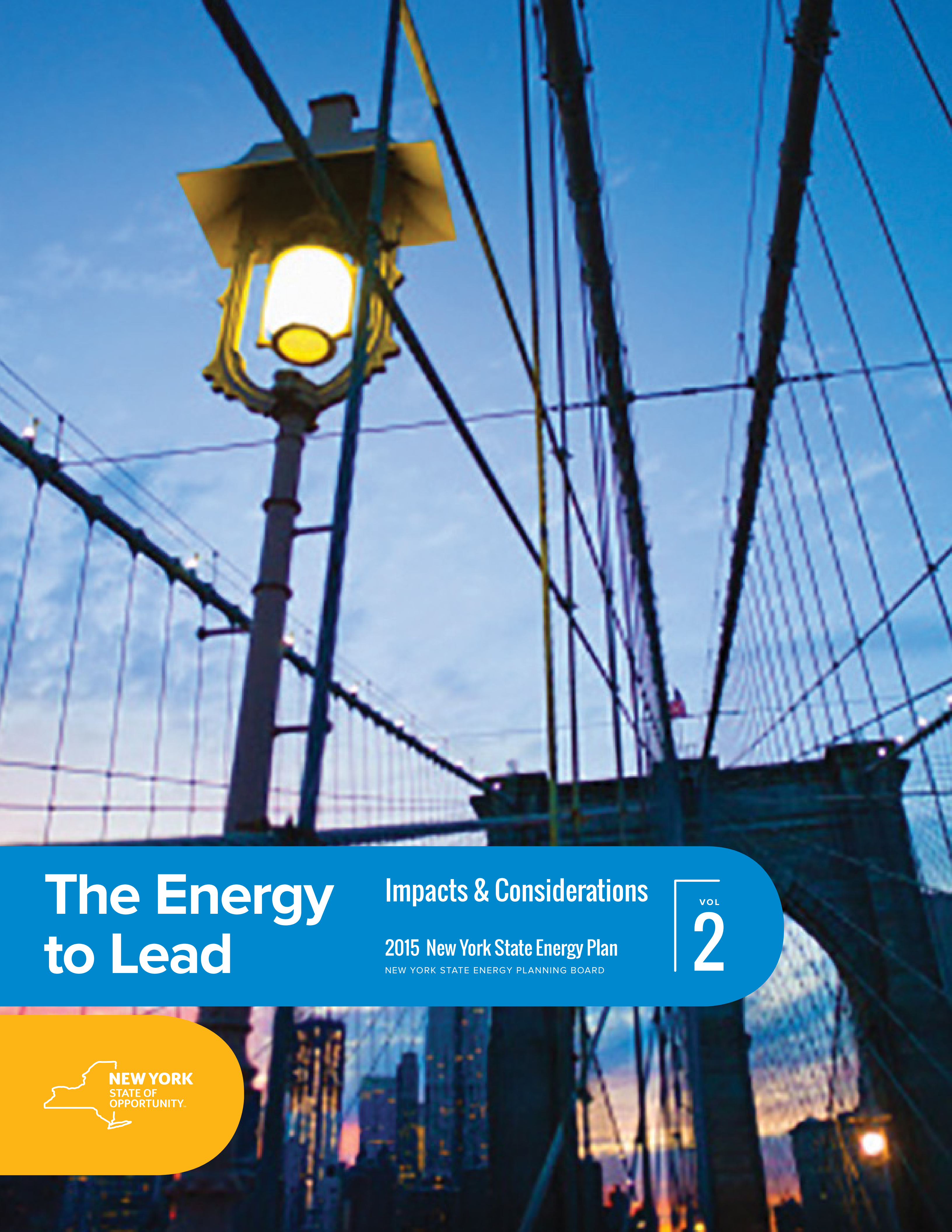

The Energy to Lead

Impacts & Considerations

VOL 2

2015 New York State Energy Plan

NEW YORK STATE ENERGY PLANNING BOARD

NEW YORK STATE OF OPPORTUNITY.

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1 Impacts of the Energy System

A clean and healthy environment and an abundant supply of affordable and reliable energy are essential elements of a high quality of life for all New Yorkers. Measures that move the total energy system (generation, distribution, and consumption) away from dependence on carbon-based fuels can meet communities' immediate needs and also build more sustainable communities in the long run. New York already has put in place some important and effective renewable energy and energy efficiency policies that support this transformation.

Most prominently, the Regional Economic Development Plans and Regional Sustainability Plans now being developed by community representatives will help chart locally-appropriate pathways to a cleaner energy system and economy. New York has demonstrated that environmental protection can be enhanced while new energy sources are developed.

National and State environmental laws and regulations have been established to prevent or minimize impacts to the environment and public health from all forms of pollution, including emissions into the air, discharges to groundwater and surface waters, and placement of harmful substances aboveground and underground. Air pollutants emitted when carbon-based fuels are burned are associated with serious health conditions such as asthma and cardiovascular disease, and contribute to the climate change that threatens New York's residents, natural resources, and built infrastructure. Emissions of acid precursors (NO_X and SO_2) from sources in New York and upwind continue to degrade the State's forests and water bodies and impair visibility, although much progress has been made in reducing this deposition. Many power plants use large amounts of water, resulting in mortality to fish and other aquatic life. Wind turbines can kill birds and bats; and power lines can disrupt sensitive habitats. Energy planning and permitting processes provide opportunities to minimize and mitigate such impacts, ensuring that the State's energy system is compatible with a healthy and thriving environment.

Particular attention is given in this Plan to protecting public health and the environment from the adverse impacts of climate change. Climate scientists have concluded that limiting the increase in global average temperatures to 2 degrees Celsius above pre-industrial levels is necessary to minimize the likelihood of severe, disruptive climate impacts. In response, New York has adopted a goal of reducing its emissions of heat trapping greenhouse gases (GHGs) 80 percent by 2050.[1] Achieving this goal will require sustained support for energy conservation and efficiency programs that support a comprehensive, synergistic reduction in energy demand, and for new local sources of clean energy, targeted modernization of supply-side infrastructure and adoption of renewable energy. All of these efforts can greatly reduce emissions of GHGs and other pollutants and all are important components in meeting the State's economic and energy needs.

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1. Executive Order 24

Climate Change and the Energy System

Unequivocal warming of the Earth over the past century is documented by observations that include increases in global average temperatures (lower atmosphere, ocean surface, and land surface), rapid melting of mountain glaciers, and land ice sheets and higher global average sea levels.[2] In North America, extreme heat and drought events are becoming more frequent and prolonged; although total precipitation is increasing only slightly, intense and damaging storms like Sandy and Irene are occurring more often. A changing climate affects human health, society and the economy both directly and indirectly, through its effects on agriculture, sea level, fisheries, and other natural resources.

2. Intergovernmental Panel for Climate Change (IPCC). *Climate Change 2007: Synthesis Report; Summary forPolicymakers. IPCC. 2007.* http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_synthesis_report.htm

Greenhouse Gas (GHG) Emissions in New York: Sources and Trends

The rate and extent of climate change depend on the amount of GHGs present in the troposphere (lower atmosphere). A detailed accounting of New York's energy-related GHG emission sources and sinks[3] from 1990 and projected to 2030 is presented in Patterns & Trends.[4] A forthcoming GHG Inventory report covers the six types of gases included in the U.S. GHG inventory: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). Emissions of these GHGs are presented using a common metric, the CO_2 equivalent (CO_2e), which indicates the relative contribution of each gas, per unit mass, to global average radiative forcing.

New York State 2011 GHG Emissions Inventory

In 2011, New York emitted approximately 210.8[5] million metric tons of carbon dioxide equivalents ($MMtCO_2e$), an average of a little more than 10.8 $MtCO_2e$ for each State resident. (New York's per capita GHG emissions were approximately half the U.S. average.) The great preponderance of New York's GHG emissions came from fuel combustion, with CO_2 constituting the majority of these emissions.

Emissions by economic sector

In 2011, the transportation sector accounted for approximately 40 percent of the CO_2 emissions from fuel combustion; the residential and commercial sectors were each responsible for roughly 26 percent, including emissions from electricity generation. For both the residential and commercial sectors, emissions from fuel combustion on-site were greater than those associated with electricity generation or power imported from outside the State. The industrial sector contributed the lowest amount of CO_2 emissions from fuel combustion, accounting for approximately 9 percent of the CO_2 fuel combustion emissions in New York; most of these emissions came from on-site fuel combustion.

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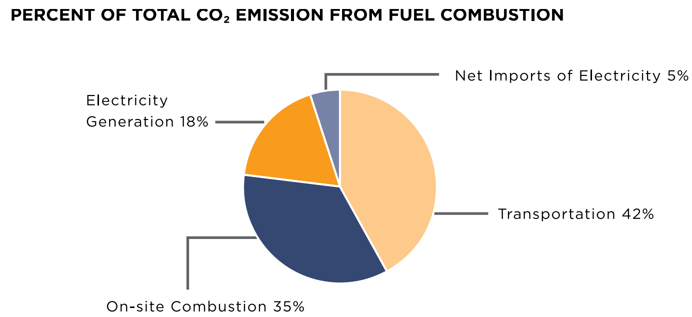
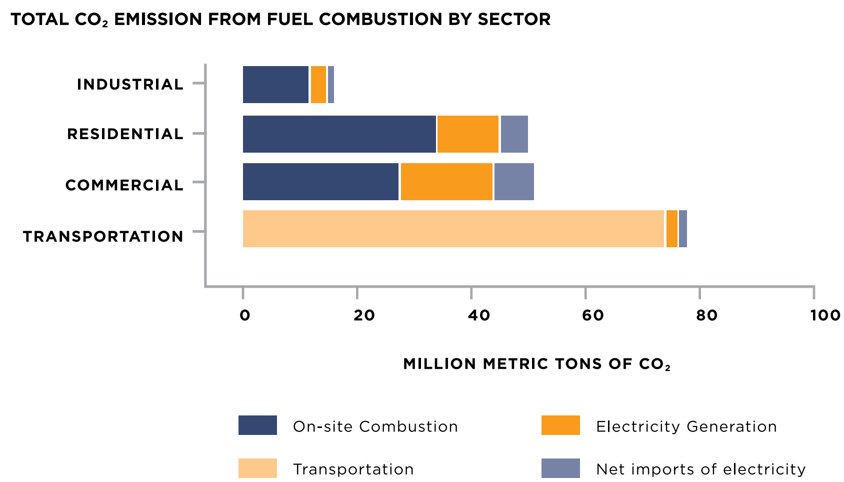
3. GHG sinks represent the removal and subsequent storage of GHGs from the atmosphere.

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

5. Emissions include net imports of electricity, which account for 9.1 million metric tons of carbon dioxide equivalent.

Figure 1 | 2011 Carbon Dioxide (CO_2) Emissions from Fuel Combustion by End Use Sector





Note: This graph includes net imports of electricity, which account for 9.1 million metric tons of carbon dioxide equivalent.

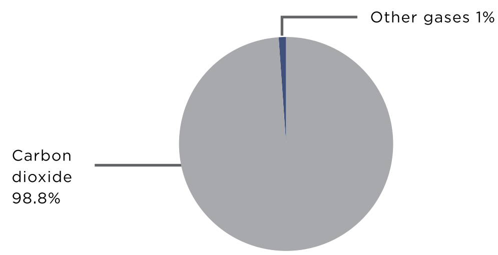
Source: NYSERDA

Emissions by fuel

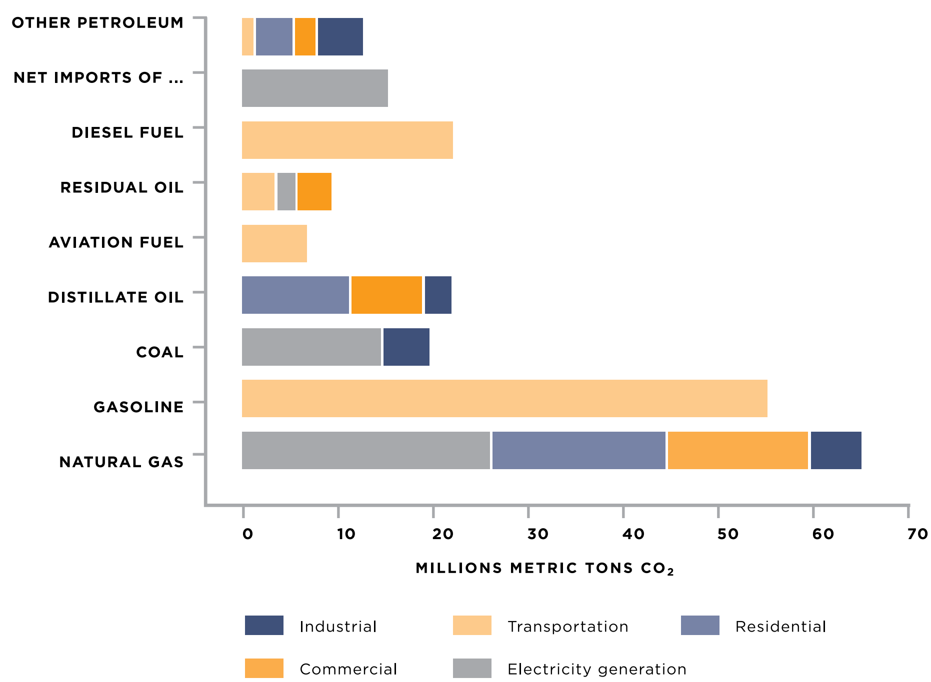
Natural gas accounted for 37 percent of fuel combustion emissions, with emissions occurring in all five fuel combustion sectors (transportation, electricity generation, residential, commercial and industrial) (Figure 2 below). An additional 29 percent of the fuel combustion emissions resulted from the burning of gasoline by the transportation sector, with the remaining emissions due primarily to the burning of coal, distillate oil, aviation fuel, residual oil, diesel, and other petroleum sources, as well as imported electricity. In addition to releasing CO_2, these fuel combustion sources also emitted a small amount of nitrous oxide (N_2O) and methane (CH_4), accounting for about 1 percent of the 2011 New York GHG emissions from fuel combustion (See Appendix 1, Figure 11).

Figure 2 | 2011 Carbon Dioxide (CO_2) Emissions from Fuel Combustion by Fuel Type

GHG EMISSION FROM FUEL COMBUSTION



TOTAL CO_2 FROM FUEL COMBUSTION: 187 MILLION METRIC TONS (87% OF TOTAL GHGs)



Note: Includes net imports of electricity.

