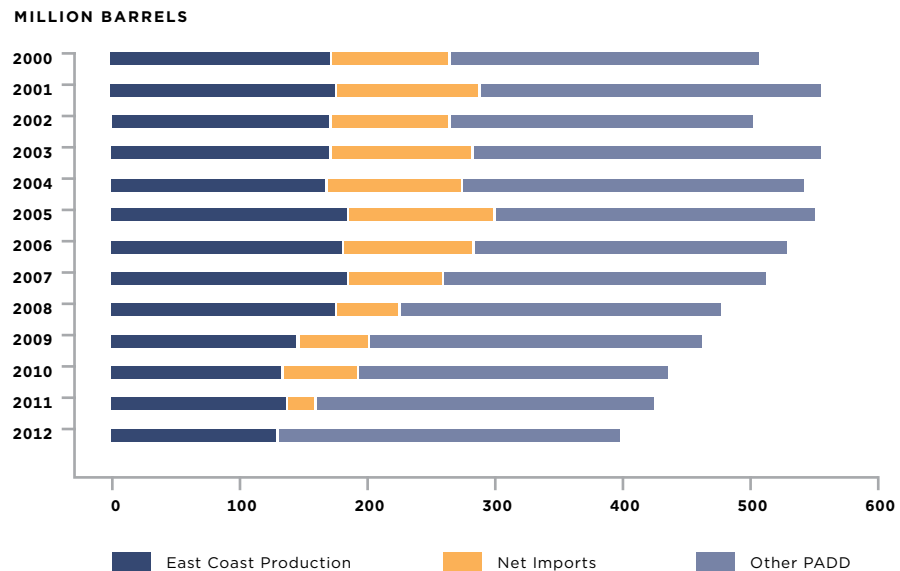
Although New York specific data for sources of supply is not readily available for calculation, EIA calculates PADD 1 level refined product source data.²² As shown in Figure 57, total East Coast distillate supply equaled 379 mmbbl in 2012, 155 mmbbl below the 534 mmbbl peak in

21. NYSDERDA. *Patterns and Trends: New York State Energy Profiles (1997-2011)*. June 2013. <http://www.nysderda.ny.gov/patterns-and-trends>

22. Petroleum Administration for Defense Districts (PADD) are geographic aggregations of the 50 States and District of Columbia. PADD 1 includes 17 States from Maine to Florida, including New York.

2001. Cumulatively, East Coast states received 126 mmbbl, 33.3 percent, of distillate supplies from refineries located within the East Coast PADD 1 region, and 260 mmbbl, 68.6 percent, from other U.S. regions. Of significance, for the first time the East Coast exported more distillate fuel than it imported on an annual basis. On a net import/export basis the East Coast exported 7.1 mmbbl, 1.9 percent, of total supply. Through 2006, the percentage share of imports generally ranged from 18 percent to 20 percent. However, beginning in 2007, the import share fell as a combination of reduced demand and increased domestic production limited import requirements. The percentage decline in East Coast imported supplies of distillate fuel has been offset primarily by a growth in shipments from other parts of the U.S., notably the Gulf Coast PADD 3 region. With the often immediate need for supply in response to cold temperature demand spikes, less reliance on distant imports and more production from closer East Coast refineries may be a critical factor to meeting short-term demand spikes.

Figure 57 | East Coast Total Distillate Supply Sources



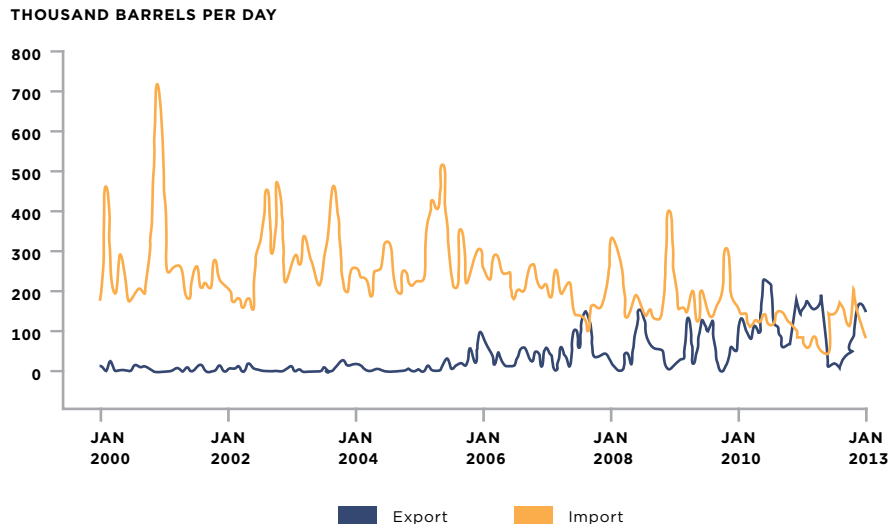
Source: EIA. *Petroleum Supply Annual*. Years 2000-2012. 2013.

Imports are an important source of supply to meet demand during peak seasonal periods, particularly during the winter heating season. The Port of New York/New Jersey, because of its large distribution infrastructure and immediate access to the large Northeast population, attracts shipments from around the world. On a month-to-month basis, import flows vary depending on regional production, Gulf Coast shipments, and demand variations. As shown in Figure 58, from 2000 to

2008, East Coast import volumes averaged approximately 300,000 b/d with occasional high-demand period spikes as high as 700,000 b/d. During this period East Coast exports averaged less than 40,000 b/d. However beginning in 2008, exports of distillate fuels began to climb during the summer months as demand from world markets increased. While imports continue into the Northeast on a monthly basis, by late 2011 monthly distillate exports from PADD 1 occasionally exceeded import volumes. Monthly data for the 2013 periods illustrates in Figure 59 that during the warm summer month's exports regularly exceed imports, a completely new supply trend.

Distillate fuel import and export volumes contain different sulfur content levels. By 2011, as East Coast distillate exports increased, the region primarily exported higher sulfur content fuels.²³ Beginning in 2007, the East Coast began to import greater volumes of the low-sulfur and ULSD grades to meet federal requirements for on-road diesel fuel use. Increasingly, the ULSD 15 parts per million (ppm) distillate will be used for home heating oil application in the Northeast, particularly as New York mandated ULSD heating oil effective July 1, 2012. New York is the only state in the Northeast requiring this cleaner emission fuel.

23. EIA. *U.S. Exports of Crude Oil and Petroleum Products*. 2012. http://www.eia.gov/dnav/pet/pet_move_exp_dc_nus-z00_mbb1_m.htm. EIA. *U.S. Imports of Crude Oil and Petroleum Products*. 2012. http://www.eia.gov/dnav/pet/pet_move_imp_dc_nus-z00_mbb1_m.htm

Figure 58 | East Coast Distillate Imports and Exports

Source: EIA. *East Coast Exports of Petroleum Products and Crude Oil*. 2013. http://www.eia.gov/dnav/pet/pet_move_exp_dc_R10-Z00_mbbbl_m.htm.

EIA. *East Coast Imports of Petroleum Products and Crude Oil*. 2013. http://www.eia.gov/dnav/pet/pet_move_imp2_dc_r10-z00_mbbbl_m.htm

East Coast Distillate Inventory Trends

Inventory volumes are important components of the distillate fuel supply system and, at the regional level, act as critical buffers to meeting demand spikes during the winter months. Monthly distillate fuel inventories for the Mid-Atlantic Region (PADD Sub-District 1B)²⁴ are presented in Figure 60. Regional analysis is important because New York's fuel needs, as well as those of neighboring Northeast states, are met from terminals located both within and outside the State. Correspondingly, some fuel inventories held at terminals in the Port of New York/New Jersey area and northward along the Hudson River supply neighboring New England and other Central Atlantic states.

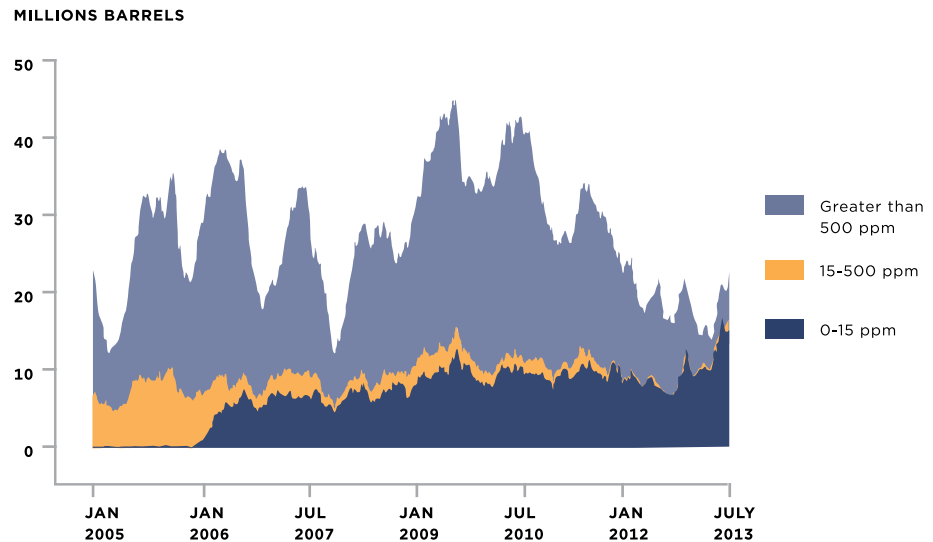
As illustrated in Figure 59, EIA classifies distillate fuel by three sulfur content levels. The 0-15 ppm ULSD fuel refers to on road transportation diesel fuel. Beginning in mid-2006, the implementation of the U.S. Environmental Protection Administration's (EPA) Highway Diesel Rule²⁵ required the use of ULSD for on-road application. The 15-500

24. EIA. PADD sub-district 1B includes Delaware, District of Columbia, Maryland, New Jersey, New York, and Pennsylvania.

25. U.S. EPA. *Heavy-Duty Highway Diesel Program*. 2012. <http://www.epa.gov/otaq/highway-diesel/>

ppm fuel shown on Figure 59 is for off-road application. This fuel was moved the ultra low sulfur (ULS) 15 ppm requirement in 2010. The final classification is for greater than 500 ppm sulfur content fuel, typical of home heating oil. Effective July 1, 2012 New York will require home heating oil to also achieve the 15 ppm standard, the only state in the Northeast to do so. The chart illustrates that total inventory volumes have declined. More importantly for New York, inventories of the 15 ppm fuel, used in New York for both transportation and heating are on the increase.

Figure 59 | Central Atlantic Distillate Inventories (By Sulfur Content)



Source: EIA. *Weekly Central Atlantic (PADD 1B) Ending Stocks of Distillate Fuel Oil, 0-15 ppm Sulfur*. http://tonto.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=WD0ST_R1Y_1&f=W; EIA. *Weekly Central Atlantic (PADD 1B) Ending Stocks of Distillate Fuel Oil, Greater than 15 to 500 ppm Sulfur*. http://tonto.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=WD1ST_R1Y_1&f=W; EIA. *Weekly Central Atlantic (PADD 1B) Ending Stocks of Distillate Fuel Oil, Greater than 500 ppm Sulfur*. <http://tonto.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=WDGST1B1&f=W>

Northeast Home Heating Oil Reserve

As a result of the home heating oil shortfalls that occurred during the 1999-2000 Winter season, the U.S. Department of Energy (DOE) established the Northeast Home Heating Oil Reserve in the Summer of 2000. This reserve currently consists of one million barrels of government-owned ULS heating oil. The reserve is intended to provide insurance against lower than normal inventories, supply shortfalls, and delivery interruptions. Reserves are held in storage facilities located in Connecticut and Massachusetts. Until 2010, an additional one million barrels was held at facilities in New Jersey. This was discontinued in 2011.

when the federal government determined that the Port of New York/New Jersey area had adequate storage, refining capacity, and pipeline connection to U.S. Gulf Coast refineries that ensured adequate supplies of distillate fuels.

Gasoline Focus

Gasoline and Ethanol Demand

New York gasoline consumption equaled approximately 5.5 billion gallons in 2011, 98.7 percent of which was used in the transportation sector. The State's gasoline requirements are satisfied by either conventional grade fuel or U.S. EPA mandated RFG. Gasoline retailers are required to sell RFG grade gasoline throughout the year in New York City, Long Island, and in the counties of Westchester, Putnam, Orange, Dutchess, and Rockland. In 2011, this region of the State used an estimated 2.7 billion gallons, slightly less than 50 percent of New York's annual gasoline demand.²⁶

As shown in Figure 61, gasoline demand grew steadily from 1960 through 1973 as growing population, expanding vehicle fleets, and moderate prices stimulated demand. Beginning in 1973, several factors, including the OPEC crude oil embargo, higher gasoline prices, and improved vehicle mileage acted to decrease demand, and by 1984, New York's annual demand had fallen to 4.8 billion gallons, a decline of 22 percent. From that low point demand rebounded and since the 1990s gasoline demand has remained relatively flat, ranging between 5.4 and 5.8 billion gallons.

Since the early 1990s, ethanol, a clear, colorless, flammable alcohol typically produced biologically from biomass feedstocks such as agricultural crops, from cellulosic residues of agricultural crops or wood, and from ethylene, has been blended into gasoline.²⁷ Fuel ethanol is used principally for blending in low concentrations with motor gasoline as an oxygenate or octane enhancer. In high concentrations, it is used to fuel alternative-fuel vehicles specially designed for its use.²⁸ Beginning in 2006, greater volumes of ethanol have been blended into gasoline to meet

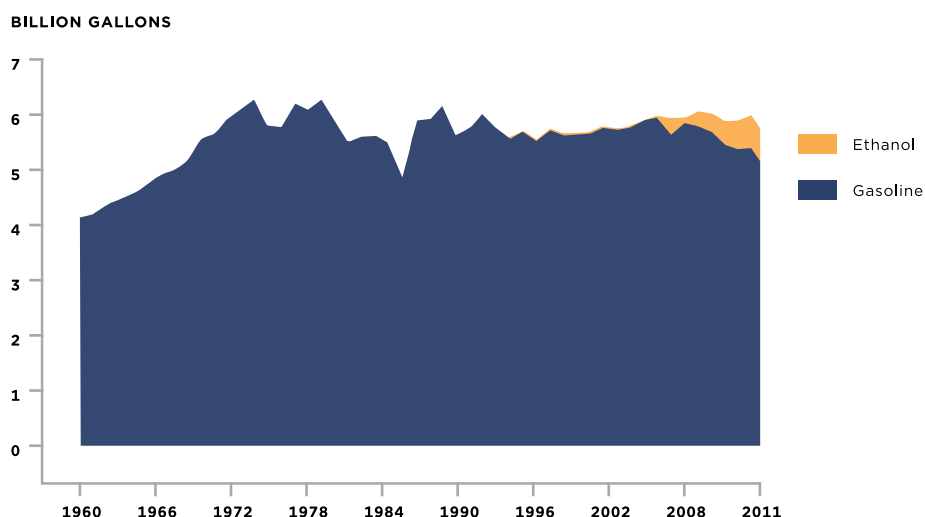
26. NYSDA. *Patterns and Trends: New York State Energy Profiles (1997-2011)*. June 2013. <http://www.nyserda.ny.gov/patterns-and-trends>

27. EIA. *Glossary*. 2012. <http://www.eia.gov/tools/glossary/index.cfm?id=E>

28. EIA. *Glossary*. 2012. http://www.eia.gov/tools/glossary/index.cfm?id=F#fuel_eth

fuel specification and renewable fuel requirements.²⁹ In 2011, 583 million gallons of ethanol were blended into gasoline for transportation use in New York, representing 10.6 percent of total gasoline volumes.³⁰

Figure 60 | New York State Gasoline and Ethanol Demand (1960-2011)



Source: EIA. *State Energy Data System*. 2013.

Gasoline Supply

New York and the East Coast obtain gasoline supplies from regional refineries, shipments by pipeline from U.S. refining centers, primarily on the Gulf Coast, and from overseas imports. Blending facilities at large storage terminals located in the Port of New York/New Jersey area play an important role in the production of finished motor gasoline. Blending plants are facilities that have no refining capability but are capable of producing finished motor gasoline through mechanical blending of oxygenates with motor gasoline.

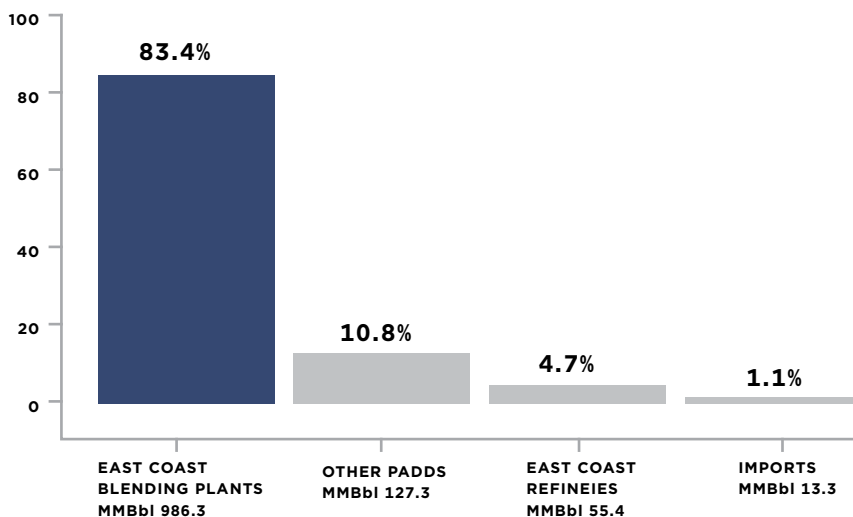
As illustrated in Figure 61, the operations of these blending facilities generated 73.4 percent of East Coast finished gasoline in 2012. Gulf Coast supplies make up a substantial amount of the volumes eventually used to create finished gasoline. Most of this fuel is shipped by pipeline from the Gulf Coast to storage terminals in the Port of New York/New Jersey

²⁹. The Renewable Fuel Standard (RFS) program was created under the Energy Policy Act of 2005 (EPACT05). The Energy Independence and Security Act (EISA) of 2007, created RFS2, which expanded the program.

³⁰. EIA. *State Energy Data System*. 2013.

area. Additionally, a small volume of Gulf Coast supply is transported by tanker and barge to the Port of New York/New Jersey area. Imports also contribute to the gasoline component feedstock.

Figure 61 | Supply Sources of East Coast Finished Gasoline (2012) (Mmbbl and percent)



Source: EIA. *Petroleum Supply Annual. Years 2000-2012*. 2013.

East Coast refinery production of gasoline dwindled from 22 percent of supply in 2005 to 4.7 percent in 2012. These refining facilities are located primarily in New Jersey, Delaware, and Pennsylvania. The fuel produced is moved into The Port of New York/New Jersey and Long Island terminals by barge, truck, and by pipelines. Tanker trucks then move the gasoline from these regional terminals to local retail outlets.

Beginning in 2004, New York banned the use of the gasoline additive methyl tertiary-butyl ether (MTBE) because of pollution concerns during fuel spills and leaks. This additive had been used in gasoline since 1979. Initially it was used as an octane enhancer to replace lead as an additive, and later, as an oxygenate to reduce ozone, carbon monoxide, and other air pollutants. In New York, MTBE was replaced by ethanol to meet the oxygenate requirements in place at that time. By 2005, many other states and gasoline producing companies also began to remove MTBE from their gasoline.

In December 2007, the Energy Independence and Security Act of 2007 (EISA) was signed into law. EISA amends the Renewable Fuel Standard, signed into law in 2005, and includes provisions mandating the use of renewable fuels such as ethanol in RFG. It also required a total of 16.55 billion gallons of renewable fuels for 2013. The quantity of renewable fuel

mandated increases each year until 2022 when 36 billion gallons will be required. By 2012, ethanol is also included in the conventional gasoline market in the upstate New York area.

Due to a mix of tax incentives, elimination of MTBE, blending requirements, and more recently federal renewable fuel standard requirements, ethanol has become an important component of gasoline. Ethanol, denatured to make it unfit for human consumption, is produced domestically and imported. In the U.S., it is principally derived from corn, whereas overseas sources typically derive the fuel from sugar cane and other sources. As of January 2013, there were 193 U.S. ethanol plants with nameplate capacity of 13,852 million gallons per year, or 903 thousand b/d, the majority of which (91 percent) are located in PADD 2 (U.S. Midwest).³¹

Propane Focus

Propane Demand

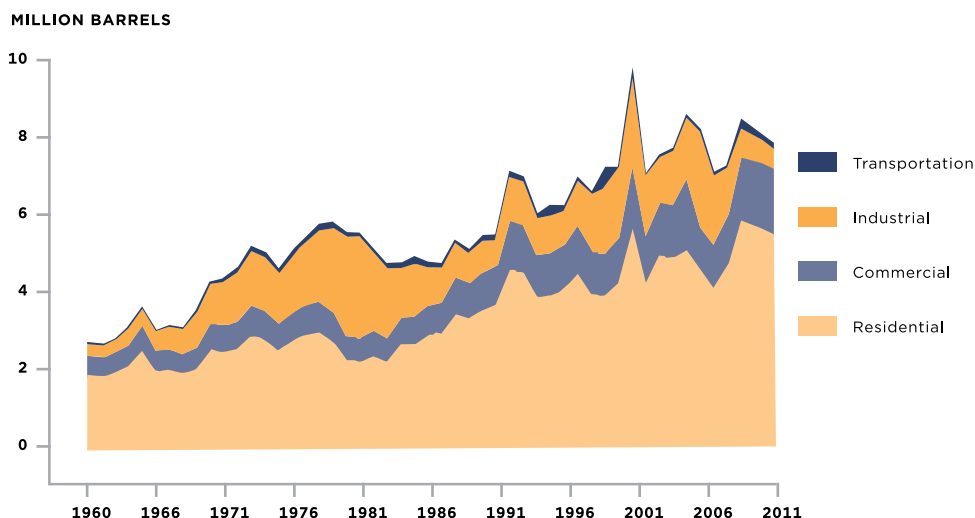
Propane fuel is a small volume, essential source of energy for New York residents and business owners. Propane, often referred to as “bottled gas” or “LP gas,” is used in the residential sector for heating homes and water, cooking, drying clothes, and fueling fireplaces. In the commercial and industrial sectors, it is used for heating and to drive manufacturing processes. In the transportation sector, both off-highway and on-highway applications continue to grow. Finally, in the agriculture sector, propane is used for heating, crop drying, and weed control. At the national level, propane is an important feedstock for the petrochemical industry, particularly in the U.S. Gulf Coast area.

On a national scale, New York’s percentage share of propane use is small, 1 percent of total U.S. demand. However, when compared to the overall East Coast PADD 1 region, the State accounts for 11.2 percent of demand, the third largest market after North Carolina and Pennsylvania. As shown in Figure 63, demand for propane fuel in New York is on a general upward trend, driven largely by expanded residential use. Annual variations in demand are influenced by winter weather conditions and subsequent heating demand. In 2000, propane demand spiked at 9.9 mmbbl on strong residential and industrial demand. Between 1990 and 2010, total annual propane demand increased from 5.6 to 7.9 mmbbl,

31. EIA. *U.S. Fuel Ethanol Plant Production Capacity*. May, 2013. <http://www.eia.gov/petroleum/ethanolcapacity/>

a gain of 2.3 mmbbl or 41.1 percent. In 2011, the residential sector accounted for 67.1 percent of total State demand, the commercial sector 24.1 percent, industrial 7.4 percent, and the transportation 2.3 percent.³²

Figure 62 | New York State Annual Propane Demand



Source: EIA. *State Energy Data System*. 2013.

Propane Supply

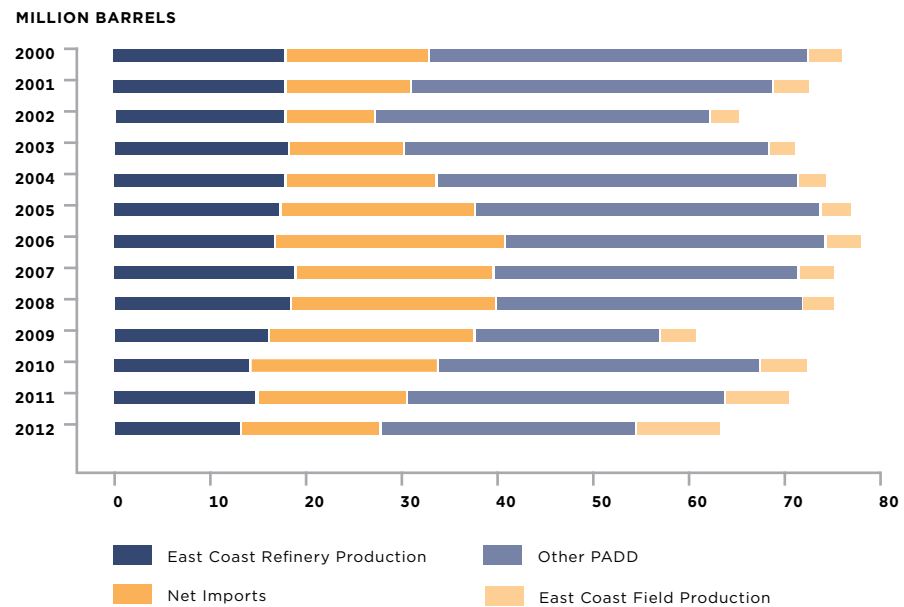
Propane is produced both as a by-product of natural gas processes and petroleum refining. Domestically, large volumes of propane have traditionally been shipped to New York State via the Enterprise TE, which originates in the U.S. Gulf Coast, and by rail car and truck. Propane also is imported from Canada by rail car and truck, and from foreign sources by ocean going tankers. Since 2000, U.S. propane demand has ranged from a low of 1.14 million barrels per day (mmb/d) in 2001 to a high of 1.27 mmb/d in 2004. The most recent year available, 2012, shows annual demand equaling 1.19 mmb/d. Much of this variation may be attributed to winter temperatures, crop drying needs, and petrochemical industry demand. In 2012, propane imports fell to 107,000 b/d from the 2005 high of 219,000 b/d, as domestic production from shale formations and refinery capacity expansion reduced the need for imports.³³

³². EIA. *State Energy Data System*. 2013.

³³. EIA. *U.S. Imports of Crude Oil and Petroleum Products*. 2013. http://www.eia.gov/dnav/pet/pet_move_imp_dc_NUS-Z00_mbbbl_m.htm

As illustrated in Figure 63, in 2012, the East Coast states received 26.6 mmbbl, 42 percent, of their propane supplies from other parts of the country, primarily the U.S. Gulf Coast region. The Gulf Coast percentage share fell steadily from the 2002 high of 53.3 percent to 31.9 percent in 2009 corresponding with a rise in net imports. Since 2009, net imports have declined to 14.6 mmbbl, 23.1 percent, in 2012 from a high of 21.6 mmbbl, 35.5 percent, in 2009 as high foreign sourced propane prices limited imports. Supplies from East Coast refinery sources also showed declines in 2012 to 12.9 mmbbl, 20.4 percent from the historic 2002 high of 17.8 mmbbl, 27.1 percent, as refinery capacity declined within the region. Partially offsetting the East Coast refinery production is PADD 1 field production. Field production has grown in recent years, reflecting increased production from natural gas and natural gas liquids production in East Coast shale formations. PADD 1 Field Production grew from 3.4 mmbbl, 4.4 percent, of supply in 2005 to 9.2 mmbbl, 14.5 percent, in 2012. Mid-Atlantic regional propane supplies are anticipated to increase as shale gas resources continue to be developed in the Appalachian Region over the coming years.

Figure 63 | East Coast Propane Supply Sources



Source: EIA. *Petroleum Supply Annual. Years 2000-2012.* 2013.

Propane Storage

The pre-winter season build up of propane inventories is a critical supply component to New York consumers. Winter season cold temperature induced demand often exceeds the resupply capacity of the propane distribution system. For example, rail car deliveries from distant refineries and natural gas processing plants, and truck transport from distant primary terminals, may be delayed due to severe cold and snowy weather conditions. These resupply delays often have the effect of severely reducing available local market area inventories, resulting in immediate local supply shortfalls and upward price pressure as the distribution industry struggles with weather related delays.

Propane inventory capacity is generally classified by three levels of storage capacity: primary, secondary, and tertiary. At the primary level, there are several underground storage caverns constructed in salt formations in central New York that hold large volumes of propane. These caverns are emptied as the heating season unfolds to meet regional demand. Many of these caverns are connected to the Enterprise TE pipeline, and have railcar and truck-loading capacity for distribution of fuel to secondary terminals located across the Northeast region. Propane is injected into these caverns during the summer and early fall period in anticipation of high demand during winter months. The fuel held in these storage caverns is not dedicated exclusively for New York users. Companies supplying propane to users in other Northeast states also may store fuel in these facilities. Similarly, New York users may receive propane from two ocean import terminals located in New England and from terminals in neighboring states. However, beginning in 2012, high international propane prices relative to U.S. prices have curtailed imports to these facilities. As a result many New England propane supply companies are now utilizing New York based distribution facilities, putting greater supply pressures on these locations.

At the secondary level, there are many large-scale, pressurized above-ground tanks located at terminals and retail dealers around the State. Again, some of this fuel may be destined for consumers in neighboring states. These facilities may include any number of individual storage tanks ranging in size from 18,000 to 90,000 gallons, separately or clustered together to supply local communities. During the heating season, these secondary tanks are repeatedly refilled with fuel from primary storage facilities and Upstate New York caverns to meet local demand. Any mid-to long-term interruption of the continuous propane flow from pipeline and railcar facilities to secondary terminals may have significant impacts on end-user resupply during cold weather periods.

Smaller, secondary storage facilities play a critical role ensuring adequate local fuel supply during high-demand periods. They are the last line of supply for a locality before a distributor must send large transport trucks to distant terminals to secure resupply. The resupply effort is time consuming and significant costs may be incurred. During the normal average cold 2008/2009 Winter season, strong season-long demand, an early drawdown of primary level storage cavern inventories, and resupply delays at the New England ocean terminals forced many northeast companies to send transport trucks to distant supply sources as far away as Indiana, Kansas, and Michigan to secure fuel. The added transport costs of this effort resulted in higher retail prices for many New York State consumers as distribution companies passed along additional costs.

Finally, end user storage tanks, including those of residential homeowners, represent final tertiary storage capacity. Tank capacities installed at the homeowner level depend on the size of the house and the number of fuel-use applications including; heating, cooking, hot water, and more. Typically, residential capacities range in size from 250 gallons for limited use to as much as 1,000 gallons for large, multiple application use homes.

Residual Fuel Focus

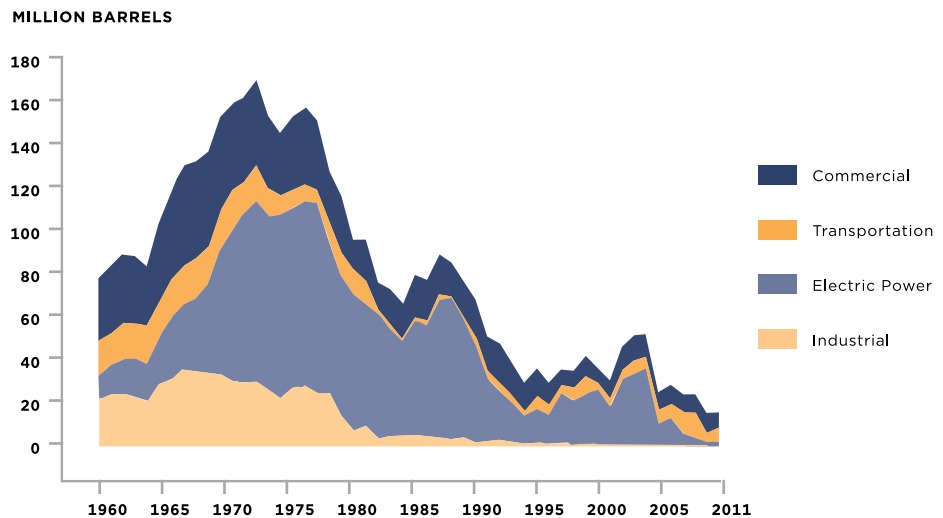
Residual Fuel Demand

Since 1991, consumption of residual fuel oil has ranked as the third largest petroleum fuel used in New York on a volumetric basis, trailing gasoline and distillate fuel oil. Residual fuel is traditionally refined and blended to different sulfur content levels, measured as a percentage by weight, to meet varying local air-emission standards across the State. The allowable sulfur content in New York ranges from a low of 0.3 percent to a high of 1.5 percent.³⁴ In New York City, residual fuel is required to have a sulfur content of no greater than 0.3 percent. Residual oil is not shipped in pipelines because of its high viscosity. Rather, it is transported by tanker, barge, and for local delivery, by truck. It is traditionally used in large boiler applications such as electric power generation, space heating in large apartment and commercial buildings, vessel bunkering, and industrial facilities.

³⁴. DEC. *Subpart 225-1 Fuel Composition and Use – Sulfur Limitations*. 2012. <http://www.dec.ny.gov/regs/4225.html>

Matching the national trend, New York's residual fuel demand has fallen sharply since the early 1970s, as illustrated in Figure 64. During the 1970s through the 1990s, the State used large, but declining, amounts of residual fuel, particularly for electric power generation, commercial, and industrial purposes. Between 1990 and 2011, statewide demand declined from 77.2 to 14.5 mmbbl, a reduction of 81.2 percent. Historically, the State's electric sector has been the largest user of residual fuel. By 2011 however, the electric sector share of total residual fuel demand had fallen to 7.1 percent, much lower than the 1990 level of 69.7 percent. In 2011, the commercial sector, including large apartment buildings common in New York City, accounted for 48.8 percent of residual demand; the transportation sector used 35.5 percent, and the industrial sector 8.6 percent.³⁵

Figure 64 | New York State Annual Residual Fuel Demand, by Sector



Source: EIA. *State Energy Data System*. 2013.

Residual Fuel Market Evolution

Under its PlaNYC, New York City will require the phase-out in the use of #6 residual fuel oil by 2015. The City will require the transitioning to either #4 fuel oil (1,500 ppm sulfur or less) or equivalent fuel, with an eventual goal of either ULS heating oil, steam, or natural gas by 2030. This is expected to affect approximately 10,000 buildings city wide.

35. As New York City phases out the use of residual fuel (#6 as well as #4) over the next few years, commercial demand will continue to decline. See the discussion in Issues and Opportunities.

When this requirement is fully implemented, it is estimated it will reduce the amount of fine particles emitted from heating buildings by 63 percent.³⁶

The sharp spike in demand in 2005 and subsequent reduction in electric sector residual fuel demand in 2006 is explained partially by inflated 2005 electric sector demand as a result of disruptive hurricane activity. In late Summer 2005, hurricanes damaged substantial system components of the U.S. Gulf Coast natural gas production and processing infrastructure. In response to reduced natural gas supplies, prices moved sharply higher. This resulted in most dual-fueled facilities in New York State switching to residual fuel for much of the fall and early Winter 2005 period.

Despite the decline in overall use, residual fuel remains an important component for the reliability of the electric power grid, particularly in the Downstate New York City and Long Island areas. Dual-fuel electric generation capacity relies on residual fuel and, to a lesser extent, distillate fuel, as the primary back-up fuels for periods when natural gas supply is curtailed to non-firm service-class customers. This backup fuel function allows for continues electric generation during high-demand winter and summer peak seasons.

36. New York City. *PlaNYC: Air*. 2011.



4

Renewable Energy Resources

Overview

This report evaluates the existing, planned, and potential use of New York's renewable energy resources, including hydropower, wind power, bioenergy¹, solar energy, and geothermal energy. The scope of this report includes large-scale renewable electricity, customer-sited renewable energy, and renewable fuels,

¹. Bioenergy resources include: biomass such as wood and biogenic waste, biogas such as landfill gas, and biofuels such as ethanol.

as well as policies and programs designed to stimulate implementation of renewable resources.

New York Leadership

New York is a national leader in the deployment and production of renewable energy. This leadership is attributable to New York's strategic pursuit of policies designed to develop a diverse portfolio of renewable energy resources including solar, wind, hydropower (both conventional and newer forms of hydrokinetic), and biomass. The success of this approach is reflected by the fact that New York has developed more than 1,800 MW of new renewable capacity since 2004 - more than any other state in the Northeast. This is largely due to the State's goal to meet 30 percent of the State's electricity needs with renewable resources by 2015. When considering existing hydropower, New York's renewable energy capacity is comparable to the entire renewable energy capacity of the other eight states in the Northeast combined. In a recent U.S. Department of Energy (DOE) report, New York ranked fifth in the nation for the amount of installed renewable energy capacity providing electricity to the State. New York was the only state east of the Mississippi named in the top five, and the only Northeast state placing in the top ten.²

Value of Renewable Resources

Help Achieve Environmental Goals

Renewable resources reduce the need for electricity generated by fossil fuel-fired sources. Based on State Energy Plan electricity modeling, it is projected that in 2020, the electricity generation displaced due to the introduction of new renewable resources will be 54 percent natural gas and 16 percent coal. Less generation from fossil fuel-fired units can result in lower emissions of air pollutants, which means that fewer emission reduction measures will be needed to achieve statewide and regional emission caps, and that the cost of compliance with emission caps also will be reduced.

2. National Renewable Energy Laboratory. *2011 Renewable Energy Data Book*, www.nrel.gov/docs/fy13osti/54909.pdf

Create Jobs, Income, and Economic Growth

New York's clean energy leadership is underscored by its growing renewable energy industry. New York ranks 11th in the nation in terms of existing wind capacity and 15th in potential wind capacity. As of the end of 2011, 860 wind turbines had been installed in the State with a total capacity of 1,403 megawatts (MW); an additional 37 turbines were under construction with 74 MW of expected capacity.^{3,4} New York is home to more than 50 companies that manufacture renewable energy technologies or related products, and 375 companies that are certified to install solar-photovoltaic (solar-PV) systems.^{5,6}

According to recent study conducted by the Brookings Institution, in 2010 New York had 5,147 jobs related to wind power (approximately double the number of wind related jobs in 2003), and 556 jobs related to solar power.⁷ The direct macroeconomic benefits of renewable energy include the creation of jobs in construction and operation of new facilities, payments to the State and localities, payments for fuel and land leases, and in-state purchase of materials and services.

Reduce Imported Energy and Reliance on Fossil Fuels

Renewable energy helps to reduce the reliance on fossil fuels imported from outside the State and/or the nation, thereby increasing the security of energy supplies. For example, based on State Energy Plan electricity modeling, it is projected that in 2020, the electricity generation displaced due to the introduction of new renewable resources will be 30 percent imports from other states.

Reduce Price Volatility Due to Fossil Fuel Use

Renewable energy contributes to the reduction of energy price volatility in the long term. Because the production cost for renewable energy remains stable throughout unpredictable fossil fuel price fluctuations,

3. Alliance for Clean Energy New York, Inc. *Wind Power Facilities in New York State*. 2011. <http://www.aceny.org/clean-technologies/wind-power.cfm>

4. American Wind Energy Association. *Wind Energy Facts: New York*. 2012. <https://www.awea.org/Resources/state.aspx?ItemNumber=5194>

5. American Council on Renewable Energy. *Renewable Energy in New York*. 2011. <http://www.acore.org/files/pdfs/states/NewYork.pdf>

6. This number reflects installers who are eligible to participate in NYSERDA's PV Incentive Program. <http://www.powernaturally.org/Programs/Solar/Installerspv.asp?i=1>

7. Brookings. *The Clean Economy in the State of New York*. 2011. [http://www.brookings.edu/about/programs/metro/clean-economy/-/media/Series/Clean Economy/36.PDF](http://www.brookings.edu/about/programs/metro/clean-economy/-/media/Series/Clean%20Economy/36.PDF)

renewable resources can provide cost-effective options for managing the risks associated with fossil fuel use.⁸

Reduce Negative Health Impacts of Energy Use

Increasing the amount of energy generated by renewable resources such as solar, wind, and hydropower will, in general, decrease the health risks associated with energy use. Many renewable resources emit no air pollutants at the site of electricity generation, or produce relatively low emissions when compared to fossil fuels, especially with respect to pollutants like particulate matter (PM), nitrogen oxides (NO_x), sulfur dioxide (SO₂), and mercury (Hg).⁹

Reduce Peak Demand and T&D Constraints

Renewable energy may increase the reliability of the local transmission and distribution (T&D) systems, especially power supply during peak demand periods. For example, since cooling load peaks during summer days when the solar resource is plentiful, distributed solar power generation can reduce the risk of localized power disruptions.^{10, 11}

Downward Pressure on Wholesale Electricity Prices

Renewable electricity resources cause downward pressure on wholesale market electricity prices by “backing out” some of the most expensive generation units. The benefit could be substantial because even a small wholesale price reduction is applied across many customers. This reduction is a benefit that can be netted against retail price increases due to the collection of ratepayer funds to pay the price premium for the purchase of renewable energy.

8. It is estimated that fossil fuel electric generators pay approximately 0.5 cents per kWh to manage risk against the potential price increase of natural gas. Bolinger, Mark; Wiser, Ryan. *Quantifying the Value that Wind Power Provides as a Hedge Against Volatile Natural Gas Prices, Proceedings of WINDPOWER 2002*. 2002. <http://eetd.lbl.gov/EA/EMP/reports/50484.pdf>

9. An important exception to this is biomass heating, which can have far (10 to 1000 times) higher emissions of PM than oil-fired heating systems.