Source: NYSERDA

Non-fuel combustion emissions

Methane accounted for the greatest portion of 2011 GHG emissions from sources other than fuel combustion, at 7.1 percent of the total. As detailed in Appendix 1, Figure 11, the major sources of these methane emissions included natural gas leakage[6] and landfills, along with agricultural animals and the use of substitutes for ozone-depleting substances (ODS).[7]

Emission sinks

New York's largest GHG sink resulted from the net CO_2 flux from forested lands in New York, including urban forests. In addition to the forestry sector, cultivation practices in the agriculture sector were also found to be net sinks of CO_2e emissions in New York. In 2000, the combined carbon sink from the forestry and agriculture sectors accounted for a total sequestration of 26 MMt CO_2e.

Emission Trends in New York

New York's total GHG emissions in 2011 were slightly lower than emissions in 1990 with a peak occurring around the year 2000. This compares to a national increase in total GHG emissions of 8 percent from 1990 to 2011. The non-fuel combustion sources that showed the greatest increase during this time period were the ODS substitutes category, imported electricity, semiconductor manufacturing, and municipal waste combustion. The fuel combustion sources in the transportation sector showed by far the greatest growth in New York, with emissions increasing by nearly 18 percent from 1990 to 2011. In contrast, emissions from electricity generated in-state dropped 47 percent during this same period, acting as a major driver of New York's decreasing GHG emissions.[8]

Emission intensity

New Yorkers emit approximately 11 metric tons of CO_2e per capita and New York's energy-related per capita emissions of 8.8 tons are the lowest of the 50 states. New York also leads the nation in having the lowest GHG emissions per unit of economic output, averaging 0.19 kilograms (kg) of CO_2e of emissions per dollar gross state product (GSP), while the U.S.

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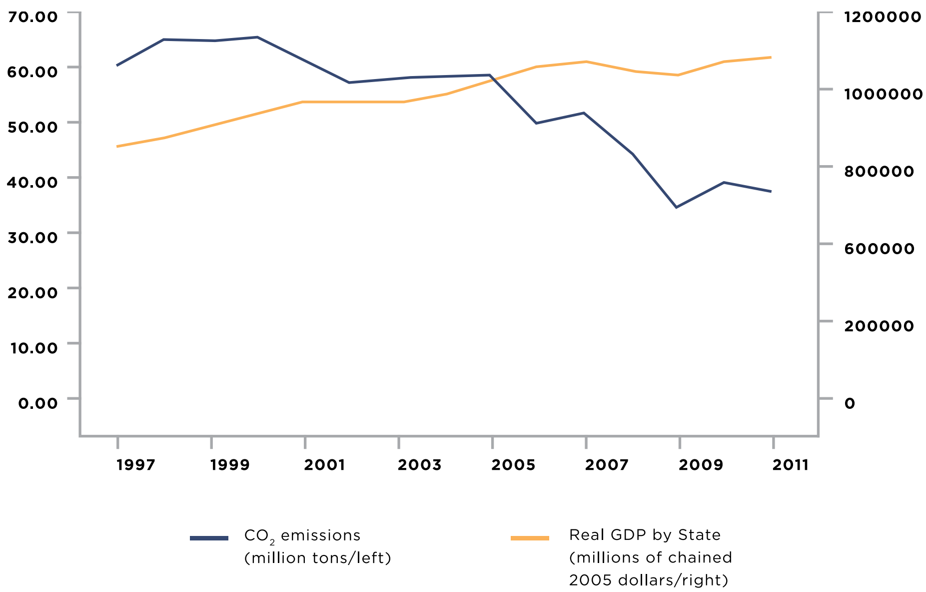
6. 'Natural gas leakage' refers to the natural gas that leaks from the natural gas transmission and distribution system.

7. ODS substitutes are chemical replacements for ozone degrading chlorofluorocarbons, these include hydroflourocarbons and perfluorocarbons.

8. Accounting for net imported electricity, the decrease is 22 $MMtCO_2e$ or a 34 percent decrease from 1990 levels.

averaged 0.50 kg of CO_2e emissions per dollar gross domestic product (GDP).[9] As detailed in Figure 3, during 1997-2011, economic output exceeded electricity sector emissions growth in New York with emissions per unit of real gross domestic product GDP dropping by 53 percent in New York.

Figure 3 | New York State Electricity Sector, CO_2 Emissions and Economic Output (GDP) (1990-2011)



Sources: RGGI CO2 Allowance Tracking System (COATS).U.S. Energy Information Administration (EIA). *U.S. Electric Power Industry Estimated Emissions by State*. U.S. Bureau of Economic Analysis, *Real Gross Domestic Product (GDP) by State*.

Emission Forecasts

New York's forecasted total GHG emissions are anticipated to decrease by about 2.4 MMt CO_2e from 2011 to reach about 208.5 MMt CO_2e by 2030, or 9 percent below 1990 levels. This downward trend in the forecast is largely due to changes in the transportation, and continued low emissions from the electricity sector. Electricity sector emissions have decreased substantially since 1990 and are forecasted to continue to decrease in the near future. In comparison, transportation emissions show a net

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9. U.S. Energy Information Administration (EIA). May 2013. State-Level Energy-Related Carbon Dioxide Emissions, 2000-2010. *Table 8. Carbon Intensity of the Economy by State (2000-2010)*. New York State's GHG emissions are lower than the national average, due to several factors: a larger-than-average fraction of electric power in NYS is generated by low-carbon hydroelectric and nuclear facilities and a smaller portion by carbon-intensive coal; additionally, a large fraction of the State's population lives in New York City, where lower use of individual vehicles and more heat-sharing by contiguous living spaces means a lower individual GHG footprint.

increase from 1990-2011, emissions were highest in 2006 and have fallen or remained constant each year from 2007-2011. Motor gasoline, diesel, and jet fuel kerosene are the main drivers of the 2006 peak and subsequent decline as maximum consumption of each fuel occurred in this year. While some of this drop in fuel use may have been due to the economy, this downward trend is anticipated to continue going forward due to changes in vehicle miles traveled (VMT) and fuel economy. While VMT are projected to continue to grow from 2012-2030, the growth rate has been recalibrated to show a much lower rate of increase. This lower growth rate, when coupled with a forecasted increase in vehicle fuel economy across all vehicle categories, results in a decrease in transportation fuel consumption, which lowers the emission forecast.[10]

Climate Change Impacts in New York

Many of the changes observed in our climate cannot be explained by natural variability alone.[11, 12] However, by taking into account the heat-trapping effects of rising atmospheric concentrations of CO_2 and other GHGs, aerosols and black carbon emitted by human activities (chiefly fossil fuel combustion), scientists are reaching a better understanding of what is happening to our climate now, and what may happen in the future.[13]

Atmospheric concentrations of GHGs today are nearly 40 percent higher than in pre-industrial times – higher than at any time in the past 800,000 years.[14] Additional solar energy retained by these excess GHGs changes the planet-wide balance between heat gain and heat loss, acting as a “forcing” to the climate system.

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10. New York State Energy Research Development Authority (NYSERDA). 2013 Greenhouse Gas Inventory and Forecast. (expected to be released in winter 2013/2014)

11. American Meteorological Society (AMS). *Climate Change. An Information Statement of the American Meteorological Society.* (Adopted by AMS Council 20 August 2012)

12. Hansen, J., Sato, M., Ruedy, R. 2012. *Perception of Climate Change.* Proceedings from the National Academy of Sciences. www.pnas.org/cgi/doi/10.1073/pnas.1205276109.

13. Many national and international scientific organizations have found that anthropogenic GHG emissions are responsible for rising global average temperatures and associated climate change. Most recently, the 2011 America’s Climate Choices report prepared by the U.S. National Research Council (the operating arm of the National Academy of Sciences) states that there is a greater than 90 percent chance that increases in human-caused greenhouse gases are responsible for the earth’s warming over the past 50 years and concludes that climate change is occurring, is caused largely by human activities, and poses significant risks for — and in many cases is already affecting — a broad range of human and natural systems. http://americasclimatechoices.org/

14. National Research Council of the National Academies. *Climate Change: Evidence, Impacts, and Choices.* 2012 http://nas-sites.org/americasclimatechoices/more-resources-on-climate-change/climate-change-lines-of-evidence-booklet/

The climate system gains energy not only from higher air temperatures, but also through increased evaporation of seawater and intensification of the hydrologic cycle. Although all weather events are affected by climate change because the environment in which they occur is warmer and moister than formerly, most weather still remains within the bounds of previous conditions. However, added energy raises the likelihood of intensifying what would have been a "normal" event into an extreme one; when an extreme event does occur, rising sea levels increase the risk of flooding.

Both human civilization and natural systems are adapted to the cooler temperatures that characterized preceding decades and centuries; global warming is already noticeably affecting the geographic and seasonal range of animals, birds and insects, and in some cases ecosystem change is occurring more rapidly than species can accommodate.[15] This cascade of changes has impacts on individual New Yorkers, as well as on communities, energy systems, economic and social conditions, public health and safety, agriculture, commerce and infrastructure, and environment and natural resources, with low-income communities particularly vulnerable. Ecosystems are being stressed by rising temperatures, and changes in the frequency and intensity of precipitation.

Recent Climate Change Science

Scientific work published since the 2009 update of the State Energy Plan offers concern about the world's lack of progress toward preventing dangerous climate change.

Rate of atmospheric GHG buildup

Rising atmospheric GHG concentrations are rapidly approaching the level at which scientists project that severe consequences are likely. The daily average CO_2 concentration exceeded 400 parts per million (ppm) for the first time in the observational record at Mauna Loa, Hawaii, since 1958. The International Energy Agency (IEA) reports that after the economic slowdown, CO_2 emissions rebounded to a record high with growth faster than the Intergovernmental Panel on Climate Change's worst-case scenarios.[16]

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15. Quintero, I. and Wiens, J.J. 2013. *Rates of Projected Climate Change Dramatically Exceed Past Rates of Climate Niche Evolution Among Vertebrate Species.* Ecology Letters. Aug; 16(8): 1095-103. A recent study concluded species would have to evolve 10,000 times faster than they have in the past in order to keep up with the earth's rapidly changing climate.

16. International Energy Agency (IEA). *World Energy Outlook*, 2011. 2011. http://www.iea.org

Rate of climate change

Some effects of climate change are occurring significantly faster than expected.[17] In 2012, the National Snow and Ice Data Center reported that Arctic sea ice appeared to have reached its lowest seasonal minimum extent since satellite measurements began in 1979.[18] A 2013 study incorporating deep ocean data reports a significant warming trend below 700 meters depth.[19] A 2013 review concluded the likely rate of change over the next century will be at least 10 times faster than any climate change in the past 65 million years. Proceeding at this extreme pace with high GHG emissions unchecked could lead to a 5-6°C spike in annual temperatures by the end of the century, placing significant stress on terrestrial ecosystems and species.[20]

Climate and energy trends

The State of the Climate in 2012 found several important climate indicators set new records or were near record levels during 2012.[21] The IEA's *World Energy Outlook Reports*[22] conclude that despite some steps in the right direction, the door is closing on the possibility of keeping the rise in global average temperature to 2°C.[23] Without further action to reduce emissions, by 2017 all CO_2 emissions permitted in the 450 Scenario (keeping atmospheric CO_2 concentrations below 450 ppm) will be "locked-in" by existing power plants, factories, buildings, and other energy consumers, while rising incomes and populations push energy

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17. Arctic Monitoring and Assessment Programme (AMAP). *Snow, Water, Ice and Permafrost in the Arctic (SWIPA)*. 2011 http://amap.no/swipa/ AMAP is an international organization established in 1991 to implement components of the Arctic Environmental Protection Strategy (AEPS).

18. National Snow and Ice Data Center. *Arctic Sea Ice News and Analysis.* http://nsidc.org/arcticseaicenews/

19. Balmaseda, M., Trenberth, K., and Kallen, E. 2013. *Distinctive Climate Signals in Reanalysis of Global Ocean Heat Content*. Geophysical Research Letters, Vol. 40, 1754-1759. Over the past 50 years, the ocean surface has absorbed about 90 percent of the total heat added to the climate system; recent evidence suggests that part of this heat has moved into the ocean depths, which removes it from global average temperature measurements in the short term but in the longer term increases the time that would be needed to return the earth's heat balance to normal.

20. Diffenbaugh, N. and Field, C. *Changes in Ecologically Critical Terrestrial Climate Conditions.* Science 2 August 2013: Vol. 341 no. 6145, pp. 486-492.

21. Climate indicators include greenhouse gas levels, lower stratospheric temperatures, ocean heat content, sea level rise, late spring Northern Hemisphere snow cover extent, arctic minimum sea ice extent, and permafrost temperature. Blunden, J. and D.S. Arndt, Eds. 2013: *State of the Climate in 2012*. Bull. Amer. Meteor. Soc., 94(8), S1-S238.

22. International Energy Agency (IEA). *World Energy Outlook*. http://www.iea.org

23. In response to scientific studies, the world's nations have agreed that a rise in global average temperature higher than 2°C has an unacceptably great likelihood of catastrophic climate consequences. An atmospheric GHG concentration of 450 ppm is expected to result in a temperature increase of 2°C.

demand higher.[24] The International Energy Agency's (IEA) *World Energy Outlook Special Report 2013: Redrawing the Energy Climate Map*, concludes the possibility of keeping the rise in global average temperature to 2°C now appears more remote than it was several years ago.[25]

Temperature

A recent study concludes that observed temperature anomalies (departures from normal) have shifted toward higher temperatures. It also notes the recent emergence of a category of summertime extremely hot outliers whose extent has expanded from much less than 1 percent of the Earth's surface to about 10 percent of the land area. This statistical study concludes that certain extreme heat waves experienced during the past decade were in fact a consequence of global warming, because the likelihood that they would occur in the absence of such warming is very small.[26]

Weather extremes

Climate scientists have long projected specific changes in weather, such as heavier precipitation events and longer droughts, as the planet's overall temperature rises. Some recent studies suggest a mechanism by which GHG-induced warming of the Arctic region reduces sea ice extent and alters wind patterns leading to persistent mid-latitude weather patterns, creating or intensifying weather extremes, such as drought, flooding, cold spells, and heat waves.[27]

Sea level rise

Recent scientific studies of vulnerability to sea level rise identify New York as one of the states where coastal habitats such as wetlands and forests, dunes, and sea grass beds have the greatest potential to defend the largest number of people and amount of total property value from damage in extreme events like storm surges, especially when those habitats fringe vulnerable communities and infrastructure.[28]

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24. The phrase CO_2 emissions will be "locked-in" refers to CO_2 emitted during the lifetime of long-lived, fossil-fuel based infrastructure currently in place or being built today and the effects of these continuing emissions to further limit our ability to avoid adverse impacts of climate change.