10. Perez, Richard. *Satellite-Based Solar Resource Assessment: Social, Economic and Cultural Challenges and Barriers, Technological Gaps*. 2004. <http://www.asrc.cestm.albany.edu/perez/publications/SolarResourceAssessmentandModeling/PapersonResourceAssessmentandSatellites/satellite-basedsolaresourceassessment-04.pdf>

11. Perez, Richard. *Solar Energy Security: Could Dispersed PV Generation Have Made a Difference in the Massive North American Blackout?* ReFocus. 2004. 5(4): 24-28.

Assessment and Outlook

Contribution of Renewable Resources

Primary Energy Use (TBtu by Sector and Resource)

As shown in Table 10, in 2011, 11 percent of the primary energy used by all sectors in New York came from renewable resources.¹² This represented a 33 percent increase in renewable energy use since 2001.¹³ Approximately 72 percent of New York's 2011 renewable resource use was in the electric generation sector, of which 88 percent was conventional hydroelectric generation, and 9 percent wind generation. The remaining 28 percent of the State's renewable energy came predominantly from ethanol (12 percent of total renewable energy use) and biomass (16 percent of total renewable energy use), which consisted largely of transportation fuels and wood used for space heating by the residential sector, respectively.

^{12.} Primary energy typically is defined as energy that has not undergone a conversion process, and thus represents the energy content of the raw fuels that are input into the energy system.

^{13.} From 1993 to 2011, 2001 had the lowest annual hydropower output. The peak for annual hydropower output within that timeframe occurred in 1997, when 311.5 TBtu were produced.

Table 10 | 2001 – 2011 New York Primary Energy Use from Renewable Resources (TBtu)

SECTOR	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Residential, Commercial, and industrial — Biomass (Wood)	82.2	79.8	82.4	85.2	74.3	68.1	71.1	73.6	71.2	71.0	64.1
Transportation — Biofuel (Ethanol)	0.4	0.3	1.9	23.9	7.9	20.6	25.9	34.1	41.1	46.8	48.1
Electricity — Hydro	214	245	241	268	263	270	237	248	251	227	254
Electricity — Wind	0.2	0.8	0.4	1.2	1.0	6.5	8.2	12.3	22.1	25.3	27.6
Electricity — Biomass (Wood)	2.8	2.0	1.9	2.1	2.5	2.6	2.5	5.4	3.2	3.0	1.9
Electricity — Biomass (Methane)	2.8	2.0	2.0	2.1	3.3	3.2	3.9	5.1	6.2	6.6	6.8
Electricity — Solar PV	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.1
TOTAL RENEWABLES	303	330	330	382	352	370	348	379	395	380	403
TOTAL PRIMARY ENERGY	3,925	3,945	4,066	4,160	4,100	3,884	4,004	3,959	3,793	3,762	3,695
PERCENTAGE FROM RENEWABLES	7.7%	8.4%	8.1%	9.2%	8.6%	9.5%	8.7%	9.6%	10.4%	10.1%	10.9%

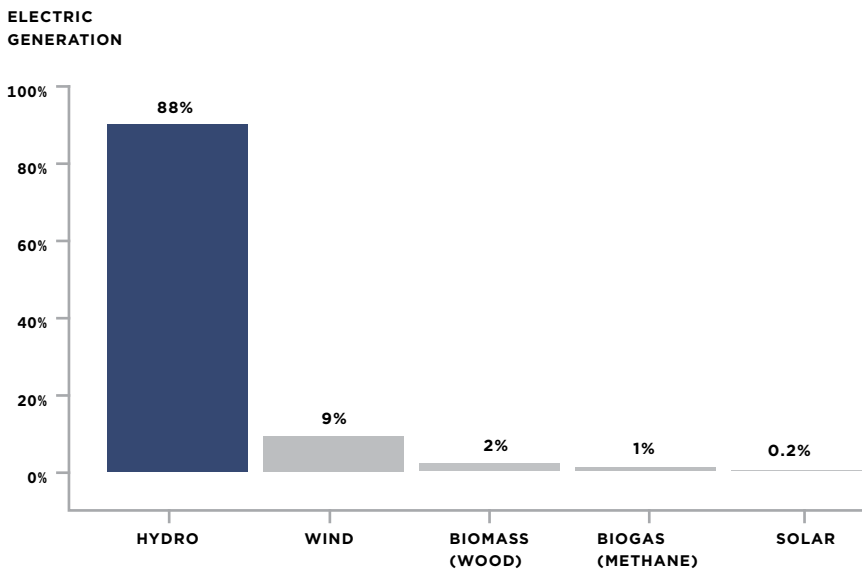
Notes: Assumes a rolling three-year average New York fossil fuel conversion factor for renewable electricity resources. Customer-sited renewable electricity primary energy consumption increased from less than 0.1 TBtu in 2001 to approximately 1.5 TBtu in 2011. In 2011, solar-PV accounted for approximately 1.0 TBtu. In 2011, biogenic waste for the commercial and industrial sector equaled approximately 3.8 TBtu while the electricity generation sector equaled 17 TBtu. There has been little variation in these values since 2001. Pumped Storage Hydropower is not included in the above values; in 2011, this amounted to 6.6 TBtu.

Sources: EIA. *State Energy Data System: New York, 2011*; NYSERDA. *Patterns and Trends: New York State Energy Profiles (1997–2011)*. June 2013.

Electric Generation (GWh by Resource)

In 2011, New York produced 31,413 gigawatt-hours (GWh) from renewable resources, representing 19 percent of the State's total electricity requirement. As shown in Figure 66, conventional hydropower provided 88 percent of the State's renewable electricity, followed by wind (9 percent), biogas and biomass (combined total of 3 percent), and solar (0.2 percent). In-State generation from renewable resources in 2012 is estimated at 30,630 GWh, representing 18.8 percent of the State's electricity requirements. Conventional hydropower contributes 80 percent of the renewable electricity (24,572 GWh), followed by wind (10 percent at 3,060 GWh), and other, which includes biogas, biomass, and solar (10 percent at 3,043 GWh).¹⁴

Figure 65 | 2011 New York Wholesale Electric Generation from Renewable Resources



Note: Does not include customer-sited generation.

Sources: EIA. *State Energy Data System: New York*, 2011; New York Independent System Operator (NYISO). *2011 Load & Capacity Data*, 2011.

14. NYISO. Load & Capacity Data "Gold Book." 2013. http://www.nyiso.com/public/webdocs/markets_operations/services/planning/Documents_and_Resources/Planning_Data_and_Reference_Docs/Data_and_Reference_Docs/2013_GoldBook.pdf

Table 11 illustrates how the percentage of New York's electricity requirement met by renewable resources can fluctuate from year to year, due to factors such as weather, economic conditions, and energy prices.¹⁵ For example, the output of hydroelectric plants is highly dependent on rainfall. Since conventional hydropower comprises most of New York's renewable electric generation, a significant decrease in total rainfall from one year to the next could result in a decrease in total renewable generation, even if the State's renewable generating capacity increased during that time.

Table 11A | 2011 New York Renewable Resources: Wholesale Electricity Generation (GWh) 2001 to 2005

SECTOR	2001	2002	2003	2004	2005
Hydro	21,486	24,612	24,207	26,745	26,204
Wind	21	82	41	116	103
Biomass (Wood)	283	206	192	211	253
Biomass (Methane)	284	198	205	209	329
Solar	n/a	n/a	n/a	n/a	n/a
Total Statewide Electricity Requirement	155,241	158,507	158,012	160,211	167,208
Total Generation from Renewable Resources	22,074	25,098	24,645	27,281	26,889
Percentage of Statewide Electricity requirement (In-State Only)	14.2%	15.8%	15.6%	17.0%	16.1%

15. Electricity requirement is the in-state electricity generation and net imports necessary to meet total end-use electricity demand, including system loss at the transmission and distribution levels.

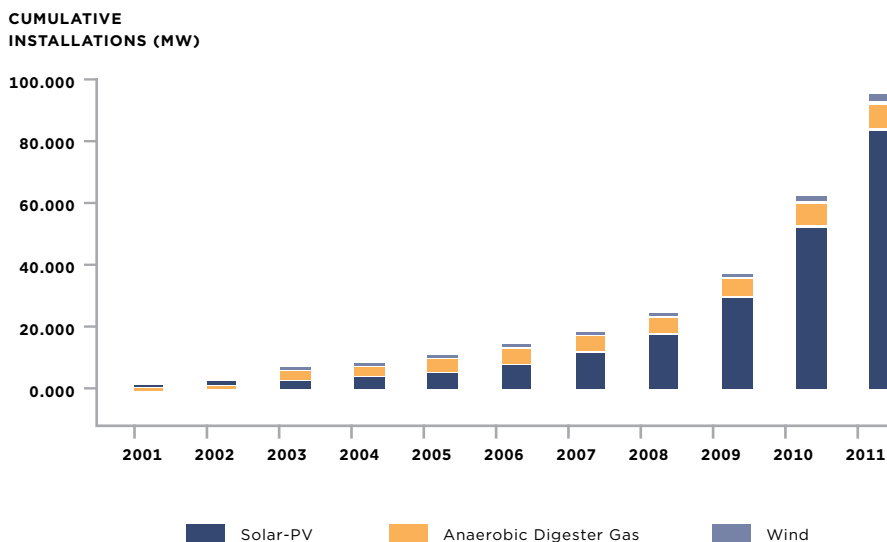
Table 11B | 2011 New York Renewable Resources: Wholesale Electricity Generation (GWh) 2006 to 2011

SECTOR	2006	2007	2008	2009	2010	2011
Hydro	27,110	24,184	25,711	26,420	24,214	27,634
Wind	655	833	1,251	2,266	2,596	2,828
Biomass (Wood)	260	256	560	340	315	210
Biomass (Methane)	326	397	533	648	708	735
Solar	n/a	n/a	n/a	n/a	n/a	7
Total Statewide Electricity Requirement	162,237	167,341	165,613	158,780	163,505	163,330
Total Generation From Renewable Resources	28,351	25,670	28,055	29,674	27,833	31,413
Percentage of Statewide Electricity Requirement (In-State Only)	17.5%	15.3%	16.9%	18.7%	17.0%	19.2%

Notes: Does not include imported renewable energy, out-of-state renewable energy attributes (acquired by New York citizens through green purchasing in the voluntary market), or customer-sited generation, which are included in assessments of compliance for the RPS. In 2011, biogenic waste for electricity generation was 1,878 GWh. There has been little variation since 2001. Pumped Storage Hydropower is not included in the above values; in 2011, this amounted to 721 GWh.

Sources: EIA. State Energy Data System: New York, 2011; *NYSERDA. Patterns and Trends: New York State Energy Profiles (1997–2011)*. June 2013.

Figure 66 shows New York's cumulative customer-sited renewable energy generation capacity for 2001 through 2011. As of 2011, approximately 90 percent of the customer-sited capacity consisted of solar-PV systems, and approximately 8 percent consisted of anaerobic digester gas (ADG) projects. This generation capacity was estimated to produce 157 GWh in 2011, less than 0.1 percent of New York's total electricity requirement.

Figure 66 | Cumulative Customer-Sited Renewable Energy Capacity (2001-2011)

Sources: NYSERDA, LIPA, and NYPA.

Potential of Renewable Energy

Technical Potential

The “pure” technical potential of a renewable resource can be estimated based on the available primary renewable resource without regard for cost, social, or engineering constraints. However, “pure” technical potential offers little guidance to policy makers since it does not present a practical assessment of resource use. In contrast, the bounded technical potential (BTP) for a given resource is an estimate of the total available thermal or electric energy based on consideration of the primary physical, social, and technological factors at play. The BTP provides a base for further economic analysis, but by itself does not account for the economic dimension. It does not account for societal or customer assessments of the costs and benefits of the required investments. An analysis of BTP has an important role in the energy planning process to help define alternative scenarios of the magnitude of renewable energy resources and available technologies, and to characterize the potential contributions towards meeting the State’s overall energy needs.

All Resources

If fully developed, the preliminary estimates of renewable resource BTP shown in Table 3 could meet nearly 18 percent of New York's projected primary energy needs in 2020, and 38 percent in 2030.¹⁶

Wind and solar resources provide the greatest potential for growth with hydro and biomass providing significant incremental resources, but lower growth. In comparison to 2011 when hydro and biomass are the dominant renewable resources, Table 12 illustrates that by 2030, renewable energy supplies in the State could be more evenly distributed across the four major resource categories.

Table 12 | Preliminary New York Renewable Energy Bounded Technical Potential (TBtu)

RESOURCE	IN-STATE TBtu USE (2011)	PERCENT OF TOTAL PRIMARY ENERGY USE (2011)	PROJECTED IN-STATE TBtu BOUNDED POTENTIAL (2020)	PERCENT OF PROJECTED TOTAL PRIMARY ENERGY USE (2020)	PROJECTED IN-STATE TBtu BOUNDED POTENTIAL (2030)	PERCENT OF PROJECTED TOTAL PRIMARY ENERGY USE (2030)
Hydro	254	6.9%	252	6.5%	340	8.6%
Bioenergy	73	2.0%	136	3.5%	220	5.5%
Wind	28	0.7%	96	2.5%	336	8%
Solar	0.1	0.002%	194	5%	595	15%
TOTAL	355	9.6%	677	18%	1,490	38%

Notes: Assumes a New York fossil fuel conversion factor for renewable electricity resources calculated from a three-year average. Bioenergy includes: (1) forestry- and agriculture-based sources of non-fossil plant materials that could be processed into various energy products; and (2) methane produced from the anaerobic decomposition of biogenic material from sources such as landfills, wastewater treatment plants, manure, and other agricultural byproducts, and food processing facilities. The bioenergy estimate does not include 48 TBtu of biofuel (ethanol) consumption in 2011 as ethanol is assumed to be created using out-of-state biomass.

Sources: Preliminary results from forthcoming NYSED report: *Energy Efficiency and Renewable Energy Resource Development Potential in New York State*; EIA. State Energy Data System: New York. 2012. NYSED. *Patterns and Trends: New York State Energy Profiles (1997–2011)*. June 2013. *New York State Renewable Fuels Roadmap*. 2010.

¹⁶. Preliminary results from Optimal Energy, Inc. *Draft Energy Efficiency and Renewable Resource Potential in New York State*. 2013.

Electricity (GWh)

It is expected that the RPS will lead to the further repowering of existing hydropower and the promotion of onshore wind energy, but additional wind potential exists beyond the expected growth, as preliminary results show in Table 13. The large estimate of BTP for renewable energy generation shows that a substantial percent, approximately 69 percent, of New York's electric needs could be met by in-state renewable resources; however, this assessment neither includes an estimate of the cost of introducing such a high level of intermittent resources into the electricity system nor provides an assessment of the supporting technology, such as energy storage, that may be required for resource integration. Furthermore, this preliminary assessment of biopower potential does not account for other competing uses of this resource, such as production of heat for residential and commercial buildings or conversion of biomass into transportation fuel.

Table 13 | Preliminary New York Renewable Energy Bounded Technical Potential Electricity Generation (GWh)

RESOURCE	IN-STATE GWh GENERATION (2011)	PERCENT OF STATEWIDE ELECTRICITY REQUIREMENT (2011)	PROJECTED IN-STATE GWh POTENTIAL (2020)	PERCENT OF PROJECTED STATEWIDE ELECTRICITY REQUIREMENT (2020)	PROJECTED IN-STATE GWh POTENTIAL (2030)	PERCENT OF PROJECTED STATEWIDE ELECTRICITY REQUIREMENT (2030)
Hydro	27,634	17%	27,858	16%	37,395	20%
Bioenergy	945	0.6%	2,473	1.4%	5,418	2.9%
Wind	2,828	2%	9,844	5.7%	32,906	18%
Solar	7	0.00%	18,919	11%	54,316	29%
TOTAL	31,413	19%	59,094	34%	130,035	69%

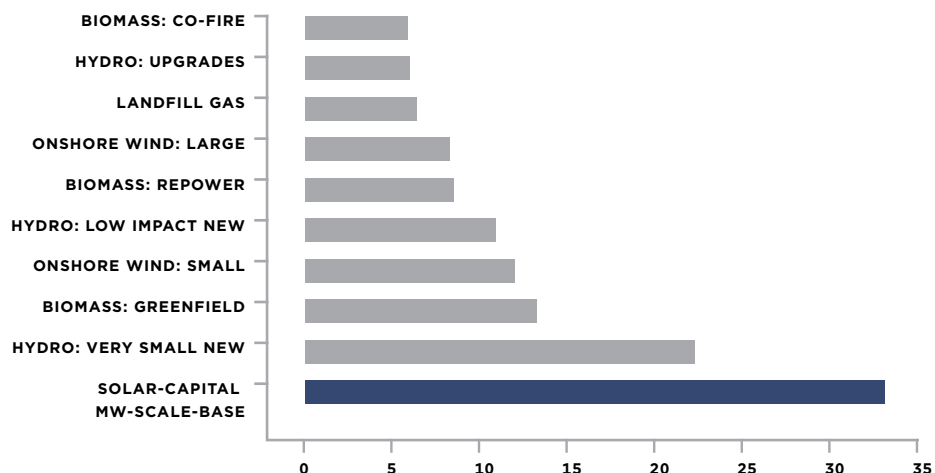
Notes: Bioenergy includes: (1) forestry- and agriculture-based sources of non-fossil plant materials that could be processed into various energy products; and (2) methane produced from the anaerobic decomposition of biogenic material from sources such as landfills, wastewater treatment plants, manure, and other agricultural byproducts, and food processing facilities.

Sources: Preliminary results from forthcoming NYSDERDA report: *Energy Efficiency and Renewable Energy Resource Development Potential in New York State*; EIA. State Energy Data System: New York. 2012; NYSDERDA. *Patterns and Trends: New York State Energy Profiles (1997–2011)*. June 2013.

Levelized Cost of Energy Comparison

This section provides a review of the levelized cost of energy (LCOE) comparison between renewable energy electricity generation technologies that was presented as part of the 2012 New York Solar Study.¹⁷ As shown in Figure 68, the least expensive resources in 2011 were co-fired and repowered biomass, hydropower upgrades, landfill gas, and large-scale onshore wind.

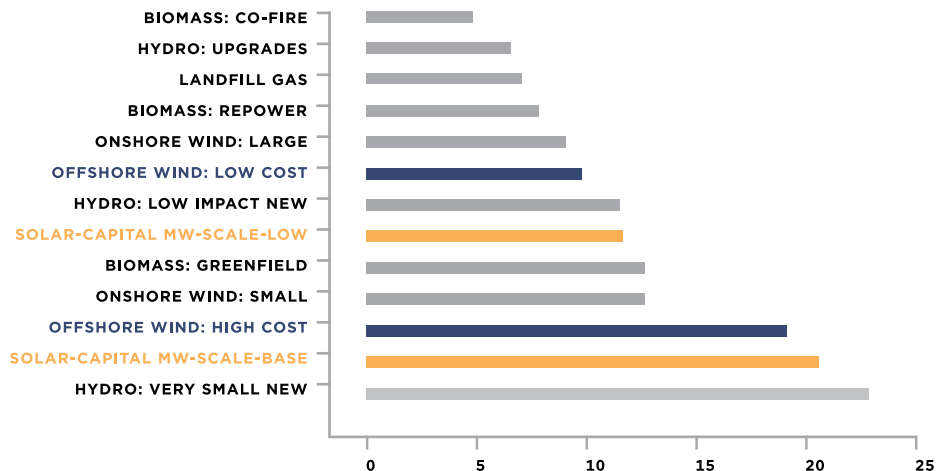
Figure 67 | Levelized Cost of Energy, by Technology for 2011 (2011\$ cents/KWh)



Source: NYSERDA. *New York Solar Study: An Analysis of the Benefits and Costs of Increasing Generation from Photovoltaic Devices in New York*. January 2012.

The least expensive technologies in 2011 are expected to continue to be the least-cost options through 2025 as shown in Figure 68. More expensive resources like utility scale solar-PV will not see sufficient cost declines to be competitive with wholesale prices on cost alone.

17. NYSERDA. *New York Solar Study: An Analysis of the Benefits and Costs of Increasing Generation from Photovoltaic Devices in New York*. 2012. <http://www.nyserra.ny.gov/Publications/Program-Planning-Status-and-Evaluation-Reports/Solar-Study.aspx>

Figure 68 | Levelized Cost of Energy, by Technology for 2025 (2011\$ cents/KWh)

Notes: Given the significant uncertainty surrounding forecasts for solar and offshore wind energy, this figure includes two scenarios for each resource. Results for these scenarios are color-coded (offshore wind is “blue” and solar is “yellow”) to show that the scenarios relate to the same resource.

Source: NYSERDA. *New York Solar Study: An Analysis of the Benefits and Costs of Increasing Generation From Photovoltaic Devices in New York*. January 2012.

It should be noted that LCOE provides a useful, but not comprehensive, metric for comparing the merits of renewable energy technologies. While LCOE is an effective tool to compare generating technologies that may differ with respect to up-front and ongoing costs, it does not account for the market value of production differences between renewable energy technologies. For example, energy produced by a solar-PV facility operating primarily during times of peak electricity consumption, and generates more during the summer than the winter is likely to have a higher market value than onshore wind energy. This generates a large portion of its output in the off-peak evening and nighttime hours, and generates more during winter than summer.

Technology Assessments

Hydropower

Conventional Hydropower and Pumped Storage

Conventional hydropower generation may use a dam to store river water in a reservoir which, when released, activates a generator to produce electricity, or it may use run-of-river facilities where an elevation drop produces electricity without a reservoir, e.g., the St. Lawrence Power Project. Output from run-of-river facilities is less predictable than output from facilities using dams. As of April 2011, New York had 345 conventional hydropower station units.¹⁸

Pumped storage plants are used to store energy to help meet peak electrical load. These facilities use electricity generated from traditional base load sources to pump water upward to a reservoir during off-peak hours, and they release the stored water to produce electricity during times of peak demand. Because energy from pumped storage plants is available during peak hours, these plants offer considerable value as reserve capacity. While these plants are net users of electricity, they actually contribute to reducing the State's total cost of producing electricity. As of April 2011, the State had five pumped storage station units.¹⁹

New York is the largest hydroelectric power producer east of the Rocky Mountains.²⁰ Hydropower produces the majority of energy generated from renewable resources in New York. In 2010, 15 percent of the statewide electricity requirement was met by in-state hydropower facilities, which represented 18 percent of the total amount of electricity produced within New York State.²¹ New York Power Authority (NYPA), the largest hydropower producer in the State, contributed 93 percent of the total hydroelectricity generation in New York in 2010.²²

The majority of electricity generated by hydropower plants stays within New York. The Federal Niagara Redevelopment Act, however,

18. NYISO. *Planning and Reference Documents: NYCA Generating Facilities*. 2012. http://www.nyiso.com/public/markets_operations/services/planning/documents/index.jsp

19. NYISO. *Planning and Reference Documents: NYCA Generating Facilities*. 2012. http://www.nyiso.com/public/markets_operations/services/planning/documents/index.jsp

20. NYISO. *Load & Capacity Data "Gold Book"*. 2011. http://www.nyiso.com/public/webdocs/services/planning/planning_data_reference_documents/2011_GoldBook_Public_Final.pdf

21. NYISO. *Load & Capacity Data "Gold Book"*. 2010. http://www.nyiso.com/public/webdocs/services/planning/planning_data_reference_documents/2010_GoldBook_Public_Final_033110.pdf

22. NYISO. *Load & Capacity Data "Gold Book"*. 2010. http://www.nyiso.com/public/webdocs/services/planning/planning_data_reference_documents/2010_GoldBook_Public_Final_033110.pdf

requires that NYPA sell a portion of this power outside of the State. While the Niagara Power Project is located in New York, the water drainage basin covers several states. The Niagara Power Project and the St. Lawrence-Franklin D. Roosevelt Power Project, which are both owned and operated by NYPA, export a total of approximately 270 MW of electric capacity to Connecticut, Massachusetts, New Jersey, Ohio, Pennsylvania, Rhode Island, and Vermont.²³

In the State, NYPA distributes low-cost hydropower through programs that promote economic development in New York. In 2011, the “New York Open for Business” initiative changed all statewide economic development programs, including ReCharge New York (RNY) to be incorporated into a single on-line Consolidated Funding Application (CFA).

RNY is a new 910 MW energy-based economic development program under which half of the power supplied will be from NYPA hydroelectric facilities. The other half will be purchased in the wholesale market. The power will be allocated to businesses in exchange for commitments to create and retain jobs in the State. RNY will provide allocations of low-cost power for up to seven years, stimulating the New York economy by encouraging long-term investment in New York.

Hydrokinetic and Other Advanced Technologies

Hydrokinetic systems generate electric power from freely flowing water. Unlike conventional hydropower facilities, which require either a dam or an elevation drop to produce energy, hydrokinetic systems produce power when turbines are placed below the water’s surface in tidal flows, rivers, canal systems, and wastewater treatment plants. While hydrokinetic energy is a promising renewable resource, the technology is still in the process of being commercialized²⁴ with active support by research, development, and demonstration efforts.

In order to complete a hydrokinetic project, a developer must first obtain a preliminary permit from the Federal Energy Regulatory Commission (FERC), which allows the developer to study the feasibility of a hydrokinetic project at an identified site. Once the feasibility of the project has been assessed, the developer then applies for a license to construct and operate a hydrokinetic facility.

23. NYPA. *Power Contracts Summary 4th Quarter*. 2010.

24. E3, Inc. (prepared for NYSERDA). *Sustainable Hydroelectric Energy Network (SHEN): Developing An Integrated Regional In-Stream Hydropower System Final Report*. 2004.

As of August 2013, there were seven proposed hydrokinetic projects in New York waterways that had been issued preliminary permits by FERC.²⁵ The proposed installed capacity of these projects totals approximately 15MW. There are currently no hydrokinetic projects in the State that have been granted a FERC license.²⁶

Wind Power

Land-Based Wind Power

The State ranks 12th in the nation in terms of existing wind capacity and 15th in potential wind capacity.²⁷ Large-scale wind capacity in New York at the end of 2012 is 1,363 MW, up from just 48 MW in 2001.²⁸

Offshore Wind Power

Currently, NYSERDA is conducting a comprehensive offshore wind energy cost and benefits study to assess the potential costs, ratepayer impacts, energy and capacity market impacts, environmental benefits, and net economic impacts to the State associated with plausible scenarios of future offshore wind energy deployment in the New York through 2025. Analysis conducted to date has shown that New York's offshore Atlantic wind resources are more synchronous with load and tend to be stronger and less intermittent than onshore resources.²⁹

The majority of the best offshore wind resources near New York's major load centers are in Atlantic Ocean waters under federal jurisdiction. The Department of Interior, through the Bureau of Ocean Energy Management (BOEM), leases the underwater lands controlled by the federal government for the development of renewable energy facilities.³⁰ The Department of State (DOS) is leading an ongoing analysis

25. Projects are required to obtain preliminary FERC permits to do feasibility studies and demonstrations and FERC licenses prior to the construction of commercial facilities.

26. Verdant Power is currently in the third and final phase of its Roosevelt Island Tidal Energy (RITE) Project, with a goal of installing 1 MW of commercially-deliverable hydrokinetic power in the East River. Verdant has been supported by \$2,994,756 of NYSERDA funds.

27. American Wind Energy Association. *Wind Energy Facts: New York*. 2012. <http://www.awea.org/learnabout/publications/factsheets/upload/3Q-12-New-York.pdf>

28. NYISO. *Load & Capacity Data Gold Book*. 2013.

29. NYSERDA [AWS Truepower, LLC; Geo-Marine, Inc.; and Energy and Environmental Analysts]. *Pre-Development Assessment of Meteorological and Oceanographic Qualities for the Proposed Long Island – New York City Offshore Wind Project Area*. 2010. <http://www.powernaturally.org/Programs/Wind/OffshoreWind.asp>

30. Under a joint agreement with FERC, BOEM leases federal underwater lands for both wind and hydrokinetic facilities but only issues licenses for wind facilities, while FERC issues licenses for hydrokinetic facilities.

of offshore areas that may be potentially suitable for wind development, in coordination with BOEM and other local, state and federal agencies, and authorities. In June 2013, DOS released the most comprehensive study to date of existing uses and natural resources in the Atlantic Ocean waters offshore New York as the first step in this siting analysis. By working in conjunction with regulatory agencies, any sites identified by DOS will be eligible for inclusion in the federal “Smart from the Start” program, which provides increased federal support for areas that have been pre-screened for potential project suitability. Under Smart from the Start, New York-selected sites could receive a streamlined federal regulatory process, eligibility for inclusion in research and development projects, and other forms of federal support.

The Long Island–New York City Offshore Wind Collaborative (the Collaborative), which includes NYPA, LIPA, and Con Edison, is evaluating the potential to develop between 350 and 700 MW of offshore wind capacity situated in a site approximately 15 miles off the south shore of the Rockaway Peninsula in the Atlantic Ocean. Preliminary technical and environmental studies evaluating the feasibility of the project in this site have been completed, and complement the siting analysis undertaken by DOS. In 2011, on behalf of the Collaborative, NYPA applied for a lease from BOEM for the proposed project site on the Atlantic Ocean’s outer continental shelf. The federal lease acquisition process also will initiate the required National Environmental Policy Act (NEPA) review process, and include opportunities for public review and input. Contingent on multiple factors regarding the viability of the proposed site, findings from the NEPA review, more detailed offshore wind and geological assessments, environmental impacts, and economic viability, the Collaborative intends to conduct a competitive solicitation to select one or more private entities to develop the project.

Wind Integration

To integrate increasing levels of wind power into the transmission system without compromising reliability, the NYISO instituted one of the first state-of-the-art wind forecasting systems in the United States in 2008. The forecasting system was developed by New York-based AWS Truepower, a company that grew with support from NYSERDA. Considered a best practice in the industry, the centralized system enables the NYISO to better use and accommodate wind energy by forecasting the availability and timing of wind-powered generation. Operators can instantly adjust generation supplies to meet the demand for electricity in real time as data are fed directly into NYISO's operational systems that balance load and generation.

A NYISO study conducted in 2010 determined that if New York increased wind energy capacity to 6,000 MW with the existing transmission system capability, 8.8 percent of the energy produced would be undeliverable. Two items deemed critical to wind integration are system flexibility, and the need for upgrades to transmission systems. The bulk power system will experience considerable ramping events and generation variability from greater quantities of wind. Resource planning must ensure that the bulk power system has sufficient flexible supply and demand resources, such as battery storage capability and off-peak load storage.

With upgrades to identified transmission lines and substations however, the amount of undeliverable wind energy could be reduced to less than 2 percent.³¹ Future adoption of advanced Smart Grid technology and processes that would support rapid system condition assessment also holds the potential to minimize undeliverable wind, precluding the need for traditional transmission line improvements.

Considerations for Future Wind Energy Use

Onshore wind power currently accounts for approximately 80 percent of the RPS-funded new renewable electricity generation in New York, and meeting the RPS target will depend on the continued development of wind power in New York. Meeting this target with wind power over the next few years will present some challenges.

Current economic conditions, financial market weakness, and uncertainty about federal renewable energy tax policy, has slowed the

31. NYISO. *Growing Wind: Final Report of the NYISO 2010 Wind Generation Study*. 2010.

pace of development of highly capitalized wind projects, or resulted in development at a higher cost. Adding to this, lower natural gas prices and wholesale electric market prices are placing upward pressure on the costs of achieving the RPS. Additionally, many attractive onshore wind sites have already been developed, and permitting at those that remain is becoming increasingly challenging.

Bioenergy

Biomass and its derivative products, such as biogas³² and liquid biofuels,³³ are organic, non-fossil plant materials initially produced through photosynthesis that are collectively known as bioenergy, and may be liquid, solid, or gaseous. The sources of bioenergy are diverse and can include wood and scrap forest materials, waste material from the forestry and pulp and paper industries, specialized energy crops, decomposed organic waste and the resulting methane stream, and liquid fuels derived from crops such as corn, sugar cane, and soybeans along with cooking oil, which can be processed into fuels like biodiesel.³⁴

Biomass also is used to produce non-energy goods and services, such as paper products, pharmaceuticals, and furniture. These applications are not analyzed in this report, though these alternative uses may reduce the actual potential available for the provision of energy services.

The uses of bioenergy are similarly broad, and include direct combustion to provide heat or generate electricity, the conversion of biomass into ethanol or biodiesel to create liquid fuels, and the use of methane gas, generated from on-farm anaerobic digestion of manure, as a primary fuel or for electricity generation. Table 14 shows New York's primary energy use attributable to bioenergy resources for 2001 through 2011.

32. Biogas is the gasified product of biomass or the methane produced from the anaerobic decomposition of biomass from sources such as landfills, wastewater treatment plants, manure and other agricultural byproducts, and food processing facilities.

33. Biofuels are liquids derived from biomass, through chemical, thermal, and biological processes. Ethanol and biodiesel are the dominant biofuels currently available and are the focus of this assessment. Biofuels typically are blended with petroleum products, e.g., ethanol with gasoline and biodiesel with diesel, and used as transportation fuels.

34. Another more challenging biofuel feedstock is "brown grease," which is waste collected from a restaurant's "grease trap." Similar to a septic tank, a grease trap separates grease from wastewater before it enters the sewage system.

Table 14A | 2001-2011 New York Primary Energy Use from Biomass and Biofuel Energy Resources (TBtu) 2001 to 2005

SECTOR	2001	2002	2003	2004	2005
Residential Biomass (Wood)	55.1	55.9	58.9	60.3	50.4
Commercial Biomass (Wood)	9.7	9.9	10.3	10.1	8.1
Industrial biomass (wood)	17.2	13.5	13.4	16.7	16.4
Transportation Biofuel (Ethanol)	0.4	0.3	1.9	23.9	7.9
Electricity Biomass (Wood)	2.8	2.0	1.9	2.1	2.5
Electricity Biogas (Methane)	2.8	2.0	2.0	2.1	3.3
TOTAL	88	83.7	88.4	115.3	88.6

Table 14B | 2001-2011 New York Primary Energy Use from Biomass and Biofuel Energy Resources (TBtu) 2006 to 2011

SECTOR	2006	2007	2008	2009	2010	2011
Residential Biomass (Wood)	44.7	48.2	52.9	50.5	49.4	50.5
Commercial Biomass (Wood)	7.5	8.0	8.4	8.4	8.3	8.1
Industrial biomass (wood)	15.4	14.5	12.3	12.4	13.5	13.6
Transportation Biofuel (Ethanol)	20.6	25.9	34.1	41.1	46.8	48.1
Electricity Biomass (Wood)	2.6	2.5	5.4	3.2	3.0	1.9
Electricity Biogas (Methane)	3.2	3.9	5.1	6.2	6.6	6.8
TOTAL	94	103	118.2	121.7	127.5	129.1

Notes: Assumes a rolling three-year average New York fossil fuel conversion factor for renewable electricity resources. In 2011, biogenic waste for commercial and industrial sectors was 3.8 TBtu, while electricity generation was approximately 17 TBtus. There has been little variation in any sector since 2001. Customer-sited renewable electricity primary energy consumption increased from less than 0.1 TBtu in 2001 to approximately 1.5 TBtu in 2011. In 2011, anaerobic digester gas accounted for approximately 0.5 TBtu.

Source: NYSERDA. *Patterns and Trends: New York State Energy Profiles (1997–2011)*. June 2013.

Bioenergy Electricity Generation

Forest product resources such as wood can be used to generate electricity at dedicated biomass plants and in co-firing applications where the biomass is used to supplement fossil fuel use at modified fossil fuel plants.³⁵ There are five central electric generation facilities in New York that currently use wood-based products as a fuel source (for a RPS bid capacity of 69 MW). Not included is the ReEnergy Black River plant located at Fort Drum, which was awarded an RPS contract for a bid capacity of 41 MW. The facility will switch from coal to biomass as the primary fuel, and is expected to be operational in 2013.³⁶

Bioenergy Electricity Generation: Landfill Gas

Depending on the age and ultimate size of a landfill, it may be economically feasible to collect and extract energy from landfill gas. Landfill gas is generated by the anaerobic degradation of organic wastes in a landfill. It typically is composed of approximately 50 percent methane, 49 percent carbon dioxide, and 1 percent other gases. The amount of gas produced depends on many factors, most notably the composition of the waste, and the conditions within the landfill. Landfill gas collection efficiencies range from 55 to 99 percent, depending on the design of the landfill and its operation.³⁷

Large landfills are required to install and operate equipment to capture and control landfill gas emissions within five years of waste placement.³⁸ This collection system is then expanded to newer areas of the landfill as its size grows. However, not all landfill gas is collected due to delays in system installation after initial waste placement, and potential leaks in the collection piping and the landfill cover. The collected gas can then be used to generate energy in a landfill-gas-to-energy (LFGTE) system, or combusted in a flare.

35. A variety of combustion technologies are available, including biomass stoker, which consists of a mechanical apparatus to continuously feed fuel into a boiler or furnace while optimizing air intake. Fluidized-bed repower technology uses biomass fuel in retired or existing steam units. The fluidized bed consists of a vessel containing a bed of solid particles, such as sand, through which air or another fluid is blown so that the fuel is suspended as it is combusted.

36. NYSEDA. *New York State Renewable Portfolio Standard Performance Report: Program Period ending December 2011*. 2012.

37. SCS Engineers. *Current MSW Industry Position and State-of-the-Practice on Landfill Gas Collection Efficiency, Methane Oxidation, and Carbon Sequestration in Landfills*,. 2007. http://www.scsenergyservices.com/Papers/FINAL_SWICS_GHG_White_Paper_07-11-08.pdf

38. U.S. Environmental Protection Agency. *Standards of Performance for New Stationary Sources and Guidelines for Control of Existing Sources: Municipal Solid Waste Landfills*. March 12, 1996. <http://www.epa.gov/ttn/atw/landfill/fr12mr96.pdf>

There are 25 LFGTE projects currently operating at landfills in New York. All together, approximately 19.5 billion cubic feet of gas was collected, or enough to produce 775,000 MWh of electricity.³⁹

Bioenergy Electricity Generation: Anaerobic Digester Gas

Beyond forest and agricultural products, New York's farms, municipal wastewater treatment plants, and food and beverage manufacturing facilities hold significant potential for biomass energy production in the form of anaerobic digester gas (ADG). ADG is generated by the anaerobic degradation of organic wastes, typically in glass-lined steel or concrete reactor vessels. ADG typically is composed of approximately 55 to 65 percent methane, 34 to 44 percent carbon dioxide, and 1 percent other gases. It can be used for distributed electric generation via combustion in engine/generators, microturbines, fuel cells, and other prime movers.

Between 2001 and 2011, 7.8 MW of customer-sited ADG electric generation was brought online in New York, representing approximately 8 percent of the total installed customer-sited renewable electric systems in the State during that time period. As of December 2011, NYSERDA had supported approximately 3.5 MW of farm and wastewater treatment facility-based ADG systems through the Renewable Portfolio Standard Customer-Sited Tier Anaerobic Digester Gas-to-Electricity Program.⁴⁰

Bioenergy Electricity Generation: Considerations for Future Use of Wastewater Treatment Anaerobic Digester Gas

Wastewater treatment plants are often located in communities with industrial facilities that produce significant quantities of organic wastes. These wastes can be processed economically via anaerobic digesters located at the plants. The amount of electricity generated by the biogas produced via digestion may exceed the plant's electricity demand, so some of the biogas may not be converted into useful energy.

To encourage the full use of biogas at wastewater treatment plants, the State could allow plants to net-meter electricity generation. Net-metering would increase the value of electricity production for the plant, thus improving the economics for industrial facilities operating in New York that produce organic wastes.

³⁹. The gas collected from the Fresh Kills landfill is not used to produce energy on site. Instead, it is conditioned and sold to a natural gas supplier, contributing approximately 1.3 billion cubic feet of natural gas to the natural gas market in New York State.

⁴⁰. NYSERDA. *Renewable Portfolio Standard Customer Site Tier Quarterly Reports*. 2011.

Non-Electric Bioenergy: Solid Biomass

New York residents use significant amounts of biomass, particularly wood, as a primary fuel. As shown in Table 5, there was a slight decrease in residential use of wood from 55 TBtu in 2001 to 50.5 TBtu in 2011. Commercial use of wood decreased from 10 TBtu in 2001 to 8 TBtu in 2011, while industrial use of wood decreased from 17 TBtu in 2001 to 13 TBtu in 2011.

Residential heating technologies used for biomass combustion include wood stoves, pellet stoves, hydronic heaters (boilers), pellet boilers, fireplace inserts, and masonry heaters. Commercial boilers range from stoker boilers burning green wood chips to staged-combustion boilers using pellets as fuel. Biomass heating is often an inefficient and high-emission process for fine particulates compared with oil, propane, or natural gas technologies. These high emissions not only cause plumes and elevated wood smoke in valleys, but for some locations, are significant enough to challenge the air quality attainment status for PM_{2.5}.

Advanced wood-boilers are entering the United States heating market slowly, and typically are low-mass i.e., low water volume in jacket, staged combustion designs with lambda sensors and variable-speed fan controls.⁴¹ For cord-wood-boilers, efficiency is maintained by the use of thermal-storage water tanks. With these systems, the boiler is fired under high load where its efficiency is greatest.