25. International Energy Agency (IEA). *World Energy Outlook 2013: Redrawing the Energy Climate Map.* 2013. http://www.iea.org

26. Hansen, J.; Makiko Sato and Reto Ruedy, National Aeronautics and Space Administration Goddard Institute for space Studies and Columbia University Earth Institute, New York: *Perception of climate change;* Proceedings of the National Academy of Sciences of the USA; Vol 109 No 37, 2012

27. Francis, J.A., and S.J. Vavrus. *Evidence linking arctic amplification to extreme weather in mid-latitudes, Geophysical Research Letters,* 2012. Vol. 39

28. Arkema, Katie K. et al. *Coastal Habitats Shield People and Property From Sea-Level Rise and Storms.* Nature Climate Change. July 2013. http://www.nature.com/nclimate/journal/vaop/ncurrent/full/nclimate1944.html

Climate in New York

Relatively small increases in average global temperature can cause disproportionate changes in climate. Climate change already has begun to affect New York, and further impacts are expected.

Observed Climate Trends in New York

Temperature

Since 1970, temperatures in New York have risen by approximately 0.6°F per decade, with winter warming more than 1.1°F per decade.[29] Mean annual temperature in New York City increased by 4.4°F from 1900 to 2011.[30] Warming has accelerated in recent decades: 2012 was the warmest year in New York since records began in 1895.[31] There also has been an increase in the number of extreme hot days and a decrease in the number of cold days (days at or below 32°F).

Precipitation

Statewide, there has been no discernable trend in annual precipitation, which typically is characterized by large variability, both from year to year and over decades. In New York City, mean annual precipitation increased 7.7 inches from 1900 to 2011 (a change of 1.4 percent per decade).[32]

Sea level rise

Sea level in the coastal waters of New York and up the Hudson River has risen steadily in the 20th century, chiefly as a result of thermal expansion of ocean waters, melting of land ice and local changes in the height of land relative to the height of the continental land mass. Tide-gauge observations in New York indicate that rates of relative sea level rise were significantly greater than the global mean, ranging from 2.41 to 2.77 millimeters per year (0.9 to 1.1 inches per decade).[33]

29. NYSERDA. *Responding to Climate Change in New York State: The ClimAID Integrated Assessment for Effective Climate Change Adaptation.* http://www.nyserda.ny.gov/climaid

30. New York City Panel on Climate Change. *Climate Risk Information 2013: Observations, Climate Change Projections, and Maps.*

31. Northeast Regional Climate Center. *New York Climate Summary,* December 2012. http://www.nrcc.cornell.edu/page_summaries.html

32. New York City Panel on Climate Change. *Risk Information 2013: Observations, Climate Change Projections, and Maps.*

33. U.S. Climate Change Science Program. Titus, J.G. *Coastal Sensitivity to Sea-Level Rise: A Focus on the Mid-Atlantic Region. Synthesis and Assessment Product 4.1.* 2009. http://www.epa.gov/climatechange/effects/coastal/sap4-1.html

Projected Climate Change in New York

While there are uncertainties regarding the rate of warming, all global climate models project that the Earth will warm considerably in the next century. Even if no more GHGs were added to the atmosphere, global climate projections show that further warming still would occur; even after atmospheric GHG levels stabilize, warm ocean waters will continue to release excess heat into the atmosphere until the planet achieves thermal equilibrium. In addition, the long atmospheric residence times of many GHGs mean that their heat-trapping effects will be slow to diminish and a portion of GHGs being emitted now will continue to warm the planet for hundreds, possibly, even thousands of years.[34]

Regional climates are more difficult to project than global outcomes, but recent regional projections can help New York's regional and local planners adapt communities to unavoidable climate change. The ClimAID study, which examined how sea level rise, changes in precipitation patterns, and more frequent severe weather will affect New York's economy, environment, community life and human health, is a climate change preparedness resource for planners, policymakers, and the public.[35] The New York climate projections that follow were developed as part of the ClimAID project.

34. Hansen, J. et al. (46 co-authors). *Dangerous Human-Made Interference with Climate: A GISS ModelE Study: Figure 9(a) Carbon Cycle Constraints (a) Decay of Pulse CO_2 Emissions. Atmospheric Chemistry and Physics, 7:1-262007b*. Atmospheric Chemistry and Physics. 2007. http://www.atmos-chem-phys.net/7/2287/2007/acp-7-2287-2007.pdf

35. NYSERDA. Responding to *Climate Change in New York State: The ClimAID Integrated Assessment for Effective Climate Change Adaptation.* http://www.nyserda.ny.gov/climaid

Temperature and Precipitation

Air temperatures

Air temperatures are expected to rise across New York, by 1.5°F to 3°F by the 2020s, 3°F to 5.5°F by the 2050s, and 4°F to 9°F by the 2080s,[36] with the higher increases predicted for the northern regions of the State. Heat waves in New York City are very likely to become more frequent, more intense, and longer in duration by the 2050s.[37]

Precipitation

Annual average precipitation in New York is projected to increase by up to 5 percent by the 2020s, up to 10 percent by the 2050s, and up to 15 percent by the 2080s, with the greatest increases in the northern region.[38] This increased precipitation will not be distributed evenly through the year; much of it is likely to occur during the winter months, while slightly reduced precipitation is possible for late summer and early fall. Total annual precipitation in New York City will likely increase by mid-century. The recent trend of more precipitation falling in heavy downpours and less in light rains is expected to continue.

Sea Level Rise

The IPCC projects that the rate of global sea level rise during the 21st century will be faster than the rate observed since 1970, leading to a likely rise of 7 to 23 inches by 2100. More recent analysis, which takes into account rapid melting of land-based ice sheets (particularly in Greenland and west Antarctica) and probable future warming scenarios, projects a global mean sea level rise of 20 to 55 inches above the 1990 level by 2100.[39]

A recent study based on 60 years of tide-gauge records indicates that the rate of increase for sea level rise along approximately 1000 km of the east coast, including New York, remains at approximately 3 to 4 times

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36. The ranges in projected temperatures reflect the outcomes of different possible future GHG emissions scenarios. The lower ends of the ranges represent lower emissions scenarios, in which society dramatically reduces heat-trapping gas emissions and atmospheric GHG levels begin to stabilize; the higher ends represent higher emissions scenarios, in which emissions continue to increase and atmospheric GHG concentrations continue to rise. These are not the best and worst cases, however. Sharp cuts in global emissions could result in lower temperature increases, while the outcome of a continuation of business as usual could exceed the highest projections.

37. New York City Panel on Climate Change. *Risk Information 2013: Observations, Climate Change Projections, and Maps*.

38. New York City Panel on Climate Change. *Risk Information 2013: Observations, Climate Change Projections, and Maps*.

39. Rahmstorf, S. *A Semi-Empirical Approach to Projecting Future Sea-Level Rise*. Science: 315(58):368-370. 2007.

higher than the global average.[40] Sea level rise already occurring over time in the New York City area increased the extent and the magnitude of coastal flooding during Hurricane Sandy.

The New York State Sea Level Rise Task Force, charged by the Legislature with developing recommendations for adapting to sea level rise, adopted sea level rise projections for two regions of New York (Table 1A-B).[41] An updated New York City Panel on Climate Change (NPCC2) report, using the latest models and information, concluded higher sea levels in New York City are extremely likely by mid-century and greater than the upper range of regional projections previously estimated for 2020s and 2050 (Table 2).[42, 43]

Table 1A | Projected Sea Level Rise in Two Regions of New York

LOWER HUDSON VALLEY & LONG ISLAND	2020s	2050s	2080s
Sea level rise	2 to 5 in	7 to 12 in	12 to 23 in
Sea level rise with rapid ice-melt scenario	5 to 10 in	19 to 29 in	41 to 55 in

Table 1B | Projected Sea Level Rise in Two Regions of New York

MID-HUDSON VALLEY & CAPITAL REGION	2020s	2050s	2080s
Sea level rise	1 to 4 in	5 to 9 in	8 to 18 in
Sea level rise with rapid ice-melt scenario	4 to 9 in	17 to 26 in	37 to 50 in

Source: *New York State Sea Level Rise Task Force Report*. December 2010.

Table 2 | Projected Sea Level Rise in New York City

NEW YORK CITY SEA LEVEL RISE	LOW- (10TH PERCENTILE)TO HIGH- ESTIMATE (90TH PERCENTILE)
2020's	2 to 11 in
2050's	7 to 31 in

Source: *New York City Panel on Climate Change. Climate Risk Information 2013: Observations, Climate Change Projections, and Maps*. 2013.

40. Sallenger, A.H., Doran, K.S., Howd, P.A. *Hotspot of Accelerated Sea-Level Rise on the Atlantic Coast of North America*. Nature Climate Change. June 24, 2012.

41. *New York State Sea Level Rise Task Force Report*. December, 2010.

42. New York City Panel on Climate Change. *Climate Change Adaptation in New York City: Building a Risk Management Response*. 2010. http://www.nyas.org.

43. New York City Panel on Climate Change. Climate Risk Information 2013: *Observations, Climate Change Projections, and Maps*. 2013.

Future studies evaluating sea level rise will continue to refine estimates and the rate of increase. Tools are under development to provide local regions, policy makers, and planners with better information to understand and respond to the risks of sea level rise and coastal flooding.[44]

Changes in Extreme Events

GHG-induced warming increases evaporation, leading to higher atmospheric water content and a more intense global water cycle with stronger storms. Some of the climate system's responses, such as the observed disproportionate warming in the Arctic, may play a role in turning normal weather events into extremes of drought, flooding, heat or cold.[45]

Extreme weather events, such as heat waves, heavy precipitation, and intense windstorms like Irene and Sandy cause significant impacts on New York's communities and natural resources. A 2012 study by the world's largest reinsurer identifies North America as the region already most affected by climate change-related storms, based on increased frequency and severity of weather-related catastrophes over the last three decades. ClimAID projects more frequent and intense heat waves, more frequent heavy precipitation events and increases in storm-related coastal flooding, especially as sea levels rise. Figure 4 shows the likelihood of extreme events occurring in New York City/Long Island.

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44. The U.S. Global Change Research Program, NOAA, the U.S. Army Corps of Engineers, and FEMA have released a sea-level rise (SLR) planning tool that includes interactive SLR maps and a SLR calculator. This tool provides information on future risk of coastal flooding in parts of New York affected by Hurricane Sandy. Using the best available science and data, federal agencies jointly developed this tool to help State and local officials, community planners, and infrastructure managers understand possible future flood risks from SLR and use that information in planning decisions. U.S. Global Change Research Program. *Sea Level Rise Tool for Sandy* Recovery. http://www.globalchange.gov/what-we-do/assessment/coastal-resilience-resources. The New York State Department of State prepared maps of coastal risk assessment areas with assistance from the National Oceanic and Atmospheric Administration Coastal Services Center (NOAA-CSC) and the Federal Emergency Management Agency (FEMA). Areas covered are New York City and Suffolk, Nassau and Westchester Counties. The maps indicate relative risk (extreme, high and moderate) using the best available topography and a combination of information from FEMA flood insurance rate maps; Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model inundation zones; and SLR and shallow coastal flooding scenarios (http://nysandyhelp.ny.gov/risk-assessment-maps). Scenic Hudson provides its Sea Level Rise Mapper for the Hudson River. This tool uses high-resolution LiDAR topography to produce graphics of high tide and 1-percent flood zones for SLR of up to 72 inches in 6-inch increments. Scenic Hudson. *Sea Level Rise Mapper.* http://www.scenichudson.org/slr/mapper.

45. Balmaseda, M., Trenberth, K., and Kallen, E. 2013. *Distinctive Climate Signals in Reanalysis of Global Ocean Heat Content*. Geophysical Research Letters, Vol. 40, 1754-1759.

Figure 4 | Qualitative Changes in Extreme Events for New York City/Long Island

EXTREME EVENT	PROBABLE DIRECTION THROUGHOUT 21ST CENTURY	LIKELIHOOD[a]
HEAT INDEX[b]	▲	VERY LIKELY
ICE STORMS/ FREEZING RAIN	▲	ABOUT AS LIKELY AS NOT
SNOWFALL FREQUENCY AND AMOUNT	▼	LIKELY
DOWNPOURS (PRECIPITATION RATE/HOUR)	▲	LIKELY
LIGHTNING	UNKNOWN	
INTENSE HURRICANES	▲	MORE LIKELY THAN NOT
NOR'EASTER	UNKNOWN	
EXTREME WINDS	▲	MORE LIKELY THAN NOT

a. Likelihood definitions: Very likely = >90 percent probability of occurrence; Likely = >66 percent probability of occurrence; More likely than not = >50 percent probability of occurrence.

b. The National Weather Service uses a heat index related to temperature and humidity to define the likelihood of harm after prolonged exposure or strenuous activity (http://www.weather.gov/om/heat/index.shtml).

Source: NYSERDA. *Responding to Climate Change in New York State: The ClimAID Integrated Assessment for Effective Climate Change Adaptation.*

Evaluating the Costs of Climate Change

The ClimAID study[46] is an important starting point for evaluating the costs of climate change impacts and adaptation measures in New York. It provides information about the relative size of climate impacts in major economic sectors and the measures that might be undertaken to deal with them. The ClimAID report notes that because New York is a coastal state and is highly developed, the largest direct economic impacts and costs of climate change are likely to occur in coastal areas, associated with infrastructure for transportation, energy and other uses, and with natural resources. However, impacts and costs will be significant statewide, in all the economic sectors examined.

By compiling actual storm losses, governments and insurers are beginning to document the trends and magnitude of the economic risks associated with extreme weather events. For instance:

In 2012, New York requested more than $32 billion in federal disaster reimbursements for damages in New York City and downstate counties from Superstorm Sandy alone, along with an additional $9 billion to help protect the region from future violent storms.[47]

A study titled *Severe Weather in North America* prepared in 2012 for its clients by Munich Re, the world's largest reinsurer, shows an upward trend in the frequency and severity of weather-related catastrophes over the last three decades. North America is the region most affected by this change, because the continent is exposed to every type of hazardous weather peril and our population is growing and moving into more exposed areas. The study concludes that climate change is a significant driver of losses from weather events, although natural climate variability also plays a role. The study estimates the overall economic loss burden from weather catastrophes at $1,060 billion (2011 values).