New York also has a significant in-state wood pellet manufacturing industry. The largest regional manufacturer is New England Wood Pellet, which has a 100,000-ton capacity plant in Schuylers and built a similar facility in Deposit in 2011.⁴² Curran Renewable Energy, located in Massena, built a plant in 2009 that also has a capacity of 100,000 tons of pellets per year.⁴³ The feedstock for these plants is primarily wood that would have been used in the pulp industry prior to its decline. Sawdust from lumber mills and furniture manufacturing facilities also serves as feedstock. Like the boiler manufacturing industry, expansion within

41. Lambda sensors measure the oxygen levels in the flue gas to determine the efficiency of the combustion process. These sensors can be used to maximize combustion efficiency by regulating air intake or rate of fuel introduction.

42. State of New York Office of the Attorney General. *Smoke Gets in Your Lungs: Outdoor Wood Boilers in New York State*. 2008. http://www.oag.state.ny.us/bureaus/environmental/pdfs/Smoke_Gets_in_Your_Lungs_Revised_March_2008.pdf

43. Curran Pellets. *Curran Renewable Energy Information*. 2011. http://www.curranpellets.com/documents/CurranRenewableEnergy_Information.pdf

the State's wood pellet industry is expected, as New York currently has a capacity of more than 550,000 tons per year of pellets and additional plants are under consideration.⁴⁴ A total of 550,000 tons of wood pellets is equivalent to 8.5 TBtu,⁴⁵ which represents 12 percent of the State's residential wood consumption in 2011.

Non-Electric Bioenergy: Considerations for Future Use of Solid Biomass for Heating

Currently, the method by which residential wood-boilers are tested, EPA Method 28 Wood Hydronic Heater, is inadequate for advanced technologies, presenting an important technology barrier. The advanced low volume, two-stage wood-boilers with external thermal storage will be regulated by EPA under the New Source Performance Standard for residential wood heaters. The lack of an appropriate test method could lead to blocking the advanced technology out of the market, and removing the technology-forcing competition that is needed to improve energy and emissions performance in this heating sector.

Brookhaven National Laboratory is developing a test method for advanced low volume, two-stage wood-boiler technology with external thermal storage with support from NYSERDA. This project, in cooperation with the EPA, should provide a robust methodology that evaluates boiler performance with respect to energy efficiency, fine particle emissions, and carbon monoxide (CO). New Source Performance Standard (NSPS), much higher performing technology should enter the residential market.

Because wood smoke can cause health problems and risks may be higher in regions with a high prevalence of wood heating, it will be important to develop the most efficient residential and commercial wood heating systems possible. This may include using advanced combustion designs with sensors and feedback controls for optimizing combustion and integration with thermal storage to maximize diurnal and seasonal efficiency, and minimize operation in low loads when efficiency is lowest and emissions are greatest. It also may be necessary to develop emission control technology for biomass heating systems given the high near-source exposure potential of biomass heat. Emission control technologies

44. NYSERDA. *Personal Communication with New York State Pellet Manufacturers*. October 2009.

45. Based on EIA's conversion factor of 17 MMBtu/ton. <http://www.eia.doe.gov/cneaf/solar.renewables/page/wood/wood.pdf>

are being developed now for the European market, and could be put to use in the U.S. as well.

Many aspects of wood chip and pellet production can impact the quality of the fuel that ultimately will affect the performance of the combustion appliance. Currently, there is only a voluntary industry pellet standard, and no standards for woodchips used for combustion in the U.S. Therefore development of a robust standard for both pellets and chips with proper quality assurance/control protocols is critical.

Non-Electric Bioenergy: Liquid Biofuels

The two most commonly used liquid biofuels are ethanol and biodiesel. While ethanol is almost exclusively used as a gasoline substitute in the transportation sector, biodiesel is used as a substitute for distillate fuels in the transportation, heating, and potentially the electric power generation sector. Biodiesel has begun to penetrate the residential home heating fuel market as blends of up to B5⁴⁶ are now certified as regular heating oil.⁴⁷ Furthermore, New York City has established a mandate that heating oil used after October 1, 2012, contain at least 2 percent biodiesel (B2).⁴⁸

The distribution infrastructure for transportation biofuels – ethanol and biodiesel – continues to grow in New York as federal and State support increases, and the fuels become more widely available. Approximately 28 biodiesel and seven ethanol distributors and terminals are operating in the State, seven of which receive State funding.

The number of biofuel retail stations, including stations that dispense E85 and blends of biodiesel up to B20, has grown dramatically in New York, due in part to favorable biofuel prices and State funding programs that promote new retail stations. Currently, at least 11 retail stations offer biodiesel blends, and 82 retail stations offer E85. New York has provided funding to 66 of these stations; 17 more stations are awaiting final funding approval.

Total annual ethanol use in New York grew to approximately 550 million gallons (48 TBtu) in 2011, or approximately 10 percent of the motor gasoline fuel mix, due in part to the phase-out of methyl tertiary

46. The format of the definition of a biofuel blend is 'BXX' or 'EXX', where 'B' = biodiesel and 'E' = ethanol, and 'XX' refers to the blend percentage by volume. For example, 'E85' refers to an 85 percent blend of ethanol with gasoline by volume.

47. Voegelé, Erin. *Biodiesel Magazine*. November 13, 2008. <http://www.biodieselmagazine.com/articles/2947/astm-publishes-biodiesel-standards>

48. Council of the City of New York. *Intro 194-A*. 2010. http://www.council.nyc.gov/html/pr/07_29_10_prestated.shtml

butyl ether (MTBE) in 2004. Most of this fuel was blended with gasoline to produce E10 and was sold as motor gasoline fuel. A small percentage (less than 0.5 percent) was sold as E85 and used in flexible-fueled vehicles. That percentage could increase in the near-term, however, since sales of E85 have been doubling annually in the past three years.

Though ethanol is currently being produced within New York, imports continue to make up the bulk of the ethanol consumed in the State. Corn-derived ethanol production in New York began in November 2007 with the opening of the Western New York Energy ethanol plant in Shelby, the uses 20 million bushels of corn to produce more than 55 million gallons of ethanol annually, along with animal feed, crude corn oil, and carbon dioxide (CO₂).⁴⁹

The State has supported the development of advanced cellulosic ethanol production. In 2006, New York provided Mascoma Corporation with \$14.8 million to construct and operate a pilot facility that is currently in its third year of optimizing ethanol production. Feedstocks tested in the facility have included locally sourced wood chips, paper-mill sludge, and switchgrass.

Non-Electric Bioenergy: Considerations for Future Liquid Biofuel Production in New York

Continued R&D along with investment in commercial-scale facility projects will be needed to bring cellulosic ethanol to price parity with gasoline. Private financing for production facilities is essentially non-existent in the current economic climate, and too frequent changes to long-term federal government programs such as the Biomass Crop Assistance Program⁵⁰ or the U.S. DOE Loan Guarantee Program have created economic and policy uncertainty. In addition, recent trends in federal policy regarding biofuels have moved away from gasoline substitutes and towards diesel substitutes.^{51, 52}

49. Western New York Energy. <http://www.wnyenergy.com/index.php?pr=Home>

50. U.S. Department of Agriculture Farm Service Agency. *Biomass Crop Assistance Program*. <http://www.fsa.usda.gov/FSA/webapp?area=home&subject=ener&topic=bcap>

51. Ethanol Producer Magazine. *Doe Places Dozens Of Loan Guarantee Applications On Hold*. <http://www.ethanolproducer.com/articles/7803/doe-places-dozens-of-loan-guarantee-applications-on-hold>. May 23, 2011.

52. U.S. DOE. *Report on the first Quadrennial Technology Review*. September 2011. http://energy.gov/sites/prod/files/QTR_report.pdf p. 60: "Diesel-powered heavy-duty vehicles will continue to use significant quantities of liquid fuel, making the development and deployment of alternative fuels for that sector a high priority. DOE will preferentially focus fuels research on the heavy-duty vehicle market, where electrification is not as effective."

New York's historic investment in the Mascoma cellulosic ethanol demonstration facility is one of the first pilot plants in the country, and has been serving as an ongoing research center, attracting millions of dollars in federal funding. Cellulosic ethanol technology is moving beyond the demonstration phase. Full-scale dedicated plants are under construction across the United States, and the corn ethanol industry has begun to explore ways to produce both corn ethanol and cellulosic ethanol at existing facilities. Through financial support, New York could attract private investment that would lead to the construction of next generation cellulosic ethanol facilities, creating jobs by locating new plants close to both supplies of New York biomass feedstocks, and large population centers that will use the product.

Funding is needed for research, development, and demonstrations of low-cost advanced biofuel pathways that use New York feedstocks. Further research is needed to consider multi-product integrated biorefineries that optimize use of biomass and maximize revenue streams. In addition, work is needed to optimize all aspects of biomass feedstock supply development.

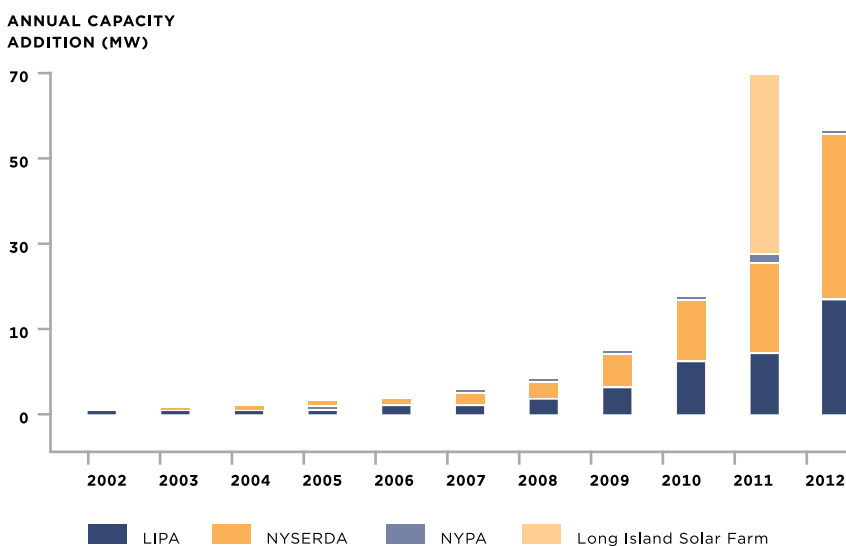
Solar Energy

For the purposes of this report, solar energy is classified into two separate categories: solar power and solar-thermal. Solar power refers to the conversion of sunlight into electricity either directly through solar-PV systems or indirectly by heating fluid used to operate electric generators that produce electricity for residential and commercial use. Solar-thermal energy is a general term for solar energy that is used to meet non-electrical demands such as the heating of domestic water and space heating and cooling.

Solar Power: Electric Generation Using Solar-PV

Supported by State and federal incentives and a growing workforce, the New York solar-PV market has grown from less than 1 MW in 2002 to a 60 MW market in 2012, as shown in Figure 69. The cumulative installed capacity by the end of 2011 was approximately 180 MW. Approximately 30 percent of this capacity is installed on Long Island, including a 32 MW solar farm installed at Brookhaven National Laboratory. Long Island is an advantageous location for implementation of this technology because of its southernmost location in the State, its relatively high electricity rates, and the availability of customer incentives.

Figure 69 | Annual PV Capacity Additions in New York (2002-2012)



Note: The LIPA “Long Island Solar Farm” bar consists of a single 32 MW-AC installation at Brookhaven National Laboratory.

Sources: NYSED, LIPA, and NYPA

Solar-Thermal Use⁵³

Through the third quarter of 2011, NYSED has incentivized approximately 225 solar-thermal domestic hot water systems, with an average installed cost of \$12,360. Each system saves single-family homeowners an average of 3,110 kWh annually. At the same time, 22 commercial/industrial and multi-family buildings have received

⁵³. Unless otherwise noted, all solar-thermal data comes from EIA.

incentives to install solar-thermal hot water systems, with an average installed cost of \$39,600, saving 12,980 kWh annually.

Solar Energy Cost Analysis

As reported in the New York Solar Study, solar-PV prices have declined significantly in the past decade.⁵⁴ Supported by stable incentive programs and favorable ancillary policies, costs in New York have followed this trend with average prices in 2003 at \$8.11 per watt, while systems installed in 2011 averaged \$6.38 per watt. For the Solar Study, three PV cost cases were developed, representing projected High-, Low-, and Base-Case installed costs. The High-Cost Case was derived based on the national average annual PV system price decline over the past decade. The Base-Case was developed from the results of a 2009 U.S. DOE PV expert survey, while the Low-Cost Case was an adaptation of the DOE's SunShot initiative. Under the Base-Case trajectory, residential systems for non-New York City sites declined from \$6.70 per watt to \$3.10 per watt in 2025, while costs for these systems under the Low Cost Case declined to \$2.00 per watt in 2025. Similarly, small commercial systems in upstate New York declined from \$6.30 per watt in the 2010 analysis year to \$3.00 per watt in 2025. Under the Low-Cost Case, installed costs for these systems declined to \$2.00 per watt in 2025. In comparison, MW-scale systems in the upstate region declined from \$4.40 per watt to \$2.50 and \$1.40 per watt in the Base- and Low-Cost Cases, respectively.

An often-stated solar-PV strategy is to support the above-market technology until the cost of solar-PV achieves "grid parity." A solar-PV installation is said to reach "grid parity" when lifetime average energy costs equal the retail cost of power purchased from the grid. Although grid parity is frequently assumed to be the point when solar-PV will be widely adopted, some policy intervention will likely still be necessary to increase market demand.

The New York Solar Study examined energy costs for a range of system types and installation load zones, considering installed cost trajectories, financing assumptions, and federal policy scenarios, throughout the 2011 to 2025 analysis period. The energy cost modeling was highly sensitive to federal incentives and solar-PV cost assumptions. Modeling showed that retail grid parity will be reached in different

⁵⁴. NYSERDA. *New York Solar Study: An Analysis of the Benefits and Costs of Increasing Generation from Photovoltaic Devices in New York*. 2012. <http://www.nyserda.ny.gov/Publications/Program-Planning-Status-and-Evaluation-Reports/Solar-Study.aspx>

regions of New York in different years, with areas of the State that have better solar-PV resources and higher electricity prices reaching grid parity before areas with relatively poor solar-PV resources and lower energy prices. Small commercial systems in New York City would reach retail grid parity in 2017 in the Low Cost Case, with upstate installations approaching retail grid parity by 2025. None of the scenarios in this analysis showed solar-PV cost competitive with wholesale electricity generation before 2025.

Considerations for Future Solar Energy Use

Both solar-thermal and solar-PV systems have substantial up-front capital costs. The 2008 New York State Renewable Energy Task Force report acknowledged that, even for situations where a solar-thermal system presents a positive net-present value, the up-front capital cost of a solar domestic hot water system may present a barrier to widespread adoption, necessitating financial support to increase deployment.

As module and collector prices decline, the balance of system costs (both ‘hard’ and ‘soft’) become a significant component of the total installed cost. Greater attention to balance-of-system cost reductions will be required for solar technologies to be competitive with conventional forms of energy.

New York has a number of existing incentive and market transformation programs funded by the SBC, RPS, RGGI, LIPA, and NYPA funds. Solar technologies also received support through the federal government’s 2008 decision to extend the Solar ITC for eight years and remove the \$2,000 cap, permitting the full use of the 30 percent credit. This decision sent an important signal of support to both the solar-PV and solar-thermal marketplaces.⁵⁵ At the State level, the development of financing programs also can serve to make resources available to interested end-users that lack sufficient initial funding. The development of new solar-PV leasing business models offers a solution to the challenge of high up-front costs as the leasing companies provide financing that

55. The federal ITC covers costs including labor costs properly allocated to the onsite preparation, assembly, or original installation of the property and for piping or wiring to interconnect such property to the home. In October 2008, President Obama signed the Emergency Economic Stabilization Act of 2008 to encourage investments in solar energy, including eight-year extensions of the business and residential ITC. Internal Revenue Service for 5695, *Residential Energy Efficiency Property Credit*. 2008. <http://www.irs.gov/pub/irs-pdf/f5695.pdf> Solar Energy Industries Association. *Solar Investment Tax Credit Frequently Asked Questions*. 2008. <http://www.seia.org/policy/finance-tax/solar-investment-tax-credit>

covers the installation costs; however, continued State incentives are required to make this model viable in the near-term. In his 2013 State of the State address, Governor Cuomo pledged to create a “Green Bank” in the State. The Green Bank would leverage public funding with private-sector money to spur investment in clean energy. NYSERDA is currently assessing market conditions, and determining financing needs and opportunities related to this effort.

Along with financial incentives, the DOE’s Solar Energy Technologies Program recommends the following steps to reduce solar-PV balance-of-system soft costs: streamlining solar permitting, facilitating interconnection to the grid, encouraging homeowner associations to limit restrictions against solar technologies, establishing installer and code official training centers, and creating public outreach and information campaigns. In New York, reducing system soft costs includes coordination with local government on permitting, and building and fire codes.

New York City was designated a Solar America City in June 2007 under DOE’s Solar America City Initiative. The NYC Solar America City Partnership, led by Sustainable CUNY, is comprised of the City University of New York, the New York City Economic Development Corporation, and the Mayor’s Office of Long-term Planning and Sustainability. The Partnership has been working together with key stakeholders, including Con Edison, NYC Department of Buildings, NYPA, and NYSERDA to support large-scale solar energy market growth in NYC.⁵⁶ NYSERDA has provided support for creation of the New York City Solar Map and the designation of NYC Solar Empowerment Zones, as well as helping fund the prototype portal for the Rooftop Solar Challenge.⁵⁷

Currently, net metering is available for solar-PV for all classes of customers, with equipment size limits for each customer class and a cap on total net metering available in each utility service territory. Time-differentiated rates are mandatory for high-energy use commercial and industrial customers (hourly pricing), and voluntary for all residential customers (time-of-use (TOU) or time-of-day (TOD) rates) under New

56. CUNY. *Groundbreaking Project to Accelerate Solar Adoption in NYC Announced at NYC Solar Summit*. 2012. <http://www1.cuny.edu/mu/sustainable-news/2012/06/07/groundbreaking-project-to-accelerate-solar-adoption-in-nyc-announced-at-nyc-solar-summit/>

57. NYSERDA. *NYC Wins Department of Energy “SunShot” Award to Make Solar Energy Cost Competitive*. 2011. <http://www.nyserda.ny.gov/About/Newsroom/2011-Announcements/2011-12-09-NYC-Wins-Department-of-Energy-SunShot-Award-to-Make-Solar-Energy-Cost-Competitive.aspx>

York utilities' tariffs. However, lower use non-residential customers are not mandated to take service under hourly pricing and some do not have access to a voluntary TOU/TOD rate similar to the one offered to residential customers.

Since solar-PV generation has a reasonably strong correlation with peak rate periods, there is an added value and credit associated with net-metered PV generation served under time-differentiated rates. Solar net metering customers who cannot take advantage of these rates are thereby disadvantaged, compared to those customers who have access to time-differentiated rates. Plans to extend mandatory hourly pricing and voluntary TOU/TOD rates to lower usage commercial and industrial customers are already under way. Extending voluntary TOU/TOD rates to those non-residential customers, who currently cannot avail themselves of time-differentiated rates, would increase the value of solar-PV installations, to and further develop the solar-PV market for those customers.

New York is in the very early stages of embracing “community solar,”⁵⁸ which is expected to provide consumers new points of market entry and lower costs from economies of scale. Community solar enables those whose homes or buildings are not well-suited for rooftop or ground-mounted solar systems to benefit from larger, community-sited systems. Community solar is also seen as a means to enable owners of condominiums and co-ops to more readily participate in the PV market – and therefore as a means to increase participation in PV incentive programs within the New York City region. Community solar may need to be enabled through changes to remote net metering law or other policies. In all likelihood, there will be a need for support and funding for the development of standards and pilot community PV projects.

Geothermal Energy

In this report, geothermal energy refers to two different uses of the earth's thermal properties: supporting the generation of electric power and the transfer of heat to or from a building. Geothermal power is the generation of electric power from heat stored below the earth's surface

58. Clean Energy Authority. *Arista launches Solarize Genesee Campaign in New York*. 2013. <http://www.cleanenergyauthority.com/solar-energy-news/arista-launches-solarize-genesee-campaign-0107013>; Your Industry News. *Arista Power Launches Community Solar Purchasing Program for Hornell, New York*. 2013. http://www.yourindustrynews.com/arista+power+launches+community+solar+purchasing+program+for+hornell,+new+york_85907.html

in the form of hot water, hot rocks, or lava. New York does not currently generate electricity from geothermal resources. A geothermal heat-pump, or ground-source heat-pump, is an electrically driven heat-pump that uses the nearly constant temperature of the earth, instead of outside air, to heat or cool a building's air or water supply. The use of a geothermal heat-pump often is classified as an energy efficiency measure, as it requires less electricity than a traditional air-source heat-pump, and can result in significant energy savings for installations that displace fossil fuels.

Geothermal Heat-Pumps

In New York, installations have ranged from single-family homes to hotels and 500,000-square-foot office buildings. The NYSERDA-supported installation at Sullivan County Community College (SCCC) provides an example of a school application. Under its New York Energy \$martSM program, NYSERDA provided SCCC with a \$250,000 incentive that helped pay for the \$4.4 million geothermal heat-pump installation, which provides heating and cooling to 170,000 square feet of space in ten buildings including offices, classrooms, kitchens, libraries, and a faculty lounge.⁵⁹ It is expected that the geothermal system will save SCCC more than 420,000 kWh a year. The New York Energy \$martSM New Construction Program provided funding for a municipal installation at the Tannery Pond Community Center that included a geothermal heat-pump system. Along with high-efficiency windows, a super-insulated building shell, and an air-to-air recovery system, the pump will help the Center reduce its energy use by 140,733 kWh per year.⁶⁰

Through the first quarter of 2012, NYSERDA has incentivized the installation of 192 geothermal heat-pump systems in single-family homes, resulting in an average annual savings of 98 MMBtu per system. Over the same period of time, NYSERDA has incentivized the installation of 32 geothermal cooling systems in single-family homes, saving 350 kWh on average.

While geothermal heating and cooling systems can provide significant energy savings, equipment, and installation costs can pose a barrier for many consumers. In New York, there currently are program incentives through NYSERDA and federal tax credits that consumers can

59. NYSERDA. *Sullivan County Community College Invests in Geothermal Heat-pump System*. 2002.

60. NYSERDA. *North Country Community Center Implements Energy-Efficiency Measures*. 2009. <http://www.nyserda.ny.gov/Publications/Case-Studies/-/media/Files/Publications/Case-Studies/NCP/tannery-pond-community-center-cs.ashx>

take advantage of to defray some of the costs. Residential consumers are eligible for a federal tax credit of 30 percent of the cost of the geothermal system; while commercial, industrial, and agricultural customers are eligible for a corporate tax credit of 10 percent of the cost of the system. In addition to tax credits, customers are eligible for financing support through NYSERDA programs.

In 2009, customers in New York received approximately 5.4 percent of all national shipments of geothermal heat-pump equipment capacity.⁶¹

Geothermal Power Potential

In 1996, NYSERDA and the DOE commissioned a study to assess the potential for geothermal electric power generation in New York.⁶² The study found that most of the potential for geothermal energy use in the State would be associated with space and water heating, given the generally lower quality heat resource at reasonable depths throughout the State. The study concluded that, while there is potential for geothermal electric power in upstate New York, primarily through the use of binary cycle conversion systems, the high cost of these systems relative to other technologies that generate electric power continues to inhibit development.

Several other studies sponsored by NYSERDA concluded that the hydro-geothermal energy potential in Western and Central New York is largely comparable to that of other regions possessing porous/permeable units of sedimentary rock at sufficient depth to contain formation waters of useful temperatures (>140 °F). The prime reservoir candidates are the Theresa and Potsdam Sandstones in the Lower Ordovician-Cambrian section lying below the Knox Unconformity. These sandstones have porous zones that are estimated to be of reservoir quality at least 100 feet thick. These studies concluded that a hydro-geothermal resource has two primary characteristics: 1) pore fluids in the target formation are heated to a useful temperature, and 2) the permeability of the target formation permits a pumping rate of pore fluids that yields economic quantities of heat energy at the surface. Other characteristics that bear on the ultimate viability of the resource are water chemistry and the hydraulic head of the formation fluids.

61. EIA. *Geothermal Heat Pump Shipments by Destination: 2008 and 2009*. 2010. http://www.eia.gov/renewable/annual/geothermal/xls/table4_6.xls

62. Dyncorp Information & Engineering Technology, Inc. (prepared for NYSERDA). *Assessing Geothermal Energy Potential in Upstate New York*. 1996.

These studies primarily focused, however, on the potential for using these relatively low-temperature geothermal settings for use as sources for heating and other low-grade process heat for industrial or agricultural applications, not for use in generating power.

The Renewable Portfolio Standard

The Renewable Portfolio Standard (RPS) was initially adopted in 2004 by the New York State Public Service Commission (PSC) Order Regarding Retail Renewable Portfolio Standard Policy.⁶³ The 2004 Order called for an increase in the proportion of retail renewable energy used by New York electricity consumers from the 2013 forecasted electricity baseline of 17.3 percent to at least 25 percent by 2013, and established an RPS Program administered by NYSERDA.⁶⁴ Objectives for the program included generation diversity; economic development; and improvements in New York's environment. In 2010, following a comprehensive mid-course review⁶⁵ of the initial RPS program and a subsequent PSC Order,⁶⁶ the renewable energy goal was expanded from 25 percent to 30 percent, and the terminal year extended from 2013 to 2015, thus formalizing a goal of the 2009 State Energy Plan. This goal was translated into an RPS Program target equaling 10.4 million MWh of new annual generation.

The 2004 Order set forth a funding source that established a non-bypassable wires charge, based on consumption, to be applied to all customers subject to the already established System Benefits Charge (SBC). The PSC recognized that, to reach the renewable energy goals, additional efforts would be required by entities not subject to the SBC⁶⁷ and “strongly encour[aged]” them “to voluntarily participate in and adopt

63. DPS. Case 03-E-0188. *In the Matter of a Renewable Portfolio Standard, Order Regarding Retail Renewable Portfolio Standard Policy*. September 24, 2004. <http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7BB1830060-A43F-426D-8948-F60E6B754734%7D>

64. The renewable electricity resources baseline in 2004 was 19.3% and was forecasted to decline to 17.3 percent by the year 2013 in Table 1 of Appendix D of the 2004 Order (Renewable Portfolio Standard Order Cost Analysis), based on long-term forecasts available at that time. Historical baseline percentages reported in this document are of a similar order of magnitude, but differ from the Appendix D forecasts because they are dependent on river conditions and system load characteristics in each specific year.

65. DPS. Case 03-E-0188. *In the Matter of a Renewable Portfolio Standard, The Renewable Portfolio Standard: Course Report*. October 26, 2009. <http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7B230CE88F-60A5-475B-A24A-6FC9B2780DEF%7D>

66. DPS. Case 03-E-0188. *In the Matter of a Renewable Portfolio Standard, Order Authorizing Customer-Sited Tier Program Through 2015 and Resolving Geographic Balance and Other Issues Pertaining to the RPS Program*. April 2, 2010. <http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7BC05CD0D6-8EA5-4CB9-A9FA-6ADD3AECB739%7D>

67. These entities included New York City municipal customers, NYPA, and LIPA.

comparable efforts to increase the percentage of renewable resources these entities use....”⁶⁸

The expected contributions of various components of the RPS goal are detailed below.

- Existing baseline renewable resources will provide approximately 70 percent of the RPS goal, or 31.5 million MWh. The existing baseline consists mostly of hydroelectric generation, including large hydropower plants at Niagara Falls and on the St. Lawrence River, Canadian hydropower imports⁶⁹, and 300 smaller hydropower plants, as well as a few biomass facilities.
- The RPS Program, administered by NYSERDA, is responsible for procuring the targeted amount of new renewable energy, of approximately 10.4 million MWh. The RPS Program targets were revised in the Mid-Course Review Order to account for substantial decreases in electricity use through the implementation of various energy efficiency measures by 2015. The revised tables reflecting the changes in the RPS goal are contained in the April 2010 Customer-Sited Tier (CST) Order. The expanded RPS Program targets assume that sustained and aggressive renewable energy expansion targets in New York will be achieved in parallel with the pursuit of lower electricity load growth consistent with the ‘15 by 15’ efficiency policy goal.
- Pursuant to Executive Order 111 (EO 111), commitments made by other State agencies and authorities will contribute approximately 0.3 million MWh towards the goal. EO 111 was an ongoing effort by State entities to satisfy up to 20 percent of their energy needs with renewable energy.⁷⁰
- While not required by the Order to meet RPS targets, LIPA is committed to expanding its own renewable energy profile. LIPA programs may contribute up to 1.9 million MWh by 2015.
- Consumers in the voluntary market are estimated to provide 1.5 million MWh by 2015. The voluntary market provides opportunities for

68. DPS. *Case 03-E-0188. In the Matter of a Renewable Portfolio Standard, Order Regarding Retail Renewable Portfolio Standard Policy*. September 24, 2004. <http://documents.dps.state.ny.us/public/Common/ViewDoc.aspx?DocRefId=%7BB1830060-A43F-426D-8948-F60E6B754734%7D>

69. The RPS baseline includes 2,250 MW of Canadian hydropower imports into New York.

70. Governor Andrew Cuomo signed Executive Order No. 88 on December 28, 2012, directing State agencies and authorities to improve the energy efficiency of State buildings. The Order established a target for reducing the average energy use intensity (EUI) in State-owned and managed buildings by 20 percent, by April 1, 2020. The Order also revokes and supersedes Executive Order No. 111, originally signed in 2001.

customers to voluntarily pay a “green” premium to purchase renewable electricity through their utilities or marketers and brokers.

RPS Program

The expanded RPS Program, adopted in 2010, remains administered by NYSEERDA, and retains the two tiers of resource types. The “Main Tier” consists primarily of medium- to large-scale electric generation facilities that deliver electrical output into the wholesale power market. The CST consists of smaller, “behind-the-meter,” end-use technologies that generate power used primarily at the site where the technology is installed. NYSEERDA administers the RPS Program for the PSC, purchasing the renewable attributes for contract-defined periods, while the energy is sold into the wholesale market (Main Tier) or net metered at retail rates (CST).

For the purpose of ensuring the continuing operation of existing baseline resources, the PSC established an additional “Maintenance Resource” category as a subset of the Main Tier.⁷¹ To be eligible to receive RPS Program funding as a maintenance resource, a baseline resource is required to demonstrate financial hardship through a formal request to the PSC. In 2010, the PSC created a “Geographic Balance” category as a subset of the CST.⁷² The Geographic Balance category was intended to encourage additional customer-sited projects for larger-scale solar-PV, anaerobic digester and fuel-cell projects in NYISO Zones G, H, I, and J to help address overall geographic balance in the RPS program, as well as examine the potential for performance-based incentives for customer-sited facilities in a bid environment. In 2012, the PSC expanded the Geographic Balance program to include upstate regions in an effort to implement the Governor’s NY-Sun Initiative.

Table 15 shows the RPS targets along with progress to date and the expected generation under contract in 2015. The expected generation under contract by 2015 represents 85 percent of the generation target. The total additional ratepayer cost to achieve the full RPS Program target

71. DPS. Case 03-E-0188. *In the Matter of a Renewable Portfolio Standard, Order Regarding Retail Renewable Portfolio Standard Policy*. September 24, 2004. <http://documents.dps.state.ny.us/public/Common/ViewDoc.aspx?DocRefId=%7BB1830060-A43F-426D-8948-F60E6B754734%7D>

72. DPS. Case 03-E-0188. *In the Matter of a Renewable Portfolio Standard, Order Authorizing Customer-Sited Tier Program Through 2015 and Resolving Geographic Balance and Other Issues Pertaining to the RPS Program*. April 2, 2010. <http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7BC05CD0D6-8EA5-4CB9-A9FA-6ADD3AECB739%7D>

would range from \$0.6 to \$2.5 billion depending on the level of federal support; see Table 9 for supporting details.

Table 15 | RPS Program Targets and Progress

TIER	MWh TARGET	MWh PROGRESS AS OF DECEMBER 31, 2012	EXPECTED MWh UNDER CONTRACT BY 2015
Main Tier	9,519,765	4,486,656	8,186,656
Customer-Sited Tier	878,089	287,972	878,089
TOTAL	10,397,854	4,774,628	9,064,745

Note: “MWh Target” reflects an increased Customer-Sited Tier target due to increased solar-PV generation as part of NY-Sun Initiative, and a reduction in the Main Tier target to preserve the combined target for 2015. “Expected MWh” estimated based on the budget from planned collections and a reallocation of Main Tier funds to support the expanded four-year increased solar-PV generation target as part of NY-Sun. The Main Tier estimates are based on updated cost-curve analysis that excluded new out-of-state renewable attribute procurements. The analysis also assumed that the federal Production Tax Credit (PTC) continues beyond 2013. The expected Main Tier achievement would be reduced to a total of 7,486,656 MWh if the PTC is phased-out over five years, starting in 2015.

Source: For progress, see NYSERDA. *The New York State Renewable Portfolio Standard Performance report, Through December 31, 2012*. March 29, 2013. Revised Targets based on PSC. *Case 03-E-0188: Order Authorizing the Expansion of the Solar Photovoltaic and Geographic Balance Programs from 2012 Through 2015 and the Reallocation of the Main-Tier Unencumbered Funds*. April 24, 2012. Expected MWh based on NYSERDA analysis.

Main Tier

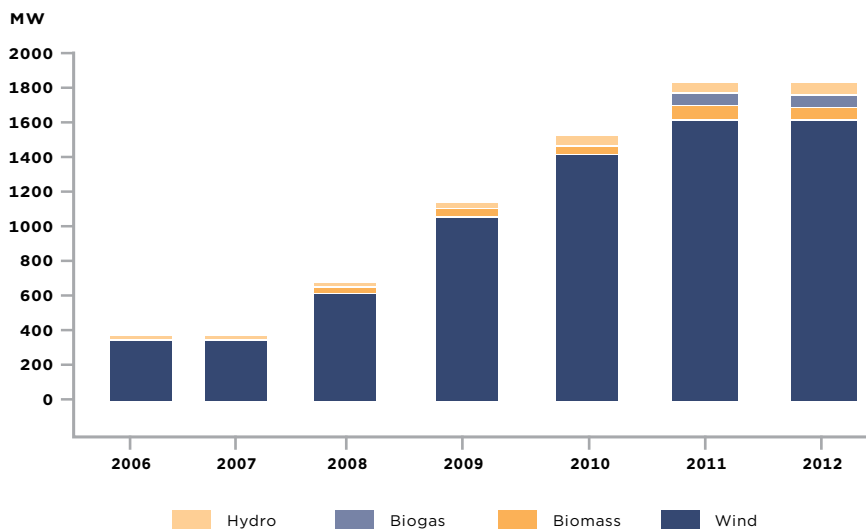
The Main Tier currently supports a variety of resources, including large onshore wind farms, biomass plants, and repowered or upgraded hydropower plants.⁷³ Figure 71 shows the contracted cumulative installed nameplate capacity, by technology, for Main Tier projects that have been funded by the RPS.⁷⁴ As shown in Figure 71, onshore wind comprises most of the capacity. Through December 31, 2011, NYSERDA conducted seven competitive solicitations in pursuit of the Main Tier renewable energy procurement target. From the seven solicitations, NYSERDA currently has contracts with electricity generators for 56 projects.

⁷³. Eligible resources in the Main Tier include biogas, biomass, liquid biofuel, fuel cells, hydroelectric, solar-PV, ocean or tidal power, and wind. Out-of-state resources also are included to support interstate commerce, promote energy-supply security and diversity, and allow the State to acquire resources sufficient to meet its renewable energy goals at the lowest cost.

⁷⁴. Nameplate capacity is the maximum output rating of a generator.

In 2015, Main Tier facilities contracted through December 2012 are expected to produce a total of 4.49 GWh, which represents approximately 46 percent of the Main Tier RPS Program target.

Figure 70 | Contracted Cumulative RPS Program Main Tier Installation Capacity (2006-2012)



Notes: Hydropower data refer to “new renewable capacity,” or the increase in facility capacity attributable to the upgrade that makes them eligible for the RPS. Biomass data represent the portion of the facility expected to burn or co-fire biomass. In 2011, out-of-state facilities include: 26.0 MW of Wind, 14.7 MW of Hydro, and 6.4 of Biogas. Figure does not include Maintenance Resources.

Source: NYSERDA

Customer-Sited Tier

Customer-Sited Tier (CST) solicitations have been issued for five technologies (solar-PV, solar-thermal, fuel-cells, anaerobic digester generators, and small wind), offering funding support on a first-come, first-served basis through a combination of capacity “buy-down” and energy production incentives. CST solicitations have been held continuously since April 2007 for each of the eligible technologies.⁷⁵ In the PSC’s April 2010 CST Order, solar-thermal resources were added to the then-existing eligible technologies, which were solar-PV systems, anaerobic digesters, small wind turbines, and fuel cells. The PSC also created a new subset of CST projects in the Geographic Balance category.

⁷⁵ Note that solar-thermal was not an eligible technology until 2010.

Through December 31, 2011, these CST programs have supported the installation of more than 73 MW of customer-sited capacity. Including all projects under contract or with contracts pending the total capacity is more than 160 MW. The total expected annual generation from this total capacity is more than 287,972 MWh, which represents approximately 33 percent of the RPS CST Program cumulative target for 2015, after adjusting for an increased solar-PV target. More than 85 percent of the expected annual generation comes from two sources, anaerobic digester gas at 112,746 MWh, and solar-PV at just over 160,000 MWh of electricity.⁷⁶

NY-Sun Initiative

In his January, 2012 State of the State message, Governor Cuomo announced the NY-Sun Initiative, an expansion of the State's solar-PV programs. The goals of the NY-Sun Initiative are to install twice as much customer-sited solar-PV capacity in 2012 as was added in 2011 and to quadruple the 2011 amount in 2013. Those goals are expected to, be achieved through an expansion of the State's existing solar programs and solar sales tax exemption. In addition, NY-Sun will fund projects designed to reduce PV balance-of-system costs.⁷⁷

As shown in Figure 5, the combined effort of NYSERDA, LIPA, and NYPA in 2012 led to the installation of more than 58 MW of PV in New York, approximately 97 percent of the NY-Sun 2012 goal. An additional 132 MW of PV was under contract or in the application process as of the end of 2012, leading to a combined total of 190 MW of PV either installed or under development, more than triple the 2012 goal.

Long Island Power Authority Programs

LIPA has undertaken several efforts that promote generation of electricity from renewable resources. Since 2000, LIPA has been aggressively investing in and promoting the use of solar PV on the customer side of its meters for residential customers (Solar Pioneer) and, beginning in 2009, for commercial customers (Solar Entrepreneur). Through its Solar Pioneer and Solar Entrepreneur programs, LIPA offers

76. NYSERDA. *The New York State Renewable Portfolio Standard, Through December 31, 2011*. 2012. <http://www.nyserdera.ny.gov/Publications/Program-Planning-Status-and-Evaluation-Reports/-/media/Files/Publications/PPSER/NYSERDA/2012-RPS-annual-report.ashx>

77. *NY-Sun*. <http://ny-sun.ny.gov/>

rebates for the installation of solar PV systems for residential homes, businesses, schools, municipal buildings, and not-for-profit entities.

Since its inception in 2000, LIPA's solar programs have provided rebates of more than \$121 million for the installation of 4,937 PV systems at total nameplate capacity of 38.52 MW (DC), or a total of more than 44,500 MWh (AC) annually in LIPA's service territory as of December 31, 2011.

In May 2012, for the fourth time in five years, the LIPA was named among the top 20 utilities in the U.S. with the most solar electricity integrated into their energy mix by the Washington, D.C.-based Solar Electric Power Association (SEPA), ranking 4th in the Eastern Region, and 9th in the U.S.

As part of the NY-Sun Initiative, LIPA's CLEAN Solar Initiative (LIPA's CSI) was approved by the Board in June of 2012 to advance the development of solar energy, and the growth of clean energy jobs on Long Island.⁷⁸ In the pilot program, LIPA's CSI is a "standard offer," performance-based initiative to purchase up to 50 MW of solar generation to be located on customers' premises through June 30, 2014. LIPA's CSI supplements existing purchases from utility-scale solar facilities that were completed in 2011 and under development in 2012 as well as LIPA's Solar Pioneer and Solar Entrepreneur Programs. To participate in LIPA's CSI, a customer's site must provide more than 50 kW of solar-PV generation.

The Backyard Wind Initiative was introduced in January 2009 to provide rebates to homeowners, businesses, municipalities, and non-profits for the installation of wind systems on Long Island. LIPA has received 26 applications to date, including: 9 residential, 2 school districts, 1 commercial and 14 farm service customers for a total of 625 kW, and more than \$1,300,000 in wind rebates.

In late 2010, LIPA launched its Residential Solar Hot Water program targeting electric hot water customers.

Utility Scale Solar Photovoltaic

LIPA has a contract with Long Island Solar Farm (LISF, an affiliate of BP Solar) for a 32 MW solar-PV generating facility sited at the federal Brookhaven National Laboratory. Construction of the project commenced

78. LIPA. *LIPA Board of Trustees Approve First Feed-In Tariff Program in New York State*. 2012. <http://www.lipower.org/newscenter/pr/2012/062812-fit.html>

in December 2010 and commercial operation began in November 2011. This project is among the largest, if not the largest, solar system at a federal facility, and will be providing renewable power directly back to LIPA's grid. Additionally, this utility-scale solar-PV project provides another way for scientists and researchers at Brookhaven National Laboratory to research and advance renewable energy, and to include solar power in their R&D portfolio.