Without adaptation measures, annual costs in New York State for climate change in the eight sectors analyzed in the ClimAID report are projected at around $10 billion by mid-century. Illustrative cost projections for one or more elements in each sector result in estimates of mid-century (2050s) annual costs (in $2010) of climate change impacts are shown in Table 3. These figures most likely understate the aggregate expected costs, especially for heavily developed coastal areas, because

46. NYSERDA. *Responding to Climate Change in New York State: The ClimAID Integrated Assessment for Effective Climate Change Adaptation.* http://www.nyserda.ny.gov/climaid

47. *Governor Cuomo Holds Meeting with New York's Congressional Delegation, Mayor Bloomberg and Regional County Executives to Review Damage Assessment for the State in the Wake of Hurricane Sandy.* November 26, 2012. http://www.governor.ny.gov/press/11262012-damageassessment they include only selected elements where extrapolations relating to climate data can appropriately be made.[48]

There is a wide range of adaptation options that, if skillfully chosen and scheduled, can reduce the impacts of climate change by amounts in excess of their costs. Analysis shows the greatest reduction in emissions resulting from policies that lead to replacement of petroleum vehicle fuel with electricity, hydrogen, and/or sustainably derived biofuels to reduce the carbon intensity of transportation; vehicle fuel emission standards; strong energy efficiency incentives that support a whole-building, integrated analysis approach to identify high-performance efficiency measures; and policies that promote low-carbon energy sources such as renewables.

New York's investments in energy efficiency and renewable energy are proving to be a significant creator of jobs and economic benefits. Investments in energy efficiency, and the annual savings in energy bills that result from these investments, create net macroeconomic benefits to New York in the form of increased employment, increased Gross State Product, and increased labor income. For example, NYSERDA and the investor-owned utilities have invested about $490 million over the first two years of the Energy Efficiency Portfolio Standard (EEPS) program (2010 and 2011). This investment is estimated to have created over 1000 additional jobs in New York's economy through the end of 2011. Most importantly, the jobs created by investment in energy efficiency are likely to be sustained over the expected lifetime of the measures installed (often 15 years or more) due to the continuous stream of annual savings in energy bills.

Based on projects initiated through 2012, investment of about $880 million in construction of renewable resources (mostly utility-scale wind turbines) through the ratepayer-funded Renewable Portfolio Standard (RPS), is estimated to leverage more than $2.9 billion in private investment in the New York economy, largely provided by investors from outside the State. Construction of these renewable energy projects has created about 1,400 net jobs through the end of 2012. Even after the labor-intensive construction is completed, these projects are estimated to sustain an average of about 700 net jobs as they operate over the next two decades. The sustained jobs are primarily due to operation

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48. Because of differences in method and data availability and the extent of coverage within sectors, these numbers are not directly comparable. For example, the high annual costs in public health are partly a function of EPA's estimate of the value of a statistical life.

and maintenance of the renewable projects, as well as continued lease payments by the developers to landowners and local governments.

Table 3 | Available Estimated Annual Incremental Impact and Adaptation Costs of Climate Change at Mid-Century for Specified Components of the ClimAid Sectors. (Values in $2010 U.S.)

SECTOR	COST COMPONENT	COST OF ANNUAL INCREMENTAL CLIMATE CHANGE IMPACTS (AT MIDCENTURY, SELECTED COMPONENTS, W/O ADAPTATION)	COSTS OF ANNUAL INCREMENTAL CLIMATE CHANGE ADAPTATIONS (AT MID-CENTURY, SELECTED COMPONENTS)	BENEFITS OF ANNUAL INCREMENTAL CLIMATE CHANGE ADAPTATIONS (AT MIDCENTURY, SELECTED COMPONENTS)
Water Resources	Flooding at Coastal Wastewater Treatment	$116-203 million	$47 million	$186 million
Coastal Zones	Insured losses	$44-77 million	$29 million	$116 million
Ecosystems	Recreation, tourism, ecosystem service losses	$375-525 million	$32 million	$127 million
Agriculture	Dairy and crop losses	$140-289 million	$78 million	$347 million
Energy	Outages	$36-73 million	$19 million	$76 million
Transportation	Damage from 100-year storm	$100-170 million	$290 million	$1.16 billion
Communications	Damage from 100-year storm	$15-30 million	$12 million	$47 million
Public Health	Heat mortality and asthma hospitalization	$2.99-6.10 billion	$6 million	$1.64 billion
ALL SECTORS	**TOTAL OF AVAILABLE ESTIMATED COMPONENTS**	**$3.8–7.5 BILLION/YR**	**$513 MILLION/YR**	**$3.7 BILLION/YR**

Source: NYSERDA. *Responding to Climate Change in New York State: The ClimAID Integrated Assessment for Effective Climate Change Adaptation.*

In connection with the estimates in Table 3, ClimAID notes that although some of New York's economic sectors are more at risk from climate change than others, all sectors are likely to experience impacts significant enough to alter their overall structures and functions. The highest direct economic costs of climate change are connected to large scale capital investment, housing, and commercial activity in the coastal zone. Water- and flooding-related management costs will affect almost all sectors. Annual public health cost estimates for New York (due to heat mortality and asthma hospitalization without implementation of protective "adaptation" strategies) have been projected to reach $3 to 6 billion by mid-century–higher than costs for any other impacted sector; e.g., agriculture, water resources, and energy. Significant adaptation costs are also projected for the health sector, and net benefits comparing avoided impacts to costs of adaptation for the Public Health sector are among the highest of all the sectors.

Key Greenhouse Gas-Related Policies and Programs in New York

New York has in place several policies and programs that currently are reducing GHG emissions, and others that position the State for reduced emissions in the future, helping to pave the way to meeting long-term climate goals. In addition, research in areas relating to GHG emissions has the potential to save significant cost in the future for public and private sectors, and to seed commercial and industrial ventures that will be important to the State's future economic success.

Regional Greenhouse Gas Initiative

RGGI is a nine-state cooperative effort to reduce GHG emissions from electric power plants by means of a cap-and-trade system.[49] As the nation's first market-based program to cap and cost-effectively reduce the GHG emissions that cause climate change, RGGI has reduced air pollution while helping the economy: region-wide, a recent independent analysis concludes that the first three years of RGGI investments are reducing energy bills by $1.3 billion, increasing domestic product by $1.6 billion, and creating 16,000 jobs.[50] The RGGI states have committed to amend the statutes and/or regulations that established their CO_2 Budget Trading programs (6NYCRR Part 242) to conform to the provisions of the updated Model Rule, taking effect by January 1, 2014. 6NYCRR Part 242 was amended on November 27, 2013 by DEC.

Carbon Dioxide Performance Standards for Fossil Fuel-Fired Power Plants

The CO_2 performance standard for new fossil-fueled fired power plants is based on the emission rate achievable by a new natural gas-fired plant and applies to power plants with a capacity of at least 25 MW. See 6 NYCRR Part 251.

Cleaner Greener Communities Program

By providing resources for developing and implementing regional sustainability plans, this $100 million competitive grant program encourages communities to adopt regional growth strategies that are environmentally sustainable.

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49. The RGGI-participating states are Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island and Vermont.

50. Analysis Group. *The Economic Impacts of the Regional Greenhouse Gas Initiative on Ten Northeast and Mid-Atlantic States (Review of the Use of RGGI Auction Proceeds from the First Three-Year Compliance Period)*. November 2011.

Smart Growth Public Infrastructure Policy Act

This law aims to shift State-supported projects, including transportation, sewer and water treatment, water supply, education and housing, away from sprawl and toward compact development that conserves resources by favoring use or improvement of existing infrastructure; location of projects in municipal centers and other developed areas; mixed land uses and compact development; preservation of open space and other resources; improved public transport and reduced automobile dependency; and collaboration with regional and local planners.

New York Adoption of California GHG Vehicle Standards

These standards will reduce GHG emissions from new cars by 37 percent and from light trucks by 24 percent by 2016. The standards also include revised mandates for the sale of electric and other zero emission vehicles (ZEVs), which will require the cumulative sale of approximately one million ZEVs by 2025. See 6 NYCRR Part 218. The NY Charge initiative complements these standards by supporting the development of electric vehicle infrastructure.

Transportation and Climate Initiative

The transportation, environment, and energy agencies of 11 Northeast and Mid-Atlantic states and the District of Columbia are coordinating strategies and policies for the first time to reduce GHG emissions from the transportation sector through improving transportation system efficiency, minimizing reliance on high-carbon fuels, promoting sustainable growth that enhances quality of life, and addressing the challenges of vehicle-miles traveled.

The State's climate goals are also supported by clean energy efforts discussed previously, including the Renewable Portfolio Standard (30 percent by 2015); the Energy Efficiency Portfolio Standard (15 percent by 2015); and the New York Energy Highway.

Environmental Resources

New York's energy system is the source of many benefits for New Yorkers. It also causes significant impacts on the State's natural resources and public health, principally because of emissions to air of a variety of substances, some of which find their way into water and other resources. Combustion of fossil fuels is the dominant source of energy-related emissions. Fossil-fuel combustion occurs in power plants, on building sites for space heat and industrial process power, and in vehicles to transport goods and people.

New York actions to reduce the negative health and environmental impacts of energy production, delivery, and use have resulted in great improvements in both air quality and water quality over the last 40 years. For the purposes of this section, GHG emissions related to the production of fuels are not discussed here.

Electricity Generation

Of the primary energy input (in British thermal units (Btus)) for New York electricity generation in 2011, 31 percent is from natural gas. Nuclear makes up 26 percent, hydroelectric 17 percent, coal 6 percent, and petroleum and other fuels (such as biofuels, landfill gas, wood and refuse) 2 percent. Electricity from wind is 2 percent. Imported electricity accounts for 15 percent of generation in 2011.[51]

Coal-fired power generation is responsible for the release of significant amounts of CO_2 and other criteria and toxic air pollutants; burning fuel oil produces many of the same air pollutants as coal. Biofuels, refuse, and other waste materials are also used to generate electricity. The estimated aggregate emissions of primary $PM_{2.5}$, primary PM_{10}, carbon monoxide (CO), volatile organic compounds (VOCs),[52] oxides of nitrogen (NO_X) and sulfur dioxide (SO_2) from electricity generation and other energy use sectors in New York are illustrated in Tables of Appendix 1. Electric utilities are the greatest source of SO_2 emissions in the State. Based on preliminary 2011 data, SO_2, NO_X, and CO_2 power plant emissions have declined by 86 percent, 76 percent and 36 percent, respectively since 2000.[53]

All electric generating facilities, new and old, must receive air permits from the DEC to operate. However, older existing facilities are not required to meet the same stringent emissions requirements that must be met by new facilities. Generally, older facilities that are less efficient and lack up-to-date pollution control systems release more pollutants than more modern facilities, or those that have been retrofited with pollution control devices or repowered with new units. For example, advanced, state-of-the-art sulfur control technologies ("wet scrubbers") can provide SO_2 removal in excess of 95 percent.

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

52. Primary emissions (of $PM_{2.5}$ (particles less than 2.5 microns in diameter) and PM_{10} (particles less than 10 microns in diameter)) refer only to particulates directly emitted from sources and do not account for secondary formation of particles resulting from emissions of precursors such as SO_2 and NO_X. Secondary formation is more significant for $PM_{2.5}$ than PM_{10}.

53. NYISO. *Power Trends 2012: State of the Grid*. 2012.

There are a number of older electric generating facilities in New York that have not been retrofitted with new emissions controls, nor repowered with new units. DEC has implemented a regulation for the installation of Best Available Retrofit Technology (BART) for pollution control on central station power plants and other stationary sources built between 1962 and 1977 that are not controlled under other programs. The regulation only applies to sources with emissions of NO_X, SO_2, and/or PM_{10} which contribute to visibility impairment in downwind "Class I areas" e.g., national parks and wilderness areas. Other non-regulatory methods of encouraging retrofitting of older electric generating facilities with modern pollution control equipment could also help to lower emissions from these facilities.

A relatively small amount of New York's electricity supply is generated by distributed electricity generation (DG), which involves the use of smaller energy sources that are closer to the point of use. Distributed generation sources, typically small, older, diesel generators with poor emission profiles, are present throughout the State. A large concentration of diesel generators is in downstate non-attainment areas where air pollution levels exceed the National Ambient Air Quality Standards (NAAQS). DG sources emit NO_X, a precursor to ground-level ozone, and $PM_{2.5}$. Individually, these sources are typically considered minor sources since they are usually part of a facility, e.g., hospital or business. The cumulative impact of these DG sources can be significant because these sources will usually operate simultaneously during periods of high demand, i.e., summer months when the New York Independent System Operator (NYISO) calls upon other facilities to cease drawing power from the grid or when power is not available from the grid due to outages. Due to their short stacks, which do not disperse exhaust plumes as effectively as plumes from central station power plants, DG sources can have a greater impact on populations living and working in their vicinity. Clean, renewable DG has a promising role in reducing air pollution impacts and increasing resiliency of the electric grid.

Natural Gas

Natural gas-fired facilities are the cleanest fossil fuel electric generating facilities, releasing primarily GHG pollutants and NO_X. Natural gas-fired facilities are located throughout New York but are primarily situated in the peak load areas including the Hudson Valley, New York City, and Long Island. Economic, operational, and environmental advantages make natural gas the current fuel of choice for new and replacement generation in New York.

CO_2 emission rates for natural gas combustion in New York are approximately 50 percent lower than emissions from coal combustion and 30 percent lower than those from oil combustion. Average NO_X emissions from natural gas in New York are 86 percent lower than oil and 81 percent lower than coal. When compared with other fossil fuels, natural gas has negligible emissions of SO_2, at only 3 percent of those of oil and coal.[54] Methane, the primary component of natural gas and GHG, is also released when natural gas is not burned completely.[55]

Nuclear

Currently, six nuclear generating facilities are operating in New York: Indian Point Units 2 and 3, Nine Mile Point Units 1 and 2, James A Fitzpatrick and R.E. Ginna. Nuclear power plant operation results in very low emissions of criteria pollutants, GHGs, and other non-criteria pollutants, but it has other potential negative environmental impacts.