LIPA also has a contract with the Eastern Long Island Solar Project (ELISP, an affiliate of enXco) for up to 17 MW of solar carport facilities on various sites owned by Suffolk County.

Offshore Wind

LIPA is participating in Long Island-New York City Offshore Wind Collaborative (LI-NYC), in collaboration with NYPA, and Con Edison. See the Wind Energy section for more details.

New York Power Authority Programs

Solar-Photovoltaic Programs

NYPA and NYSERDA have developed the Solar Market Acceleration Program (Solar MAP), to be an integral component of the Governor's NY-Sun initiative and target solar energy cost reductions.⁷⁹ Solar MAP is an extension of NYPA's solar R&D program, which has played a leadership role in building New York's solar industry over the last 25 years. Solar MAP has a total budget allocation of up to \$30 million over five years, and will fund solar research and project activity in three main areas: innovation research grants, demonstration projects, and soft-cost reduction strategies.

Since the early 1990s, NYPA has played a major role in developing and expanding the New York solar industry with more than 100 installations to date, totaling approximately 1.8 MW of capacity, including the State's first large-scale solar-PV projects dating back to the early 1990s.

In fall 2009, NYPA launched the Municipal and Rural Electric Cooperative Solar-PV Incentive Program. The Program makes small PV project installations in NYPA customers' service territories more cost-effective. While originally opened to all 51 municipal systems and

⁷⁹ NYPA. *Solar Market Acceleration Program (Solar Map)*. 2012. <http://www.nypa.gov/solar/solarmap.htm>

rural cooperatives, there are currently 12 participating utilities. As of December 2011, a total capacity of 375 kW had been installed through this program.

Offshore Wind

On September 15, 2011, NYPA, on behalf of the LI-NYC, initiated the process to obtain a lease by submitting a preliminary lease application with BOEM. Should NYPA be granted lease rights, NYPA intends to assign its lease rights, through a competitive process, to a project developer who is expected to take over all financial obligations associated with the lease. See the Wind Energy section for more details.

Voluntary Market

In New York, voluntary customers include residential customers as well as public and private entities, ranging from public authorities such as the Port Authority of New York and New Jersey, to municipalities such as Suffolk County and New York City. Private entities purchasing renewable energy voluntarily in New York include non-profit organizations as well as businesses such as the Bank of New York Mellon.

Customers in the voluntary market procure renewable energy in three primary ways: purchasing out-of-state Renewable Energy Credits (RECs),⁸⁰ enrolling in a utility or Energy Services Company (ESCO) green pricing program, or on-site installation of a renewable energy project with either direct ownership or hosting and off-take agreements. Renewable energy is commonly traded as two separate products: the electricity itself, which is indistinguishable from any other electricity in the grid, and the environmental attributes associated with the renewable generation. A REC represents the title to and claim for the environmental attributes associated with 1 MWh of energy generated from a renewable resource. Because RECs are purchased separately from power, they can be produced and traded without geographic ties. Thus, a customer can support renewable energy development without purchasing the power itself. In lieu of purchasing RECs, customers may also enroll in utility green-pricing programs in regulated markets, purchase renewable energy

⁸⁰ While RECs are not recognized in New York's RPS compliance market nor tracked in its Environmental Disclosure Program labels, some marketers sell out-of-state RECs to customers that purchase them to reduce their carbon (and other pollutant) footprint. Currently, NYSDERDA and other parties are working to create a New York Generation Attribute Certificate (NYGAC) tracking system, which would include a formal New York market for RECs. This effort is slated for completion in 2014.

from their default supplier, or purchase green power from an ESCO in deregulated markets. Green-pricing programs and ESCOs sell renewable energy as a single-bundled product, and typically allow customers to purchase green power for a certain percentage of their electricity needs, or in discrete amounts (known as blocks) at a fixed price.

Certification of Renewable Energy

While most compliance markets have delineated resource eligibility requirements and established accounting practices, the voluntary market is less defined and transparent. This has given rise to third-party certification programs such as the non-profit Center for Resource Solutions' Green-e Energy program. To be Green-e Energy-certified, a renewable energy product must undergo a thorough annual verification procedure to ensure that it has been properly accounted for, and originates from a facility that meets the requirements of the Green-e Energy National Standard.

Green-e Energy is the nation's leading voluntary certification program for renewable energy. In 2011, total retail sales of Green-e Energy certified products exceeded 27 million MWh, a 21 percent increase from 2010.⁸¹ Consumers in New York are the second largest purchaser of Green-e Energy-certified products, accounting for 9 percent of national retail sales.⁸² In New York, renewable energy purchases are verified by DPS through the Conversion Transaction Process. To be eligible for conversion transaction, the energy must be delivered into New York, have a vintage post January 1, 2003, and may not be double-counted. Renewable energy purchases are reflected in the Environmental Disclosure labels produced by DPS for each retail supplier.

Complementary Policies and Activities

Power NY Act of 2011: Article X

In 2011, Governor Cuomo signed into law the Power NY Act, a comprehensive energy bill that re-establishes and revises Article X of the New York State Public Service Law. The new Article X law provides power generation developers a more streamlined “one-stop” siting process that will assist project development efforts. The old Article 10,

81. Center for Resource Solutions. *2011 Green-e Verification Report*. January 31, 2013. [http://green-e.org/docs/2011 Green-e Verification Report.pdf](http://green-e.org/docs/2011%20Green-e%20Verification%20Report.pdf)

82. Center for Resource Solutions. *2011 Green-e Verification Report*. January 31, 2013. [http://green-e.org/docs/2011 Green-e Verification Report.pdf](http://green-e.org/docs/2011%20Green-e%20Verification%20Report.pdf)

which expired on January 1, 2003, was limited to power plants with 80 MW or more of nameplate-generating capacity. The new Article X law reduces the capacity threshold to 25 MW, thereby allowing smaller generation projects, such as wind, solar, and other renewable project developers, an opportunity to take advantage of the streamlined siting process.

State Incentives

New York policy makers have long recognized that public incentives are needed to advance, improve, and mainstream innovative renewable energy technologies. In addition to exempting residential solar-thermal and solar-PV systems from sales tax,⁸³ New York provides incentives for these systems, as well as fuel-cell systems, with personal income tax credits. The tax credit for solar systems is equivalent to 25 percent of system costs and is capped at \$5,000; while the tax credit for fuel-cell systems is equivalent to 20 percent of system costs and is capped at \$1,500. The State also has a personal income tax credit for the residential use of Bioheat®, i.e., heating oil that contains biofuel.⁸⁴ The tax credit is equivalent to \$0.01/gallon for each percent of biodiesel, and is provided up to the first 20 percent of biodiesel that is blended with conventional fuel; and thus the tax credit is capped at \$0.20/gallon. A full list of State incentives can be found at the Database of State Incentives for Renewables and Efficiency (DSIRE) website: <http://www.dsireusa.org/>.

State R&D Activities

New York will continue its commitment to renewable R&D, which is a critical component to achieving a clean energy economy. NYSERDA's R&D Program has supported the development and commercialization of innovative energy and environmental products, technologies, and processes since 1975. The New York State Foundation for Science, Technology, and Innovation, formerly the Office of Science, Technology, and Academic Research (NYSTAR), also supports technology development and commercialization with particular focus on the assistance that New York's colleges and universities can provide to private-sector companies in the clean energy sector. For example, the

⁸³. The exemption applies to both purchase and installation costs. It does not apply to solar thermal pool systems or other like applications. NY CLS Tax, Article 28 § 1115 (ee).

⁸⁴. NY CLS Tax, Article 22 § 606 (mm). Extended to 2017 with passage of bill S06039

Center for Advanced Technology (CAT) in Future Energy Systems at Rensselaer Polytechnic Institute conducts R&D on new energy systems and energy efficiency, including solar-PV systems, fuel cells, cellulosic ethanol, smart lighting, and advanced materials. Another example is the Advanced Energy Center at the State University of New York at Stony Brook, which is working with other universities around the State to provide a comprehensive set of services to various business sectors active in Smart Grid technology development and deployment. These services include assistance with R&D needs as well as providing a center for validation and verification of product functions and capabilities.

The American Council for an Energy Efficient Economy (ACEEE) recently awarded NYSERDA's leadership in energy efficiency and R&D saying, "NYSERDA has been one of the world's leaders in innovative ideas and R&D for energy efficiency concepts and technologies for the industrial, commercial, and residential sectors. NYSERDA has worked hand-in-hand with the private sector, fostering a robust energy services sector that has created jobs, and generated significant energy cost savings for New Yorkers."⁸⁵ NYSERDA's R&D program has also designed initiatives to create an entrepreneurial climate for renewable and clean business "start-ups" that will help them grow quickly from technology clusters to full-fledged companies that relocate to or remain in New York. The goals of the initiative include reducing the barriers to entry for renewable and clean energy technology business start-ups, and investing in a technically-talented workforce and technologies that would enable start-ups to build entrepreneurial growth companies. This support provides access to nearly all of the resources – capital, technology, mentoring, and customers – needed to build a successful new business. These activities, when coupled with a portfolio of programs in product development and business innovation, are expected to establish a long-lasting capacity in New York to nurture the success and expansion of early-stage clean energy companies.

Federal Policies and Incentives

According to the U.S. Energy Information Administration (EIA), in 2010 the federal government provided \$8.2 billion in tax expenditures to support renewable energy, which made up approximately 56 percent of all federal support for renewables. In total, the federal government

85. Silverstein, Alison. *ACEEE GALA RECEPTION AWARDS*. 2010. <http://www.aceee.org/files/pdf/conferences/30th/policyanalysis/galaremarks.pdf>

provided \$14.7 billion in support for all renewable energy projects, which constituted 39 percent of all federal energy funding for that year and included tax expenditures, R&D, and federal electricity support.^{86, 87}

The two major types of federal financial support for wind energy that come from the federal government include the Production Tax Credit (PTC), and accelerated depreciation through the Modified Accelerated Cost Recovery System (MACRS). The PTC for wind is set to expire at the end of 2012. Under MACRS for wind, the qualified cost basis of the equipment is depreciated over a five-year period, with approximately 50 percent of cost expensed out two years after installation. MARCS was expanded in 2010 so that property placed in service after September 8, 2010, and before the end of 2012, also qualifies for 100 percent first-year bonus depreciation.

The Energy Independence and Security Act of 2007 (EISA)⁸⁸ created a number of new programs to fund and increase the use of renewable fuels. EISA accelerated the schedule for effectuating the Renewable Fuel Standard (RFS) first enacted in the Energy Policy Act of 2005. The RFS now mandates the sale of 9 billion gallons of renewable fuels in 2008; 36 billion gallons of renewable fuels in 2022; and 21 billion gallons of which must be cellulosic ethanol or other advanced biofuels.

Solar technologies also received support through the federal government's 2008 decision to extend the Solar Investment Tax Credit for eight years, and remove the \$2,000 cap, permitting the full use of the 30 percent credit. This decision sent an important signal of support to both the solar-PV and solar-thermal marketplaces.⁸⁹

The policies, regulations, and other activities established at the federal level have a profound impact on the ability of the State to

^{86.} EIA. *Direct Federal Financial Interventions and Subsidies in Energy in Fiscal Year 2010*. 2011. <http://www.eia.gov/analysis/requests/subsidy/pdf/subsidy.pdf>

^{87.} A full list of federal incentives can be found at the Database of State Incentives for Renewables and Efficiency (DSIRE) website: <http://www.dsireusa.org/>.

^{88.} Public Law 110 - 140.

^{89.} The federal ITC covers costs including labor costs properly allocable to the onsite preparation, assembly, or original installation of the property, and for piping or wiring to interconnect such property to the home. In October 2008, the President signed the Emergency Economic Stabilization Act of 2008 to encourage investments in solar energy, including eight-year extensions of the business and residential ITC. Internal Revenue Service for 5695. Residential Energy Efficiency Property Credit. 2008. <http://www.irs.gov/pub/irs-pdf/f5695.pdf>; Solar Energy Industries Association. Solar Investment Tax Credit Frequently Asked Questions. 2008. <http://www.seia.org/policy/finance-tax/solar-investment-tax-credit>

advance its renewable energy goals.⁹⁰ Potentially the most significant current federal policy discussion related to energy pertains to the future electricity generation fuel mix. Despite the encouragement of the current federal administration, Congress has failed to pass comprehensive energy reforms or national standards for renewable resources. Absent such action, other federal regulatory efforts regarding fuel extraction, emissions regulation, and even transmission planning will continue to affect the generation mix, and the availability of renewable resources in a piecemeal fashion.

90. Importantly, through the Coastal Zone Management Act, New York can review and either concur with or deny listed federal actions and authorizations, based on their reasonably foreseeable effects on the State's coastal resources. A federal agency must determine that its direct federal action pursuant to 15 C.F.R. Part 930 Subpart C is consistent to the maximum extent practicable with the enforceable policies of New York's Coastal Management Program (CMP). Activities requiring federal authorizations, licenses, and permits must be fully consistent with the State's enforceable policies under 15 C.F.R. Part 930 Subpart D.





Acronyms

AASHTO

American Association of State
Highway and Transportation Officials

Ag&Mkts

New York State Department of
Agriculture and Markets

ARRA

American Recovery and
Reinvestment Act

ASHRAE

American Society of Heating,
Refrigerating, and Air-Conditioning
Engineers

bbl

Barrel

Bcf

Billion Cubic Feet

Board

State Energy Planning Board

Btu

British Thermal Unit

CAFE

Corporate Average Fuel Economy

cf

Cubic Feet

CHP

Combined Heat and Power

CO₂

Carbon Dioxide

CUNY

City University of New York

DEC

New York State Department of
Environmental Conservation

DER

Distributed Energy Resources

DG

Distributed Generation

DHSES

Division of Homeland Security &
Emergency Services

DOE

U.S. Department of Energy

DOH

New York State Department of
Health

DOL

New York State Department of Labor

DOS

New York State Department of State

DOT

New York State Department of
Transportation

DPS

New York State Department of Public
Service

Dt

Dekatherm

EAG

Evaluation Advisory Group

ECL

Environmental Conservation Law

ECWG

Energy Coordinating Working Group

EEPS

Energy Efficiency Portfolio Standard

EIA

U.S. Energy Information
Administration

EISA

Energy Independence and Security
Act of 2007

EM&V

Evaluation, Monitoring, and
Verification

Energy Code

Energy Conservation Construction
Code

EO

Executive Order

EPA

U.S. Environmental Protection
Agency

ESCO

Energy Service Company

ESD

Empire State Development

FERC

Federal Energy Regulatory
Commission

GEIS

Generic Environmental Impact
Statement

GHG

Greenhouse Gas

GJGNY

Green Jobs–Green New York

GW

Gigawatt

GWh

Gigawatt Hour

HCR

New York State Homes and
Community Renewal

Hg

Mercury

HVAC

Heating, Ventilation and Air
Conditioning

IECC

International Energy Conservation
Code

kW

Kilowatt

kWh

Kilowatt Hour

LDC

Local Distribution Company

LEED

Leadership in Energy and
Environmental Design

LEV

Low Emission Vehicles

LIHEAP

Low Income Home Energy
Assistance Program

LIPA

Long Island Power Authority

LNG

Liquefied Natural Gas

Mcf

One Thousand Cubic Feet

MMBtu

Million British Thermal Units

MMcf

Million Cubic Feet

mpg

Miles per Gallon

MPO

Metropolitan Planning Organization

MTA

Metropolitan Transportation
Authority

MW

Megawatt

MWh

Megawatt Hour

NAAQS

National Ambient Air Quality
Standards

NOx

Nitrogen Oxides

NRC

U.S. Nuclear Regulatory Commission

NY BEST

New York Battery and Energy Storage
Technology Consortium

NYCEDC

New York City Economic
Development Corporation

NYISO

New York Independent System
Operator

NYPA

New York Power Authority

NYSERDA

New York State Energy Research and
Development Authority

OEM

Office of Emergency Management

OGS

Office of General Services

OMH

Office of Mental Health

PANYNJ

Port Authority of New York and New
Jersey

PHEV

Plug-in Hybrid Electric Vehicle

Plan or SEP

State Energy Plan

PM

Particulate Matter

PPA

Power Purchase Agreement

PSC

Public Service Commission

PSL

Public Service Law

PV or Solar-PV

Solar Photovoltaic

REC

Renewable Energy Credit

REDC

Regional Economic Development
Council

RFS

Renewable Fuel Standard

RGGI

Regional Greenhouse Gas Initiative

RNA

Reliability Needs Assessment

ROI

Returns on Investment

RPS

Renewable Portfolio Standard

SBC

System Benefits Charge

SEQRA

State Environmental Quality Review
Act

SGEIS

Supplemental Generic Environmental
Impact Statement

SO₂

Sulfur Dioxide

SPDES

State Pollution Discharge Elimination
System

STARS

New York State Transmission
Assessment and Reliability Study

SUNY

State University of New York

SWP

System-Wide Program

T&MD

Technology and Market Development

TBtu

Trillion British Thermal Units

Th

Therm

TOD

Transit Oriented Development

U.S. DOH

U.S. Department of Health

U.S. DOL

U.S. Department of Labor

U.S. DOT

U.S. Department of Transportation

VMT

Vehicle Miles Traveled

VOCs

Volatile Organic Compounds

WAP

Weatherization Assistance Program

Glossary

A

Alternative Fuel Vehicles

Vehicles which use fuels other than gasoline or diesel. Alternative fuels include electricity, natural gas, propane, ethanol, vegetable and waste-derived fuels, and hydrogen. These fuels may be used in a dedicated system that burns a single fuel, or in a mixed system with other fuels including traditional gasoline or diesel, such as in hybrid-electric or flexible fuel vehicles.

Anaerobic Digestion

A natural process that converts biomass to gas under oxygen free conditions. The resulting gas is principally composed of methane and carbon dioxide and is referred to as Anaerobic Digester Gas (ADG).

Ancillary Services

Services pertaining to the electricity system that are necessary to support the transmission of electric power from seller to purchaser given the obligations of control areas and transmitting utilities within those

control areas to maintain reliable operations of the interconnected transmission system. Ancillary services include reactive power, voltage control, frequency regulation, and blackstart capability, among others.

B

Barrel (bbl)

Unit of volume equal to 42 U.S. gallons which is traditionally used to quantify crude oil.

Billion Cubic Feet (bcf)

Measure of volume commonly used for natural gas.

Biodiesel

An alternative fuel that can be made from any fat or vegetable oil. It can be used in any diesel engine with few or no modifications. Although biodiesel does not contain petroleum, it can be blended with diesel at any level or used in its pure form.

Bioenergy

Biomass and its derivative products, such as biogas and liquid biofuels, are organic, non-fossil plant materials initially produced through photosynthesis that are collectively known as bioenergy and may be liquid, solid, or gaseous.

Biofuels

Liquids derived from biomass, through chemical, thermal, and biological processes. Ethanol and biodiesel are the dominant biofuels currently available and are the focus of this assessment. Biofuels typically are blended with petroleum products, e.g., ethanol with gasoline and biodiesel with diesel, and used as transportation fuels.

Biogas

The gasified product of biomass or the methane produced from the anaerobic decomposition of biomass from sources such as landfills, wastewater treatment plants, manure and other agricultural byproducts, and food processing facilities.

Biomass

Solid organic, non-fossil plant materials initially produced through photosynthesis. The types of biomass are diverse and can include wood and scrap forest materials, waste material from the forestry, food, and pulp and paper industries, specialized energy crops, and crops such as corn, sugar cane, and soybeans.

British Thermal Unit (Btu)

The amount of heat required to raise the temperature of one pound of water one degree Fahrenheit. This unit provides a common denominator for quantifying all types of energy on an equivalent energy content basis.

See also MMBtu (million Btu) and TBtu (trillion Btu).

Byproduct

A secondary or incidental product of a manufacturing or other process.

C

Capacity

The maximum capability of an energy system or component of that system to either produce or move energy at or within a specific time frame. Within the context of electricity, capacity is commonly expressed in megawatts (MW), and means the maximum amount of power that can be generated at any given time. Natural gas capacity usually refers to the maximum cubic feet of gas that can be transported by a pipeline within an hour or within a day. In the context of petroleum, capacity can refer to either the maximum amount of product that can be moved through a pipeline or the maximum product that can be processed in a refinery.

Carbon Dioxide

A colorless, odorless noncombustible gas with the formula CO_2 that is present in the atmosphere. It is predominantly formed by the combustion of carbon and carbon compounds (such as fossil fuels and biomass), by respiration (which is a slow combustion in animals and plants), and by the gradual oxidation of organic matter in the soil.

Climate Change

As defined by the Intergovernmental Panel on Climate Change (IPCC), climate change refers to any change in climate over time, whether due to natural variability or as a result of human activity. It is extremely likely that human influence has been the dominant cause of observed warming since the mid-20th century.