Permitted Radioactive Discharges to Air, Surface Water or Groundwater

Nuclear power plants have radioactive emissions that result from routine operations. To minimize radiation exposure to the public, nuclear power plants are regulated by the U.S. Nuclear Regulatory Commission (NRC), who requires radioactive emissions to be As Low As Reasonably Achievable (ALARA), based on specified radiation exposures.[56]

Potential for Unscheduled Releases of Radioactive Materials

Several minor nuclear power plant accidents in the U.S. have had atmospheric releases that were higher than those for routine operations, but still less than the ALARA limits, including Site Area Emergencies at R.E. Ginna in 1982[57] and at Indian Point in 2000.[58] In addition, leaks of

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54. EPA. *Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources: AP-42, Fifth Edition*. 1995. http://www.epa.gov/ttn/chief/ap42/

55. Kirchgessner, A. *Natural Gas Industry: Chemosphere*. 1997. Sep 35(6):1365-90.

56. To be considered ALARA, radioactive releases to the atmosphere must be limited to a quantity that will not result in an annual dose to a member of the public in excess of 10 millirem for gamma radiation and 20 millirem for beta radiation or a total dose to any organ in excess of 15 millirem. Radioactive releases to surface- or ground-water must be limited to a quantity that will not result in an annual dose to a member of the public in excess of three millirem to the whole body or 15 millirem total dose to any organ through all routes of exposure. U.S. Code of Federal Regulations (USCFR). A*ppendix I to Part 50--Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion "As Low as is Reasonably Achievable" for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents:* 72 FR 49507. 2007.

57. Martin, Tami T. *NRC Report on the January 25, 1982 Steam Generator Tube Rupture at R. E. Ginna Nuclear Power Plant: NUREG-0909*. 1982.

58. NRC. *Steam Generator Tube Failure at Indian Point Unit 2. NRC Information Notice 2000-2009*. 2009.

radioactive liquid effluents into the groundwater on-site have occurred at several U.S. nuclear power plants. These liquid effluents are primarily contaminated with tritium, but may also contain small quantities of other radioactive materials. Liquid effluents may also seep into lakes and rivers that provide heat sinks for nuclear power plants. Although any effluents released are diluted, the potential exists for bioaccumulation of radioactive materials in aquatic life, which would in turn result in radiation exposures to persons who consume them. Groundwater drinking water sources may also be contaminated at levels that may require mitigation.

Production, Transportation, Processing and Disposal of Radioactive Wastes and Nuclear Fuel

New nuclear fuel is primarily uranium-238 and uranium-235. Both of these materials have long half-lives and are, therefore, not very radioactive. The process used to produce nuclear power converts uranium-235 into radioactive materials such as cesium-137 and strontium-90 which have relatively short half-lives and is highly radioactive.

Nuclear fuel is not produced in New York; rather it is transported to the nuclear power plants via rail and truck in specialized shipping containers. These containers are designed to withstand severe accident conditions, including high temperature fires, collision, and submersion in water. Every two years, one-third of the fuel in the core of a nuclear power plant is off-loaded and replaced with new fuel. The spent fuel (high-level radioactive waste) is transferred under water through a channel to the spent fuel pool, where it is stored in underwater racks. The water provides physical cooling and radiation shielding. If fuel is damaged during transfer, safety systems at the plant are in place to mitigate releases of radioactive materials.

In cases where the spent fuel pools are at or nearing capacity, spent fuel may be removed from the pool and stored in specialized or dry casks on plant property. All of the nuclear power plants in the State either have or are in the process of building interim spent fuel storage areas on plant property near the reactor. There are normally no radioactive emissions from dry cask storage; but if there were any emissions, they would be subject to the same ALARA limits described above. In the absence of alternative storage options, it is necessary to store spent fuel rods on site long after a reactor discontinues operation (as with several New England plants). In these cases, the facility continues to be staffed 24 hours a day in order to maintain oversight of the fuel storage facility. Another option for spent fuel is reprocessing to reclaim unused uranium and plutonium for use in new fuel, but reprocessing of commercial nuclear fuel does not currently occur in the U.S.

Coal

Coal-fired facilities are primarily located in the western part of the State where many of these facilities have operated for several years. Many of these facilities are located on freshwater lakes and rivers, such as Lake Erie, Lake Ontario, Finger Lakes, Susquehanna River, and Hudson River.

Although current air regulations require these facilities to install controls to minimize air impacts, they continue to emit large amounts of pollutants, including PM, SO_2, NO_X, CO, CO_2; heavy metals including mercury; acid gases; and a number of organic compounds. In addition, coal contains naturally occurring metals such as uranium and thorium that emit radiation. Specific air contaminants and their emission rates from coal combustion depend on the type of coal, the type and size of the boiler, firing conditions, load, type of control technologies, and the level of equipment maintenance. Under DEC's permitting program, SO_2 emissions limits for a new coal-burning facility (0.1 to 0.2 lb/MMBtu)[59], based on the best available control technology, are generally two to three times higher than those from a new oil-burning facility (0.06 lb/ MMBtu) and approximately two to three hundred times higher than a new gas-burning facility (0.0006 lb/ MMBtu). Based on U.S. Environmental Protection Agency's (EPA) Emissions and Generation Resource Integrated Database (eGRID), the average emission rates in New York for 2007 from oil-fired facilities for SO_2, and NO_X were much higher than natural gas-burning facilities, as shown in Appendix 1, Tables 8A and 8B. Analysis of DEC's 2007 emissions inventory shows that coal was the dominant source of $PM_{2.5}$, PM_{10}, NO_X, and SO_2 for electric utilities.[60] Tables 8A and 8B also show that coal releases more CO_2 than oil- and natural gas-burning facilities. Annual emissions from coal-fired electricity facilities of NO_X and SO_2 decreased between 1995 and 2010 by 76 and 82 percent respectively.[61]

59. Million British thermal units

60. EPA. *The Emissions and Generation Resource Integrated Bdatabase*. Version 1.1 eGRID. 2010. http://www.epa.gov/cleanenergy/energy-resources/egrid/index.html

61. DEC. *Division of Air Resources*. 2011.

Petroleum Fuels

Two main grades of fuel oil are burned by electric generating facilities: distillate oil (#2 fuel oil) and residual oil (#6 fuel oil). However, other distillate fuels, e.g. diesel, kerosene, jet fuel, and home heating oil, are also used to power peaking units and provide backup fuel capability at natural gas powered plants. Emissions depend on the grade and composition of the fuel, type and size of the boiler used, firing and loading practices, and the level of equipment maintenance. Burning fuel oil produces many of the same criteria and non-criteria pollutants as coal. Compared to residual oils, distillate fuel oils are more volatile, have lower nitrogen and ash content, and usually contain less sulfur by weight. Combustion of distillate oils results in significantly lower PM formation than does combustion of heavier residual oils.[62] Based on EPA's eGRID, the average emission rates in New York for oil combustion for electricity generation in 2009 for CO_2, SO_2, and NO_X were considerably higher than those for natural gas, as shown in Appendix 1, Table 8A.[63]

Municipal Waste-to-Energy Facilities

New York has 10 active facilities that combust municipal solid waste to generate electricity ("waste-to-energy" or WTE). In 2011, these facilities processed approximately four million tons of solid waste and generated approximately two million megawatt hours of electricity. Additionally, they recovered approximately 90,000 tons of metals for recycling. Permitted fuels vary from facility to facility but may include industrial waste, municipal solid waste (residential/institutional and commercial), construction and demolition debris, regulated medical waste, and waste tires.

Combustion of municipal solid waste can release PM, metals, organic compounds (including VOCs, dioxins, and furans), acid gases, and oxides of nitrogen and sulfur.[64] Though emission rates on a per megawatt hour comparison for NO_X from WTE facilities are higher than those for coal, SO_2 emissions are lower than those from coal combustion. Additionally, mercury, cadmium, and CO are higher on a per megawatt hour

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62. EPA. *Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources: AP-42, Fifth Edition*. 1995. http://www.epa.gov/ttn/chief/ap42/

63. EPA. *The Emissions and Generation Resource Integrated Bdatabase: Version 1.1 eGRID*. 2010. http://www.epa.gov/cleanenergy/energy-resources/egrid/index.html

64. Tchobanoglous, George. *Integrated Solid Waste Management; Engineering Principles and Management Issues*. New York, NY: McGraw-Hill. 1993.

comparison for WTE facilities as compared to coal. See Appendix 1, Table 8A for New York emissions for coal and oil.[65]

WTE emissions that can pose health concerns include dioxins, furans, polycyclic aromatic hydrocarbons, mercury, and other heavy metals.[66] Emissions have been greatly reduced, e.g., by greater than 99 percent for chlorinated dibenzo-p-dioxins and chlorinated dibenzofurans, over the last 25 years through retrofitting facilities with maximum achievable control technology.[67] Barring certain waste from entering the municipal waste combustion facility waste stream, e.g., batteries and fluorescent light bulbs, to reduce mercury emissions has also resulted in less harmful stack emissions. Emissions data from modern, state-of-the-art municipal waste combustors demonstrate that they operate well within their permitted limits and in some instances, at a fraction of those limits.

Ash is an unavoidable byproduct of municipal WTE plant operations. Ash from WTE facilities has several beneficial uses, but is primarily used as daily cover at active landfills, which combats rodent and windblown debris problems, and provides a sturdy base for vehicles.

Landfill Gas-to-Energy Facilities

Extraction of landfill gas for energy recovery can reduce non-methane organic compound (NMOC) releases from landfills, mitigate unpleasant landfill odors, and reduce landfill gas contributions to global climate change and ozone depletion. Air pollutants from power systems burning scrubbed landfill gas include CO_2, NO_X,and trace amounts of toxic materials.[68] The amounts of these emissions vary depending upon waste mass characteristics, facility design, and operator-controlled adjustments. Sulfur removal at landfill gas-to-energy facilities may be particularly advantageous, in that sulfur removal nearly eliminates the potential for air emissions of SO_2 combustion product. Emissions of some pollutants from power systems burning scrubbed landfill gas can be relatively high, on a per kilowatt hour (kWh) basis, compared with emissions from power plants burning pipeline natural gas, due to more frequent use of internal

65. EPA. *Clean Energy*. 2012. http://www.epa.gov/cleanenergy/energy-and-you/affect/air-emissions.html
66. NRC. *Waste Incineration and Public Health*. Washington D.C.: National Academy Press. 2000.
67. EPA. *Emissions from Large and Small MWC Units at MACT: Compliance from Walt Stevenson, EPA Office of Air Quality Planning and Standards, to the Large MWC Docket*. 2007.
68. EPA. *Landfill Methane Outreach Program: Basic Information*. 2011. http://epa.gov/lmop/basic-info/index.html

combustion engines, rather than turbines, at landfill gas-to-energy facilities.[69, 70, 71, 72]

Biogas Recovery for Power Generation

Organic wastes from New York's farms, municipal wastewater treatment plants, and food and beverage manufacturing facilities are of particular interest with regard to biogas and its potential to generate clean, renewable heat or electric power. Such fuel use for biogas from wastes converts methane, a potent GHG, into less potent CO_2, displaces fossil fuels in the transportation and energy sectors, and also avoids water and air pollution. A conservative estimate of energy potentially available to New York from biogas is approximately 10 trillion Btus.

Anaerobic digester technology has long been used to manage the organic components of municipal wastewater by controlling the breakdown of organic materials and capturing the resulting biogas. Wider adoption of anaerobic digestion can help expand New York's renewable energy portfolio. Farms and wastewater treatment facilities equipped with digesters and biogas-powered electric generators can market locally-sourced clean energy, contribute consistent, base load power to the grid, reduce loads on transmission and distribution equipment, and provide waste heat for onsite and offsite use. In particular, excess power generated by farms could benefit the grid by serving local electric loads in the areas around these farms. Unlike facilities using other alternative carbon-based fuels discussed herein, manure-to-energy plants are individually incapable of generating substantial amounts of electricity.[73, 74] An advantage of these facilities is that they can use manure blended with food waste, which eliminates carbon emissions normally associated with off-site disposal of food waste.[75]

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69. Caterpillar. *A Typical Internal Combustion Engine*. 2011.

70. GE Energy. *6B Heavy Duty Gas Turbines. 2011*. http://www.ge-energy.com/products_and_services/products/gas_turbines_heavy_duty/6b_heavy_duty_gas_turbine.jsp.

71. Lee, Jechan. *A Study on Performance and Emissions of a 4-Stroke IC Engine Operating on Landfill Gas with the Addition of H_2, CO and Syngas. Master of Science thesis, Columbia University, New York, New York*. 2010.

72. Bove, Roberto., and Lunghi, Piero. *Electric Power Generation From Landfill Gas Using Traditional and Innovative Technologies*. Energy Conversion and Management. 2006. 47; 11-12:1391-1401.

73. Cornell University. *Anaerobic Digestion: Performance Evaluation of Seven On-Farm Digesters in NYS*. 2012.

74. NYSERDA. DG/CHP *Intergrated Data System*. 2012. http://chp.nyserda.org/facilities/index.cfm?sort=Fuel&order=ASC&Filter=ALL

75. Scott NR, Ma J. & Aldrich BS. 2005. *Using food wastes in farm-based anaerobic digesters. Northeast Dairy Business. Innovations in Manure Management (special section)*. http://www.manuremanagement.cornell.edu/Pages/General_Docs/Press_Articles/NYSERDA_Innovations_in_MM_February_2005.pdf.

Revenues generated from on-farm biogas and other renewable energy resources could help some farmers eventually reduce operating costs and support the costs of adapting their facilities and operations to climate change. New York's Renewable Portfolio Standard Customer-sited Tier Anaerobic Digester Gas-to-Electricity Program already has helped to develop approximately 3.5 megawatt (MW) of farm and wastewater treatment facility-based anaerobic digester gas systems, and another 13.5 MW is under development.

However, several current circumstances limit biogas electricity generation. State assistance in breaking down these barriers would improve adoption of renewable biogas generation. For instance, on-farm use of biogas is limited by an individual farm businesses' ability to invest significant planning time and capital when rates of return span multiple years in which weather, disease, pests, and market conditions are unpredictable. Transmission and distribution charges for farms are based almost entirely on demand, rather than consumption – that is, under current net metering rules excess power exported to the grid is only valued using wholesale rates. As a result, the overall value of net metering to most on-farm biogas projects in New York is significantly less than it would be if they were on a residential style tariff.

Similar limitations affect wastewater treatment plants that receive large quantities of industrial organic waste. For these facilities, legal constraints on net-metering excess power to the grid make biogas generation less attractive. Both municipal and agricultural operations are limited by high costs for interconnection to the electric power grid and local grid capacity improvements.

Wood-Based Biomass Burning Facilities

Wood is a biomass fuel that can take different forms such as firewood, chips, pellets, and sawdust. The use of biomass for electricity generation is supported by the Renewable Portfolio Standard in New York and electricity modeling for the 2013 State Energy Plan indicates that its use is increasing.[76] Currently, there are five electric generating facilities in New York that burn wood-derived fuels, and one that is under development. The amount and kind of emissions depends on the nature of the wood fuel, moisture content, the temperature of the fire, and the

76. NYSERDA. *The New York State Renewable Portfolio Standard Performance Report*. 2012. http://www.nyserda.ny.gov/Publications/Program-Planning-Status-and-Evaluation-Reports/Renewable-Portfolio-Standard-Reports.aspx amount of oxygen available.[77] Compared with coal, biomass feedstocks contain less sulfur, resulting in lower SO_X emissions.[78] For some wood waste product fuels, burning of residual glues may increase emissions of NO_X and other chemicals. Biomass generation can result in very low net CO_2 emissions if carbon life-cycle accounting allows for sufficient regrowth of the biomass feedstock to resequester the carbon emitted through combustion.

Transportation

The transportation sector was responsible for 27 percent of the primary energy use in New York in 2011, in addition to a small amount of electricity consumption.[79] The transportation sector releases air contaminants from burning carbon-based fuels and from evaporative fuel losses, and is responsible for 34 percent of the total GHG emissions in New York. As shown in Appendix 1, Table 7F the transportation sector releases the vast majority of emissions of CO and the ozone-precursors NO_X and VOCs. Transportation sources are responsible for more primary $PM_{2.5}$ emissions than the electricity-generating sector (Appendix 1, Table 7F). Of transportation sources, on-road gasoline vehicles contribute the most emissions of NO_X, VOCs and CO and on-road diesel engines contribute the majority of the primary $PM_{2.5}$ emissions (Appendix 1, Table 7E).

Currently, most transportation source emissions result from combustion of gasoline and traditional petroleum-based diesel fuel. Even with recent implementation of federal requirements for use of ultra-low sulfur diesel (ULSD) fuel to reduce on-road vehicle PM emissions, diesel-burning cars still emit more than thirty times as much $PM_{2.5}$ per mile driven than gasoline-powered cars.[80] There are no requirements for ULSD currently in place for some non-road sources, though requirements for various source categories are being phased in over the next few years. Emission control technologies for new and existing diesel engines are available.

The two most commonly used biofuels are ethanol and biodiesel. While ethanol is almost exclusively used as a gasoline substitute in the

77. EPA. *Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources: AP-42, Fifth Edition*. 1995. http://www.epa.gov/ttn/chief/ap42/

78. EIA. *Biomass for Electricity Generation*. 2012. http://www.eia.gov/oiaf/analysispaper/biomass/

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

80. Estimated 2008 average New York State emissions for diesel and gasoline cars are 0.115 and 0.004 grams per mile, respectively. Source: EPA Mobile 6.2 Vehicle Emission Modeling Program.

transportation sector, biodiesel is used as a substitute for distillate fuels in the transportation, heating, and potentially the electric power generation sectors. Biodiesel has begun to penetrate the residential home heating fuel market. The State has supported the development of advanced cellulosic ethanol production.

Stationary Uses (Residential, Commercial and Industrial [RCI])

The RCI sector includes onsite fuel combustion, industrial process emissions, as well as fugitive methane emissions from natural gas transmission and distribution. Energy-related RCI emissions result principally from the onsite combustion of oil and natural gas, with a smaller contribution by onsite combustion of coal. RCI sector emissions are largely related to heating/cooling and lighting. Industrial sector emissions are largely related to power generation. The RCI sector is the largest source of GHG emissions in New York, accounting for 36.7 percent of gross GHG emissions in 2011.

According to DEC's 2007 emissions inventory data for New York, the residential sector alone is responsible for more primary $PM_{2.5}$ emissions than the electric utility, commercial, and industrial sectors combined, and a substantial fraction of the PM_{10} emissions, as shown in Appendix 1, Table 7F. The vast majority of these residential PM emissions are from wood combustion in fireplaces and wood stoves, even though wood makes up only a small fraction of the primary energy use in this sector. Residential wood combustion in fireplaces and wood stoves is also estimated to be the second most significant source of VOC and CO emissions, as shown in Appendix 1, Tables 7D and 7F. However, wood combustion emissions estimates for this sector have large inherent uncertainty due to wide variation in wood combustion technology performance, consumer behavior and burning practices, and wood quality (e.g., seasoned wood, wood chips and pellets).[81, 82]

The residential sector is only subject to limited permitting requirements. This sector is regulated through limits on the sulfur content of oil or coal, PM emission standards for indoor wood stoves, and DEC promulgated PM emission standards for new outdoor wood boilers (OWBs).[83] OWBs provide space heating, whole house heating,

81. NARSTO. Report #10-001: *Improving Estimates of Air Pollutant Emissions in the Northeast and Mid-Atlantic States.* March 2010.

82. NYSERDA. *Assessment of Carbonaceous $PM_{2.5}$ for the New York and the Region.* March 2008.

83. 6 NYCRR, Part 247: Outdoor Wood Boilers and domestic hot water using heaters. Due largely to their design (low temperature, oxygen-starved combustion and cyclical operation), studies have shown that OWBs are significant emitters of particulate matter, CO and other pollutants, and OWBs have significantly higher emissions than other EPA-certified wood burning appliances, especially when over-sized for heating needs.[84, 85] Because of numerous complaints about excessive smoke associated with OWBs, DEC established emission limits, set-back and stack-height requirements for new OWBs. While the OWB regulation addresses new OWB installations, emissions from older OWBs, conventional wood stoves and wood boiler technologies could still result in problems associated with excessive smoke.

The industrial sector is also a significant source of SO_2, as shown in Appendix 1, Table 7F, even though it burns a relatively small amount of fuel compared to other sectors. The majority of these industrial PM_{10} and SO_2 emissions are from coal combustion, although coal accounted for only approximately 13 percent of the total energy used (in Btu) by industrial sources.[86] The commercial sector is a relatively small contributor to emissions of PM, NO_X, SO_2, VOCs, and CO and most of its emissions of these pollutants are the result of fuel oil combustion.

Woody biomass fuels for institutional, commercial, and industrial (ICI) applications to heat buildings and generate electricity use are proliferating across the Northeast driven by economics (relatively low costs of wood), increasing demand for renewable energy sources, and subsidies to off-set costs. Variations in woody biomass characteristics (i.e., moisture content) can vary emissions. Over-sized boilers, inadequate emission controls, and poor dispersion of these pollutants could lead to increased environmental impacts and health risks.[87, 88] While traditional stoker boilers directly combust the wood, advanced, high efficiency two-stage biomass combustion systems with thermal storage are associated with higher efficiencies and more complete combustion than traditional

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84. Office of the Attorney General (OAG). *Smoke Gets in Your Lungs: Outdoor Wood Boilers in New York State*. 2008.

85. NYSERDA. *Environmental, Energy Market, and Health Characterization of Wood-Fired Hydronic Heater Technologies*. June 2012.

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

87. Hoppin, P. and Jacobs, M. 2012. *Wood Biomass for Heat & Power: Addressing Public Health Impacts*. U. Mass. Lowell Center for Sustainable Production. http://www.sustainableproduction.org/proj.envh.woodbiomass.symposium.php

88. U.S. Forest Service. Emission Controls for Small Wood-fired Boilers. May 2010. http://www.wflccenter.org/news_pdf/361_pdf.pdf systems.[89] Still, these advanced technologies emit more than the displaced fuels.[90]

Conventional biomass heating in the U.S. consists mainly of wood and pellet stoves, fireplaces, and residential and commercial wood boilers. The majority of biomass devices in use are low-efficiency and high emitting (including $PM_{2.5}$, hydrocarbons, and CO) compared to ultra-low sulfur fuel oil use. As residential wood heating has increased in New York, wood smoke has become an important source of wintertime ambient $PM_{2.5}$, especially in valley locations, both in rural and urban areas.[91] For example, studies have shown that in rural New York, more than 90 percent of carbonaceous $PM_{2.5}$ is wood smoke;[92] and winter nighttime particulate matter levels in northern towns and villages can exceed 100 micrograms per cubic meter.[93]

Energy Distribution

The State's energy system includes the transmission of energy over electric transmission lines and the movement of fuel through natural gas pipelines and refined petroleum product pipelines. Construction and operation of energy transmission facilities can result in direct disturbances to agricultural land, wetlands, streams and other water bodies, protected State lands, and other terrestrial habitats. In addition to the clearing and loss of habitat, construction may result in storm water runoff, siltation of streams, and destruction of wetland vegetation. Maintenance of right-of-ways (ROWs) involves periodic clearing of vegetation, the use of herbicides, and the installation of permanent infrastructure and access roads-sometimes in sensitive environments.

Pipeline installation projects must obtain DEC's authorization to discharge storm water, including a requirement to prepare a Storm Water Pollution Prevention Plan (SWPPP) that details construction erosion and sediment controls and post-construction storm water controls and

89. Hoppin, P. and Jacobs, M. 2012. *Wood Biomass for Heat & Power: Addressing Public Health Impacts.* U. Mass. Lowell Center for Sustainable Production. http://www.sustainableproduction.org/proj.envh.woodbiomass.symposium.php

90. Chandrasekaran, S.R., Laing, J.R., Holsen, E.M, Raja, S., Hopke., P. *Emission Characterization and Efficiency Measurements of High-Efficiency Wood Boilers.*

91. Wang, Y., Hopke, P., Xia, X., Rattigan, O., Chalupa, D.C. 2012. *Source Apportionment of Airborne Particulate Matter Using Inorganic and Organic Species As Tracers.* Atmospheric Environment. Vol. 55 (525-532).

92. NYSERDA. Assessment of Carbonaceous $PM_{2.5}$ for New York and the Region. March 2008.

93. NYSERDA. *Spatial Modeling and Monitoring of Residential Woodsmoke Across a Non-Urban Upstate New York Region.* February 2010.

maintenance. Where the provisions of a water quality certificates (WQC) apply, DPS, in consultation with DEC may also impose conditions to ensure that water quality standards that protect fish and wildlife species are met.

The construction and operation of transmission lines are governed by proceedings convened before the Public Service Commission (PSC). In these proceedings, protective standards for agricultural land, streams, and wetlands will be incorporated into the construction and operation conditions for the project to avoid or minimize environmental impacts. Depending on the classification of wetlands, disturbances that cannot be avoided or minimized must be mitigated, generally by a habitat restoration project near the site of construction. Scenic and ecological sensitive areas such as the Adirondack and Catskill Parks could be particularly impacted by the siting of new transmission lines. The siting of new transmission line corridors through State-owned lands within the Parks will require a Constitutional amendment, which is a time-consuming process with an unpredictable outcome. Outside the Parks, transmission corridors on State-owned lands may require either a Constitutional amendment or a statutory change, depending on the location and classification of the lands in question.

Endangered, threatened, and special concern species and habitats may also be affected by transmission facility construction. Project sponsors may be required to obtain a special permit that allows temporary disturbance of habitat during construction. Likewise, the existence of rare or endangered plants or rare ecosystems may require environmental assessment studies prior to approval of a project to determine expected impacts and appropriate avoidance or mitigation measures. As with pipelines, WQC conditions may also protect water quality and associated fish and wildlife.

Transmission and pipeline infrastructure projects that are located in, or which affect, the State's coastal area, and the siting of offshore wind turbines, must be reviewed by the New York Department of State (DOS) for consistency with the policies of the State Coastal Management Program and any applicable Local Waterfront Revitalization Programs (LWRPs). Many energy projects require cable or pipeline construction that traverse near-shore and shallow-water areas which serve as spawning, nursery and critical habitats for a wide range of marine organisms which can be affected by noise, temperature changes, vibration, and other effects that may be caused by cables and/or pipelines. Research is needed to: evaluate post-construction recovery of shallow water areas in these projects' footprints, especially where unfilled or incompletely filled trenches may result in changes in sediment type; assess changes in benthic communities related to on-bottom structures that support energy facilities;[94] and assess potential effects of electric, magnetic, and electromagnetic fields that may be attributable to energy facilities.

Upgrades to the electricity transmission and distribution system can reduce reliance on high pollutant emitting peaking units during high electric demand day (HEDD) periods in New York City. From a health and environmental perspective, the benefits of these upgrades will be greatest in the summer when HEDD generally correspond to contraventions of the ozone NAAQS in the New York City metropolitan area. A significant benefit to upgrading the transmission and distribution system would be to reduce the dispatch of peak generation sources that lack emissions controls and are among the most inefficient generation sources in the State. Upgrades to transmission can have a negative effect on air quality, if the generation supplying the electricity has a greater emission profile than the generation it is replacing. For example, access to less expensive, uncontrolled coal generation in neighboring regions can result in higher overall GHG, criteria and toxic pollutant emissions, increased acid deposition, and diminished air quality in New York as a result of pollution transport into the State.

NYSERDA's 2011 inventory of GHG emissions in the State attributes 1.7 percent of the total GHG emissions to methane from the natural gas transmission and distribution system. In 1997, EPA estimated that approximately 1.4 percent (plus or minus 0.5 percent) of all gas that travels through pipes in the U.S. was emitted. Distribution system emissions result mainly from fugitive emissions from gate stations and pipelines. An increased use of plastic piping, which has lower emissions than other pipe materials, has reduced emissions from this stage nationally. National distribution system methane emissions in 2011 were 16 percent lower than 1990 levels.[95] A higher percentage of pipelines may be considered leak-prone in New York's older distribution system,[96]

94. Species that occupy the region that include the bottom of a lake, seas, or ocean, and the littoral and supralittoral zones of the shore.

95. EPA. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2011*. April 2013. http://www.epa.gov/climatechange/ghgemissions/usinventoryreport.html

96. American Gas Foundation (AGF). G*as Distribution Infrastructure: Pipeline Replacement and Upgrades*. 2012. The report notes that "approximately 9 percent of distribution service mains in the United States are constructed of materials that are considered leak-prone." The percentage of leak-prone distribution pipe components for New York State is 28 percent.

although it is not clear that New York's leakage rate is above the national average.[97]

Impacts by Media

Air

Due to State and federal government programs to control air emissions through regulations and permitting, New York's air quality has greatly improved over the last 40 years. Air quality is evaluated through the State's ambient air quality network that measures levels of SO_2, nitric oxide, nitrogen dioxide (NO_2), ozone, CO, lead, PM and total hydrocarbons. Currently, the State operates 54 monitoring sites for the measurement of criteria and non-criteria pollutants, most of which are located in populated areas.