Coal

A readily combustible black or brownish-black rock composed largely of carbonaceous material. It is formed from plant remains that have been compacted, hardened, chemically altered, and metamorphosed by heat and pressure over geologic time.

Coke

A solid carbonaceous residue derived from coal by a high-temperature baking process. Coke is used as a fuel and as a reducing agent in smelting iron ore in a blast furnace.

Combined Cycle Generation

A relatively highly efficient type of generating facility in which a gas

turbine generates electricity and waste heat is used to make steam to generate additional electricity via a steam turbine. Most of the new fossil-fueled generation capacity built in the northeastern states over the past two decades has been of this type. Combined cycle generation is contrasted by simple cycle generation, which uses only a single turbine.

Commercial Sector

The part of the energy-using economy that is associated with the providing of goods and services other than manufacturing. The commercial sector includes both private and public entities, and is made up of offices, wholesale and retail businesses, hotels and restaurants, educational and health care facilities, financial institutions and services, and religious and social organizations.

Constant Dollars

Values that are adjusted to remove the effects of price changes due to inflation; also referred to as real dollars.

Crude Oil

The raw material from which petroleum products such as gasoline and heating oil are made by the refining process. Crude oil is a dark liquid fossil fuel comprised of a mixture of hydrocarbons usually found deep in the Earth.

Cubic Foot (cf)

Measure of volume commonly used for natural gas.

D

Dekatherm (Dt)

Unit commonly used to measure amount of natural gas, based on its heat content in Btu rather than its volume in cubic feet. One therm equals 100,000 Btu; one dekatherm equals ten therms or 1,000,000 Btu.

Demand

In economic terms, demand refers to the amount of any product, including electricity, natural gas, petroleum products, or other fuel, that is required to meet customer needs.

Electricity demand is also known as load, and can refer to the amount that is needed by customers within a specific period of time, such as an hour or month or year. In the context of electricity, the term “demand” is also used to refer to the highest amount of electricity that a customer may require within a short period such as a 15-minute interval, for the purpose of determining the demand charge component of electricity rates paid by customers.

Demand Response

Temporarily reducing electricity usage in response to a request from the system operator to do so, typically

to maintain system reliability, and typically in exchange for a financial incentive.

Deregulation

The elimination of some or all regulations from a previously regulated industry or sector of an industry. Deregulation of the electricity industry refers to the separation in ownership of generation, transmission, and distribution. Prior to deregulation the electricity industry consisted primarily of vertically integrated utilities which owned generation facilities as well as transmission and distribution. Deregulation resulted in utilities selling their generation assets to independent entities such that their primary business became providing distribution services to customers.

Diesel Fuel

The primary refined petroleum fuel used by heavy trucks, construction equipment and emergency power generators. Diesel fuel, along with heating oil, is a major component of the category of fuels known as distillates.

Distillate Fuel

A general classification for one of the petroleum fractions produced in conventional distillation operations. It includes diesel fuels and fuel oils. Products known as No. 1, No. 2, and No. 4 diesel fuel are used in on-highway diesel engines, such as those in trucks and automobiles, as well as

off-highway engines, such as those in railroad locomotives and agricultural machinery. Products known as No. 1, No. 2, and No. 4 fuel oils are used primarily for space heating and electric power generation.

Distributed Generation

Small electric generating facilities, either renewable or other, located near the end consumer, such as solar panels installed on residential home roofs, fuel cells located in office buildings or fossil-fuel burning back-up assets.

Distribution

The delivery of energy to end-users or customers. The distribution component of New York State's electric system is generally used to carry electric power from the transmission component to the locations of end-use consumers. The distribution component of the natural gas system transfers natural gas from the large interstate pipelines through a network of various sizes of "mains" to individual customer locations. The distribution component of petroleum products includes pipelines, barges, railroads, trucks, and service stations.

Dual-fuel Generation Unit

Electricity generation facilities that are able to run on either natural gas or oil. In some units, only the primary fuel, most often natural gas, can be used continuously; the alternate fuel(s) can be used only as a start-up fuel or in emergencies.

E

E85

An alternative motor fuel that contains a mixture of 85 percent ethanol and 15 percent gasoline.

Emission Cap

Emission cap usually refers to an environmental regulatory system that imposes a cap or limit on the amount of pollution that can be emitted in a state or region over a specific time period. Emissions trading, or cap and trade, is a market-based approach used to control pollution by providing economic incentives for achieving reduction in pollutant emissions, and allowances to comply with emission reductions requirements. Pollution sources can buy or sell allowances on the open market. Sources can choose how to reduce emissions, including whether to buy additional allowances from other sources that reduce emissions. The Regional Greenhouse Gas Initiative (RGGI), which sets an emission cap on carbon dioxide emissions from power plants in nine northeastern states including New York, is an example of an emission cap system.

Energy

The capacity for doing work as measured by the capability of doing work (potential energy) or the conversion of this capability to

motion (kinetic energy). Energy has multiple forms, which vary widely in their ability to be convertible and to be changed to another form useful for work. A large amount of the world's convertible energy comes from fossil fuels that are burned to produce heat that is then used as a transfer medium to mechanical or other means in order to accomplish tasks. Commonly used forms of energy include natural gas, petroleum, coal, hydro power, nuclear, wind, solar, biomass, and biofuels. Heat energy is usually measured in British Thermal Units (Btu). Energy converted to electricity is usually measured in kilowatt hours (kWh). *See also primary energy, net energy, fossil fuels, renewable energy, Btu, and kWh.*

Energy Efficiency

Energy efficiency means any technology or activity that results in using less energy to provide the same level of service, work, or comfort to customers. End-use energy efficiency takes place at the customer's location and means that individual customers use less energy to complete the same task. System-level efficiency means that improvements are made in either producing or transporting energy such that less energy is used in the process of providing energy to end-use customers.

Energy Services Company (ESCO)

In deregulated energy markets, an ESCO is a company other than the local utility company which

purchases energy (electricity or natural gas) on the open market and sells the energy to consumers, with the delivery continued to be done through the utility. The term ESCO also refers to a company other than a utility that provides a variety of energy-related services to consumers that may include energy audits, energy management, efficiency projects, renewable energy projects, and financing opportunities.

Environmental Justice

The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people should bear a disproportionate share of the negative environmental consequences resulting from industrial, governmental and commercial operations or policies. Meaningful involvement means that: (1) people have an opportunity to participate in decisions about activities that may affect their environment and/or health; (2) the public's contribution can influence the regulatory agency's decision; (3) their concerns will be considered in the decision making process; and (4) the decision makers seek out and facilitate the involvement of those potentially affected.

Ethanol

A colorless liquid that burns to produce water and carbon dioxide. The vapor forms an explosive mixture with air and may be used as a fuel in internal combustion engines.

F**Feedstock**

The raw material input to an industrial process. Fossil fuels are often used as feedstocks to industrial processes because of their chemical properties, rather than their energy value.

Firm Gas

Natural gas provided to customers under rate structure that guarantees that gas will be delivered at all times, including the times of highest hourly demand which are generally the coldest periods when the largest amount of gas is needed for space heating.

Firm Power

Power or power-producing capacity, intended to be available at all times during the period covered by a guaranteed commitment to deliver, even under adverse conditions.

Fossil Fuel

Fuels derived from organic material formed by the compression in the Earth's crust of ancient plants and animals over millions of years.

The most common fossil fuels are petroleum products, coal, and natural gas.

G**Gallon (gal)**

A measure of volume equal to 4 quarts (231 cubic inches), commonly used to measure petroleum products such as gasoline and heating oil.

Gasoline

Highly refined petroleum product used primarily to fuel highway vehicles. Gasoline is a complex mixture of relatively volatile hydrocarbons, often containing various additives, that have been blended to form a fuel suitable for use in internal combustion engines.

Generation

Generation refers to both the mechanical units and the process of producing electricity by transforming other types of energy, including fossil fuels, hydro, nuclear, wind, photovoltaic, etc. Generation is commonly expressed in kilowatt-hours (kWh) or megawatt hours (MWh).

Gigawatt-hour (GWh)

Unit of measure for amount of electricity generated or used. Equals one million kilowatt-hours, or one billion watt-hours.

Greenhouse Gases (GHG)

A gas in the atmosphere that absorbs or emits radiation within the thermal infrared range. GHG prevent radiant energy from leaving the Earth's atmosphere or trap the heat of the sun producing the greenhouse or warming effect. The primary GHG include carbon dioxide, methane, nitrous oxide, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride, as well as water vapor. Greenhouse gases are transparent to short-wave solar radiation but opaque to long-wave infrared radiation, thus preventing long-wave radiant energy from leaving Earth's atmosphere. The net effect is a trapping of absorbed radiation and a tendency to warm the planet's surface gases that trap the heat of the sun in the Earth's atmosphere, producing the greenhouse effect. Increases in the amount of GHG in the atmosphere enhances the greenhouse effect leading to more heat being trapped. This extra heat is causing climate change.

H

Henry Hub

The natural gas pipeline hub on the Louisiana Gulf coast that is most frequently used as a benchmark for natural gas commodity prices. It is

the delivery point for the natural gas futures contract on the New York Mercantile Exchange (NYMEX).

Hydraulic Fracturing

Process for extracting natural gas or crude oil. The process produces fractures in the target rock formation by pumping large quantities of fluids at high pressure down the wellbore. The fractures stimulate the flow of natural gas or crude oil, increasing the volumes that can be recovered.

Hydroelectric Power

Electricity generated by turbines turned by moving water, often shortened to "hydro."

Industrial Sector

The part of the energy-using economy that is associated with manufacturing, processing, mining, and quarrying.

Installed Capacity

Refers to the total amount of electric generating capacity installed.

Interruptible Gas

Natural gas provided to customers under a rate structure at a lower price that allows the provider to curtail the supply during periods of highest demand, such as during cold periods when the greatest amount of gas is needed for space heating.

Interruptible Power

Power and usually the associated energy made available by one utility to another. This transaction is subject to curtailment or cessation of delivery by the supplier in accordance with a prior agreement with the other party or under specified conditions.

K

Kilowatt (kW)

A unit of power, usually used for electricity.

Kilowatt Hour (kWh)

A measure of electricity defined as a unit of work or energy, measured as 1 kilowatt (1,000 watts) of power expended for 1 hour. One kWh is equivalent to 3,412 Btu.

L

Liquefied Petroleum Gas (LPG)

Also known as propane (*see definition*).

Load

The power and energy requirements of users on the electric power system in a certain area or the amount of power delivered to a certain point.

Load Serving Entity (LSE)

A legal entity, often a utility, municipal electric system, or electric cooperative, authorized or required by law, regulatory authorization or requirement, agreement, or contractual obligation to supply Energy, Capacity and/or Ancillary Services to meet the electricity needs of retail customers, including an entity that takes service directly from the NYISO to supply its own load. Since the restructuring of the electricity industry, the sale of electricity and/or delivery arrangements may be handled by other agents, such as Energy Services Companies (ESCOs).

Local Distribution Company (LDC)

A legal entity, often a utility, engaged primarily in the retail sale and/or delivery of natural gas through a distribution system that includes mains (i.e., pipelines designed to carry large volumes of gas) and laterals (i.e., pipelines of smaller diameter that connect the main to end users). Since the restructuring of the gas industry, the sale of gas and/or delivery arrangements may be handled by other agents, such as producers, brokers, and marketers that are referred to as “non-LDC.”

M

Megawatt (MW)

A unit of electrical power equal to 1000 kilowatts or one million watts

Megawatt Hour (MWh)

A measure of electricity defined as a unit of work or energy, measured as 1 Megawatt (1,000,000 watts) of power expended for 1 hour. One MWh is equivalent to 3,412,141 Btu.

Micro Grid

A group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid and that can connect and disconnect from such grid to enable it to operate in both grid-connected or island mode.

Million British Thermal Units (MMBtu)

See British Thermal Unit (Btu).

N

Natural gas

A colorless, tasteless, nonrenewable clean-burning fossil fuel, widely used to generate electricity and also used directly by end-use customers to provide space heat, water heating, and cooking.

Net Energy Use

The energy consumed by customers at the end-use location (i.e. building or vehicle, including electricity as well as the fuel burned on-site to provide space heat, water heat, etc. Net energy use accounts for electricity based on the heat content of energy at the plug (3,412 Btu per kWh), and excludes the heat losses incurred during generation, transmission, and distribution of electricity. Adding the heat losses associated with electricity to net energy use results in “primary energy use.”

Net Metering

Allowing a customer’s electric meter to measure both the reverse and forward flow of electricity, allowing the meter to register when a customer is producing more energy on site than it is using (which will cause the meter to reverse), as well as when a customer is producing less energy than it is using (which will cause the meter to move forward).

The combined effect, or netting, of the reverse and forward flows, results in net metering.

Nominal Dollars

The price paid for a product or service at the time of the transaction; i.e. values that are not adjusted to remove the effect of price changes due to inflation.

Non-attainment Areas

Areas that do not meet (or contribute to nearby areas that do not meet) the primary or secondary National Ambient Air Quality Standards (NAAQS) for one of six criteria air pollutants “ozone, particulate matter, carbon monoxide, nitrogen dioxide, sulfur dioxide and lead.” Designations are based on measured air quality. Primary standards set limits to protect public health and secondary standards set limits to protect public welfare including decreased visibility, damage to animals, crops, vegetation, and buildings.

O

Off-Peak Periods

Periods of time when energy use and the cost to provide energy are lowest. For electricity, this is usually during the night. For natural gas, heating oil and propane, this is usually during the summer.

One Thousand Cubic Feet (Mcf)

Measure of volume commonly used for natural gas.

P

Peak Periods

Periods of time during which energy use and the cost to provide energy are highest. For electricity, this is usually during the hottest hours of the day in summer. For natural gas, heating oil, and propane, this is usually during the coldest periods of the winter.

Peaking Assets

Electricity generation units that are called on primarily during peak periods. These are often relatively inefficient combustion turbines that have a high cost per kWh, but that can be cycled on and off quickly to meet immediate electricity needs.

Petrochemicals

Chemicals isolated or derived from “petroleum” or natural gas that are used as feedstocks in the manufacturing of plastics, synthetic fabrics, and a wide variety of industrial and consumer products.

Petroleum

Generally refers to crude oil or the refined products obtained from the processing of crude oil (gasoline, diesel fuel, heating oil, etc.) Petroleum also includes lease

condensate, unfinished oils, and natural gas plant liquids.

Primary Energy Use

Total consumption of fuels, including the fuels used to generate electricity.

Primary energy accounts for electricity based on the equivalent heat content of fuel at the generator. Subtracting the heat losses associated with electricity generation, transmission, and distribution from primary energy use results in “net energy use.”

Propane

Also known as liquefied petroleum gas (LPG). A colorless, highly volatile hydrocarbon that is readily recovered as a liquefied gas at natural gas-processing plants and refineries.

It is used primarily for residential and commercial space heating, and also as a fuel for transportation and industrial uses, including petrochemical feedstocks. Propane is often used at customer locations where natural gas is not available, as it can be easily transported by truck and stored at the customer site.

R

Refined Petroleum

Refined petroleum products include but are not limited to gasoline, kerosene, distillates (including No. 2 fuel oil), liquefied petroleum gas,

asphalt, lubricating oils, diesel fuels, and residual fuels.

Refinery

An industrial plant that heats crude oil in a complex distillation process so that it separates into chemical components, which are then made into a wide variety of petroleum products with very specific properties and uses. Refinery products include various types of gasoline, diesel fuel, heating oil, kerosene, aviation fuel, and residual oil.

Reliability

Bulk electric system (i.e. generation and transmission) reliability consists of a series of very specific engineering-based metrics that measure both resource adequacy and transmission operating reliability. Resource adequacy measures the degree to which system resources are sufficient to be able to meet customer load when and where needed. Transmission operating reliability measures the ability of the delivery system to get the power to the load and its ability to withstand various contingencies such as generators or transmission lines being out of service without dire consequences. Electricity distribution (i.e. service) reliability is measured by utility-filed data on frequency and duration of service interruptions. The term reliability also applies to the performance of natural gas and petroleum delivery systems, but the metrics for measurement and system

design criteria are far less formalized by regulatory processes.

Renewable Energy Resources

Sources which are capable of being continuously restored by natural or other means, or are so large as to be usable for centuries without significant depletion, and include but are not limited to solar, wind, plant and forest products, organic wastes, tidal, hydro, and geothermal. While renewable energy resources are virtually inexhaustible in duration, they may be limited in the amount of energy that is available per unit of time. In contrast, fossil fuels such as coal, natural gas and petroleum take millions of years to develop naturally and are considered nonrenewable.

Repowering

Repowering refers to the retirement of a power plant and the reconstruction of a new, cleaner, and more efficient plant on the same property.

Residential Sector

The part of the economy having to do with the places people stay or live. The residential sector is made up of homes, apartments, condominiums, etc.

Residual Oil

The heavier oils, including No. 6 fuel oil, that remain after the distillate fuel oils and lighter hydrocarbons are boiled off in refinery operations. Residual oil is used for production of electric power,

space heating, vessel bunkering, and various industrial purposes.

Resiliency

Ability of the energy system to reduce the impact and duration of disruptive events. Resiliency encompasses the capability to anticipate, prepare for, respond to, and recover from significant multi-hazard threats with minimum damage to the energy system, environment, economy, and social well-being.

Regional Greenhouse Gas Initiative (RGGI)

The Regional Greenhouse Gas Initiative is a mandatory, market-based effort to reduce greenhouse gas emissions in nine Northeastern and Mid-Atlantic States, including New York. It is implemented in New York by DEC and NYSEERDA.

S

Shale Gas

Natural gas produced from wells that are open to shale formations. Shale is a fine-grained, sedimentary rock composed of mud from flakes of clay minerals and tiny fragments (silt-sized particles) of other materials. The shale acts as both the source and the reservoir for the natural gas.

Smart Grid

According to the U.S. DOE, Smart Grid generally refers to “a class of technology people are using to bring

utility electricity delivery systems into the 21st century, using computer-based remote control and automation. These systems are made possible by two-way communication technology and computer processing that has been used for decades in other industries.” Smart grid technology can enable system operators to more quickly identify the location and cause of an outage as well as enable customers to adjust their energy usage patterns in response to pricing information from the grid.

Smart Growth

Smart Growth is development that serves the economy, community, and the environment. It provides a framework for communities to make informed decisions about how and where they grow. Smart Growth makes it possible for communities to grow in ways that support economic development and jobs; create strong neighborhoods with a range of housing, commercial, and transportation options; and achieve healthy communities that provide families with a clean environment.

Solar Photovoltaic

A technology that directly converts the energy radiated by the sun as electromagnetic waves into electricity by means of solar panels.

Solar Thermal

A system that uses sunlight to heat water or create steam, which can then be used directly, stored, or used to generate electricity. Solar

thermal energy may be applied to water heating, space heating, or heating pools.

System Security Constraints

Limitations imposed on the energy system to maintain reliability, such as transmission line ratings and transfer limits across interfaces between zones.

T

Trillion British Thermal Units (TBtu)

See British Thermal Unit (Btu).

Ton or Short Ton

A unit of weight equal to 2,000 pounds, often used to measure amounts of coal and air emissions of various pollutants. A long ton or metric ton is equal to 2,200 pounds.

Transmission

Transmission refers to the high-voltage, long-distance lines through which electrical power is transported from generation units.

Transportation Sector

The part of the energy-using economy related to vehicles, fuels, and systems that move people and goods from one place to another. The transportation sector is made up of automobiles, buses, trucks, trains, and ships, and all fuels and systems that power and control them.

Turbine

A device for producing continuous power in which a wheel or rotor, typically fitted with vanes, is made to revolve by a fast-moving flow of water, wind, steam, gas, air, or other fluid. Typically, the mechanical energy of the spinning turbine is converted into electricity by a generator.

W**Watt (W)**

The unit of measure for electric power or rate of doing work. It is analogous to horsepower of mechanical power. One horsepower is equivalent to approximately 746 watts. *See also megawatt.*

Wellhead Price

The price of natural gas at the point of extraction.

Wind Energy

A renewable source of energy used to turn turbines to generate electricity.

PHOTO CAPTION LIST

Front Cover

Wind turbine in corn field.

Photographer: Dana Hoff (Getty Images)

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Turning a valve on a pipeline.

Photographer: HAYKIRDI (Getty Images)

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Man working on lattice tower.

(New York Power Authority)

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Worker at a gas refinery.

Photographer: hrabar (iStock)

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Close up of gas nozzle in tank.

Photographer: Image Source/Ditto (Getty Images)

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New York Power Authority's Niagara Hydroelectric Power Plant.

(New York Power Authority)

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Workmen installing solar panels on roof in Tonawanda, Buffalo.

(New York Power Authority)

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