Ambient pollutants

The health-based NAAQS for all criteria pollutants are presented in Table 4. These standards are set at levels requisite to protect public health and welfare with an adequate margin of safety. Short-term exposure to ground-level ozone can cause a variety of respiratory problems, including coughing, shortness of breath, decreased lung function, and increased susceptibility to respiratory infection. Chronic exposure to ground-level ozone may cause permanent lung damage. $PM_{2.5}$ exposure can also result in the development of chronic bronchitis, non-fatal heart attacks, and premature death in people with heart or lung disease. NO_2, a component of NO_X, is a respiratory irritant that can cause increased incidents of asthma.

97. Average lost and unaccounted for gas (LAUF) percentages for the years 2007 to 2010 reported by the Local Distribution Companies ranged from -0.359 to 2.242 percent. http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7B0413ECDD-C194-46DE-8B04-AFDB3FBBE404%7D

Table 4 | National Ambient Air Quality Standards (NAAQS)[98]

POLLUTANT	LEVEL	AVERAGING TIME
Carbon Monoxide (CO)	9 ppm (10 mg/m^3)	8-hour 1971 std
Carbon Monoxide (CO)	35 ppm (40 mg/m^3)	1-hour 1971 std
Lead	0.15 µg/m^3	Rolling 3 month Average 2008 std
Nitrogen Dioxide (NO_2)	100 ppb (188 µg/m^3)	1-hour 2010 std 98th percentile
Nitrogen Dioxide (NO_2)	53 ppb (100 µg/m^3)	Annual 1971 std (Arithmetic Mean)
Particulate Matter (PM_{10})	150 µg/m^3	24-hour 1997 std
Particulate Matter ($PM_{2.5}$)	15.0 µg/m^3	Annual 1997 std (Arithmetic Mean)
Particulate Matter ($PM_{2.5}$)	12.0 µg/m^3	Annual 2012 std (Arithmetic Mean)
Particulate Matter ($PM_{2.5}$)	35 µg/m^3	24-hour 2006 std
Ozone	0.075 ppm (150 µg/m^3)	8-hour 2008 std
Ozone	0.08 ppm (160 µg/m^3)	8-hour 1997 std
Sulfur Dioxide (SO_2)	0.075 ppm (197 µg/m^3) (2010 std)	1-hour 2010 std

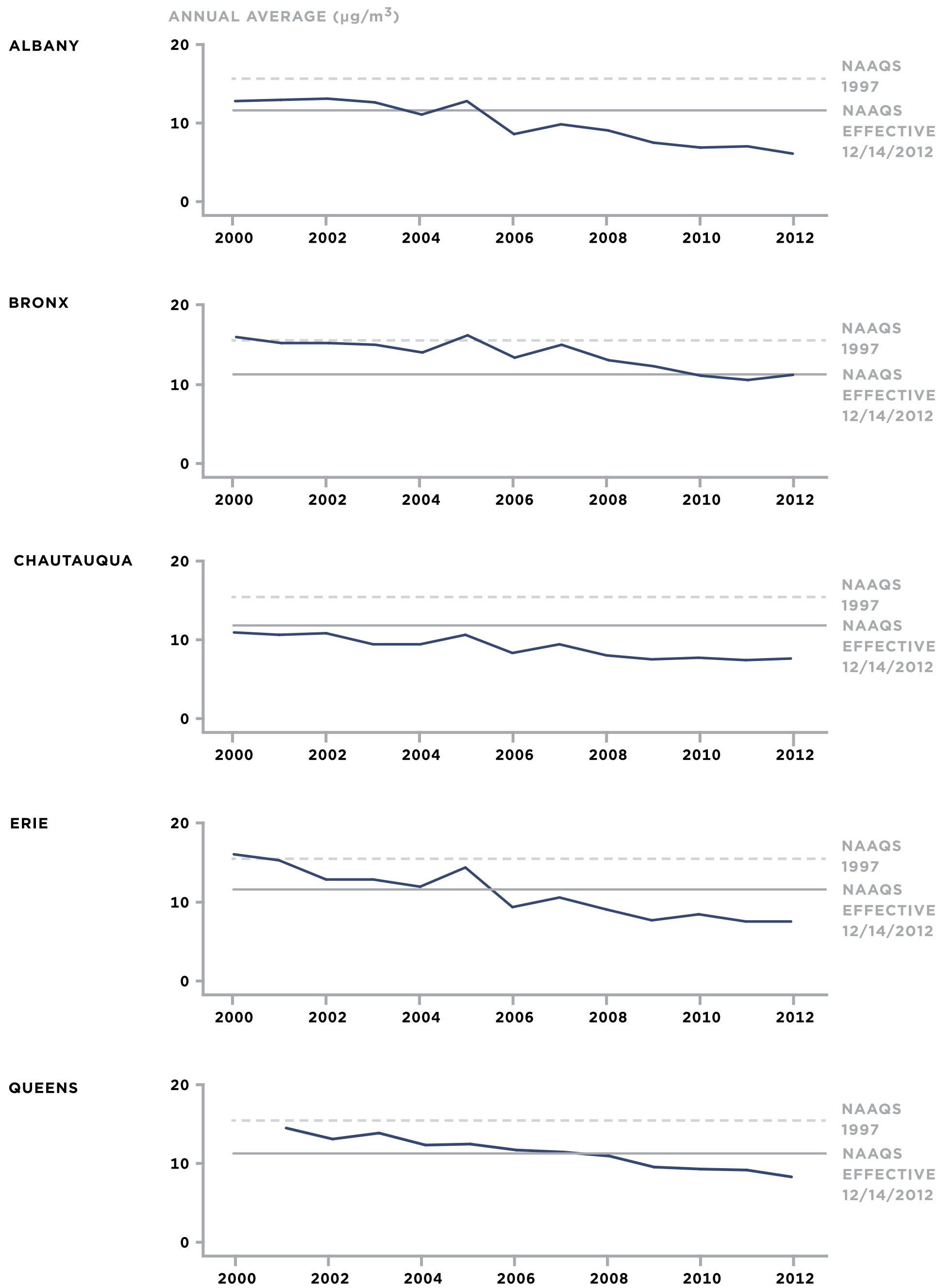
Source: EPA. *National Ambient Air Quality Standards.* http://www.epa.gov/air/criteria.html. Accessed online, July 3, 2013.

Currently, the State complies with the requirements of, or is "designated attainment for," the NAAQS for CO, lead, NO_2, PM_{10},[99] and SO_2. In other cases, monitored ambient concentrations of criteria pollutants have exceeded the standards set by EPA. On April 30, 2012, EPA formally designated ten counties in New York as non-attainment for the 2008 ozone NAAQS. Although ten counties in and around New York City are designated as non-attainment for the 1997 annual and 2006 24-hour $PM_{2.5}$ standard, recently monitored concentrations measure below the annual (as shown in Figure 5) and 24-hour $PM_{2.5}$ standards and DEC formally submitted a request for redesignation to EPA on June 27, 2013. On October 2, 2013 DEC recommended to EPA that the entire State be designated as attainment with the more stringent 2012 annual $PM_{2.5}$ standard.

98. Details for each criteria pollutant and NAAQS determination can be found at http://www.epa.gov/air/criteria.html

99. New York County is officially designated moderate non-attainment. Monitored concentrations report compliance with the NAAQS for PM_{10}.

Figure 5 | Fine Particulate Matter ($PM_{2.5}$) Historical Monitoring (2000 to 2012)



Note: The annual NAAQS of 15 µg/m³ is applicable for all years illustrated. For all counties displayed, the most recent three years are below the current annual standard, of 12 µg/m³, effective 12/14/2012.

Source: DEC. *Bureau of Air Quality Surveillance Monitoring Network*. 2013.

Environmental degradation from ambient releases of criteria pollutants include crop damage, visibility impairment, depletion of soil nutrients, corrosion of buildings and monuments, and change in nutrient balance in coastal waters and large river basins. Emissions of some of the criteria pollutants and carbon compounds are the primary contributors to visibility problems – called regional haze – since these pollutants can be transported great distances once they enter the atmosphere. A listing of the criteria pollutants, ambient monitored concentrations, and environmental concerns can be found in Appendix 4.

Non-criteria pollutants

Non-criteria pollutants that are emitted from fuel combustion include VOCs, semi-volatile organic compounds, metals, and others. VOCs like octane, benzene and others are produced as evaporative emissions from carbon-based fuel and as emissions from incomplete combustion of fuel. VOCs are important precursor compounds for ozone, which is formed in the atmosphere by reaction with NO_X in the presence of heat and sunlight.[100] The identity of individual VOCs emitted vary with fuel type, combustor type, and operating conditions.

Of the VOCs emitted, benzene is one of the most significant in terms of environment degradation and public health. In 2008, approximately 16,500,000 pounds of benzene were released from sources in New York. Forty-seven percent of the benzene emissions in the State for 2008 can be attributed to the transportation sector, and most of the remainder is attributable to other uses of petroleum (Figure 6). As illustrated in Figure 7, benzene concentrations across the State have decreased significantly over the last decade due in part to programs and regulations directed at reducing transportation source pollution, including the adoption of Reformulated Gasoline (RFG) Programs and improvements in vehicle emissions technology; the State-wide adoption of the California Low-Emission Vehicle program; and emission reductions from oil refineries and other stationary sources under the federal and State air pollution control programs. Although tremendous reductions of benzene have taken place, Figure 7 illustrates that all locations in the State, even the most rural, are above the State's benzene annual guideline concentration of 0.13 $\mu g/m^3$ set at a one-in-one-million cancer risk.

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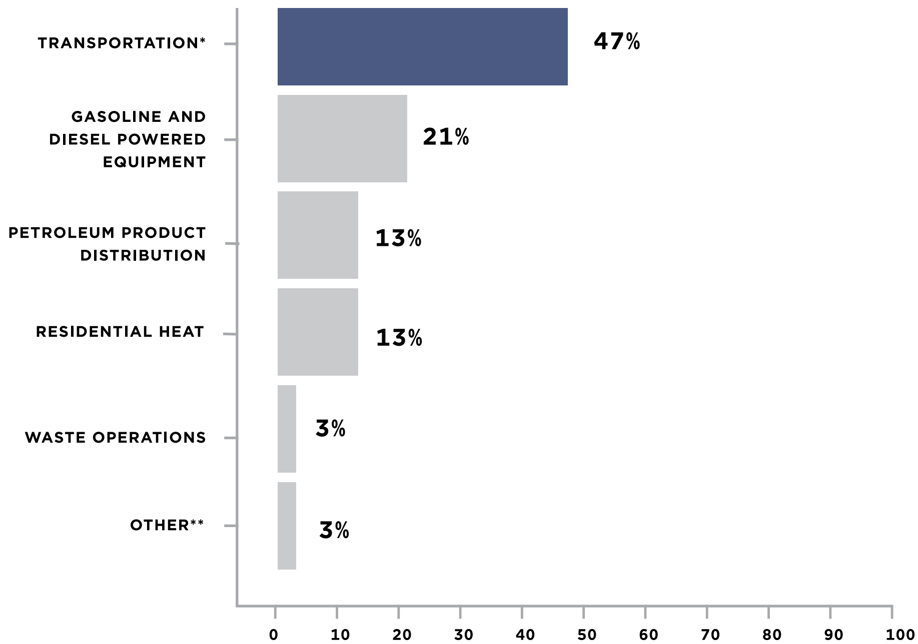
100. EPA. *Air Quality Criteria for Ozone and Related Photochemical Oxidant*. 2006.

Figure 6 | Total Benzene Emissions in New York (2008)

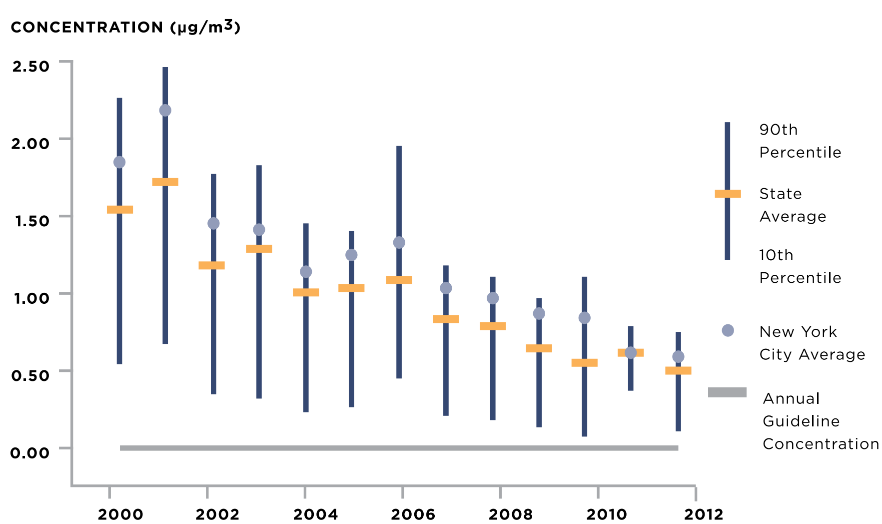


* Gasoline and diesel vehicles, aircraft, marine vessels, railroad equipment

** Electric generation, commercial/institutional/industrialreleases, oil and natural gas production and distribution, solvent use

Source: EPA. *National Emissions Inventory*. 2008

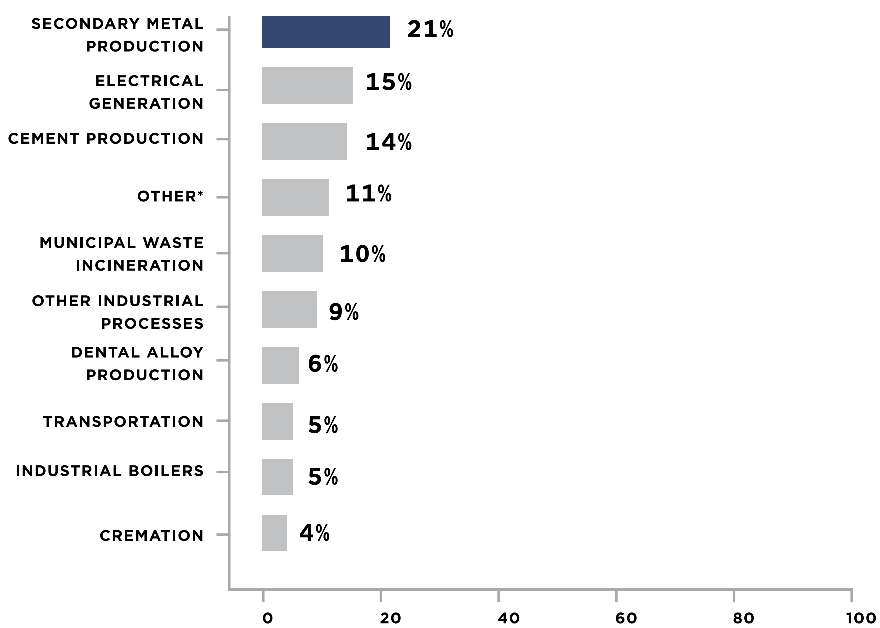
Figure 7 | Benzene Ambient Air Concentration in New York (2000 to 2012)



Source: DEC. *Bureau of Air Quality Surveillance Monitoring Network*. 2013.

Mercury is a naturally occurring element that is found in air, water, and soil. Airborne mercury can be deposited on the ground through raindrops, dust, or simply due to gravity (collectively called "air deposition"). Mercury is a powerful neurotoxin that causes developmental and reproductive problems for wildlife. When mercury deposits in streams, lakes, or estuaries, it can be converted to methylmercury through microbial activity. Methylmercury accumulates in fish at levels that may harm the fish and the other animals that consume them. For this reason, fish consumption advisories have been issued by the Department of Health (DOH) and DEC for high risk populations in specific areas of the State, and for the general population elsewhere.[101] The Northeast Regional Mercury Total Maximum Daily Load identified mercury from atmospheric deposition as the primary cause of water body impairment.[102] The highest mercury concentration in fish is found in the Catskill and Adirondack Mountains.[103]

Figure 8 | Total Mercury Emissions for New York (2012)



*Laboratories, commercial/institutional/residential heat, fluorescent lamp breakage, primary metal production, others

Sources: DEC. *Emissions Inventory.* 2012.
EPA. *National Emissions Inventory. 2008*

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101. DOH. *Health Advice on Eating Sportfish and Game*, June 2013. Accessed online on 7/8/2013

102. New England Interstate Water Pollution Control Commission. (NEIWPCC) et al. *Northeast Regional Mercury Maximum Daily Total Load.* October 2007. http://www.epa.gov/region1/eco/tmdl/pdfs/ne/tmdl-Hg-approval-doc.pdf.

103. Loukmas, Jeffrey; Roy, Karen; Simonin,Howard; and Skinner, Larry. *Strategic Monitoring of Mercury in New York State Fish.* 2008.

Nation-wide, coal-burning electric generating units are the largest source of mercury,[104] while for New York, as seen in Figure 8, electric generation contributes only 15 percent. Mercury emissions in the electrical generation sector have been trending downward in New York due to a greater reliance on natural gas to produce electricity and regulations which target mercury in coal-fired electric generation facilities. The largest contribution of atmospheric mercury in the State still comes from mid-western utilities[105] and, as shown in Appendix 4, Figure 17 mercury levels in New York have been relatively consistent over the past decade. Strong national and regional mercury emission standards are essential to reduce out-of-state generation of mercury and acid deposition. Because mercury is one of the most important persistent, bioaccumulative, toxic contaminants of concern for New York,[106] greater reductions in releases are still necessary to reduce overall environmental burdens.

Acid deposition

SO_2 and NO_X emissions from fossil fuel combustion form acidic chemicals through atmospheric reactions and return to the surface through settling or dry deposition, or as wet deposition, in the form of rain, snow, sleet, or fog. Acid deposition has many far-reaching ecological effects. It causes soil to lose its buffering capacity or its ability to neutralize some or all of the acidity in rainwater. Acidic water will leach nutrients from the soil before plants and trees are able to use them to grow. Damaged leaves caused by acid deposition will decrease a plant's ability to produce and store food, or prevent frost damage, possibly leading to injury or death.

Acid deposition also lowers the pH of lakes, rivers, and streams, and increases the concentration of aluminum. As surface waters become acidic, species of zooplankton, mayflies, and fish begin to disappear because they can no longer reproduce or survive. Concentrations of aluminum may increase to toxic levels, resulting in uninhabitable lakes and streams. Further, the deposition of NO_X and SO_2 in soils affects the growth and composition of forests. Acid deposition may also inflict aesthetic damage to statues and buildings.

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104. United Nations Environment Programme. *The Global Atmospheric Mercury Assessment: Sources. Emissions and Transport*. Geneva, Switzerland: Chemicals Branch, DTIE, 2008.

105. NYSERDA. *Contributions of Global and Regional Sources to Mercury Deposition in New York State.* 2002.

106. DEC. *Mercury Work Group Recommendations to Meet the Mercury Challenge.* 2006.

The 1990 changes to the Clean Air Act introduced a nationwide approach to reducing acid pollution by dramatically reducing emissions of sulfur dioxide (SO_2) and oxides of nitrogen (NO_X) through control policies and a market-based cap and trade approach. As a result, acid deposition is generally decreasing across New York (as shown in Appendix 4), but there are still lakes, streams, and soils that are too acidic to support healthy fish and vegetation communities. Deposition changes (achieved under Title IV from electrical generation units) are leading to chemical recovery, but there may be a delay in biological recovery in these sensitive ecosystems and continued emission reductions are necessary in order to protect sensitive ecosystems.

Air Related Policies and Programs in New York State

Fuel sulfur content

Recently adopted regulations[107] lower the permissible sulfur content of fuel for source combustion installations, including at electric utilities. Facilities will be required to purchase residual (#6) fuel oil with a maximum sulfur level of 0.50 percent in all areas of the State beginning July 1, 2014. The sulfur content limit of distillate (#2) fuel oil has been reduced to 15 ppm, with compliance deadlines of July 1, 2014 or July 1, 2016, depending on the type of fuel that is currently burned. In addition, in April 2011, New York City enacted legislation phasing out #6 residual fuel oil by 2015 and eventually requiring all boilers to burn fuels that meet the equivalent emissions of burning 15 ppm #2 fuel oil or natural gas.[108]

Nitrogen oxides

Boilers and turbines located at central station power plants will be required to meet more stringent NO_X reasonably available control technology emission limits by July 1, 2014.[109]

Hazardous air pollutants

On February 16, 2012, EPA published National Emission Standards for Hazardous Air Pollutants (NESHAPs) from Coal- and Oil-Fired Steam

107. 6 NYCRR Subpart 225-1: Fuel Consumption and Use – Sulfur Limitations

108. New York City Administrative Code, §24-169 (Sulfur Content of fuel restricted)

109. 6 NYCRR Subpart 227-2: Reasonably Available Control Technology (RACT) for Major Facilities of Oxides of Nitrogen (NO_X)

Electric Generating Units (EGUs).[110] This rule set mercury and air toxic standards (MATS) from new and existing coal-and oil-fired EGUs. Sources generally have three years to comply with the MATS, though an additional one year may be available on a case-by-case basis. For all existing and new coal-fired EGUs, the rule establishes numerical emission limits for mercury, PM (a surrogate for toxic non-mercury metals), and hydrochloric acid [HCl] a surrogate for all toxic acid gases). For existing and new oil-fired EGUs, the standards establish numerical emission limits for PM (a surrogate for all toxic metals), HCl, and hydrofluoric acid (HF). Oil-fired EGUs may also show compliance with the HCl and HF limits by limiting the moisture content of their oil. The revisions to the New Source Performance Standards (NSPS) for fossil-fuel-fired EGUs include revised numerical emission limits for PM, SO_2, and NO_X.

Visibility-impairing pollutants

Significant improvements are expected in regional haze in national parks and wilderness areas through the implementation of the control strategies to reduce visibility-impairing pollutants from central station power plants. Another program[111] adopted by New York, requires major stationary sources within certain process categories built between 1962 and 1977 to analyze potential controls for NO_X, SO_2, and PM_{10} emissions.

Control of emissions from mobile sources

A series of regulations addresses emissions from the transportation sector: emissions inspection programs; fuels regulation; requirements for emission control technologies, where appropriate. New mobile source measures will greatly reduce NO_X and VOC emissions through improvement in combustion efficiency and fuel quality, as well as the use of control devices.

Boilers

On February 21, 2011, EPA finalized a rule to reduce emissions of toxic air pollutants from new and existing ICI boilers and process heaters at major sources (potential to emit 10 tons per year [tpy] or more of any single air toxic or 25 tpy or more of any combination of air toxics) and another

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110. EPA. *National Emission Standards for Hazardous Air Pollutants From Coal- and Oil-Fired Electric Utility Steam Generating Units and Standards of Performance for Fossil-Fuel-Fired Electric Utility, Industrial-Commercial-Institutional, and Small Industrial-Commercial. Air Quality Standards.* February 2012. http://www.epa.gov/ttn/atw/utility/fr16fe12.pdf

111. 6 NYCRR Part 249 http://www.dec.ny.gov/regs/64659.html rule for new and existing ICI boilers and process heaters at area sources (potential to emit less than 10 tpy of any single air toxic or 25 tpy of any combination of air toxics).

Greenhouse Gas Emissions

On June 29, 2012, EPA issued a final rule to establish GHG permitting thresholds. These emissions thresholds determine when Clean Air Act permits under Prevention of Significant Deterioration (PSD) and Title V operating permits are required for new and existing industrial facilities. DEC adopted regulations to implement these requirements in New York.[112]

Water

In addition to air resources, New York possesses abundant water resources, which include lakes, rivers, estuaries, and oceans. Like air quality, water quality in the State has improved dramatically over the last several decades. This improvement can be attributed to federal and State regulations that have required wastewater treatment prior to discharge into the environment. Still, as discussed briefly above, some waterbodies, particularly in the higher elevations of the State, have been significantly impacted by the deposition of air pollutants.

Lakes and Rivers

New York is richly endowed with more than 7,600 freshwater lakes, ponds and reservoirs, and portions of two of the five Great Lakes. The most significant lake resource in the State includes the Great Lakes of Lake Ontario and Lake Erie, Lake Champlain, and the numerous Finger Lakes of central New York.[113] The State also has more than 70,000 miles of rivers and streams, including the Hudson, Susquehanna, Delaware, Saint Lawrence, and Niagara Rivers. These resources are impacted by emissions and discharges from energy facilities and the combustion of fuels for heating, cooling and transportation. At the same time, many industrial users, including EGUs, rely on these water resources. Many central generation power plants utilize significant amounts of water from these resources for cooling purposes.

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112. 6 NYCRR Part 201: Permits and Registration http://www.dec.ny.gov/regs/2492.html
113. DEC. *Lands and Waters.* 2012. http://www.dec.ny.gov/61.html

Estuaries and Oceans

Estuaries include salt water from the ocean and freshwater from inland. In New York, some of the freshwater rivers and streams draining into the ocean mix around the New York City and Long Island area creating several distinct estuaries that flourish with marine life. Estuaries are important biologically and economically, providing commercial and recreational fishing grounds, navigation ways, significant habitats, and a range of recreational attributes. The Peconic Estuary, New York/ New Jersey Harbor, and Long Island Sound are nationally-recognized through the U.S. EPA National Estuary Program, while the Hudson River Estuary Program and the Long Island South Shore Estuary Reserve are State-recognized estuaries. Due to their unique nature, State and federal agencies, local municipalities, and other stakeholders are implementing management plans for these areas to address protection and management strategies.[114] Many of these management plans, like the Hudson River Estuary Plan, recognize the impacts from energy generation facilities. Many power plants and other industries utilize the water from the Hudson River for cooling water and industrial processes, which will continue to impact the fish and habitats in these valuable waters.

Ocean waters are increasingly recognized for their potential for energy generation. The DOS has been generating and compiling the best available data on ocean uses and resources as a starting point for further analysis on identifying appropriate locations for energy-related facility development and other future uses.[115]

Impingement and Entrainment

The generation of electricity from power plants frequently requires the use of large volumes of water to cool condensers. This is true regardless of the fuel source unless the facility has a closed-cycle cooling system. Throughout the State, 16 billion gallons of water per day is withdrawn from New York waters via cooling water intake structures. As a result, it is estimated that over 17 billion fish of all life stages (eggs, larvae, juveniles, and adults) are impinged (on the intake structure) or entrained (in the structure) annually. According to the U.S. Geological Survey, New

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114. DEC. *Oceans and Estuaries* 2012. http://www.dec.ny.gov/lands/207.html
115. DOS. *Offshore Atlantic Ocean Study*. 2013.

York ranked third in 2005 among the nation for total water used for cooling purposes by the electric generating sector.[116]

Thermal Discharges

In addition to the potential impacts caused by cooling water intake structures, the thermal effluent from steam electric generating facilities can also have an adverse environmental impact on aquatic biota. The potential impacts caused by thermal pollution include: the disruption of fish migratory routes; thermal stress; shock; mortality to biota; and interference with spawning and nursery areas.

Water Quality

In addition to the impacts of acid and mercury deposition discussed above, water quality is further impacted by central station power plants that require the discharge of treated process water. Relative to other industrial users and wastewater treatment plants, these discharges are minimal but must be monitored for temperature, total suspended solids, and chlorine. Under the State Pollutant Discharge Elimination System (SPDES) permit program, facilities are required to meet effluent limitations to minimize the impact of the discharge.

Wetlands and Wildlife

From the ocean coastline and Long Island Barrens to the Adirondack Mountains and Great Lakes, New York State has abundant natural resources including thousands of wetlands and a diverse wildlife population. These resources are significantly impacted by the energy sector.

Wetlands—Freshwater and Tidal

Wetlands (swamps, marshes, bogs, and similar areas) are areas saturated by surface or ground water and are sufficient to support distinct vegetation. Wetlands serve as natural habitat for many species of plants and animals and absorb the forces of flood and tidal erosion to prevent loss of upland soil. The two principal types of wetlands in New York are tidal wetlands on Long Island, New York City and the Hudson River to the Troy Dam, and freshwater wetlands found on river and lake floodplains. These resources are impacted by emissions and discharges from various sources including agricultural, transportation, residential, commercial and industrial sectors.

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116. Kenny, F., Joan; Barber, L., Nancy; Hutson, S., Susan; Linsey, .S., Kristin; Lovelace, K. John.; and Maupin, A. Molly. *Estimated Use of Water in United States in 2005*. Washington, D.C.: United States Geologic Service, 2009.

Human caused tidal wetland losses include dredging/filling, watershed development, and shoreline hardening.

Plants and Wildlife

New York is also the home to diverse wildlife including mammals, birds, amphibians and reptiles, insects and fish. These animal and insect populations include common species as well as rare, threatened and endangered species. Some of the rare, threatened and endangered species in New York include the Indiana bat, bog turtle, timber rattlesnake, karner blue butterfly, short-eared owl, and northern cricket frog.

Impact of Wind Energy

The development of energy projects, particularly wind projects, can impact wildlife during both construction and operation of the facility. Environmental impacts from new wind energy development include habitat disturbance or destruction during construction of turbines and transmission lines; and, potential mortality of birds and bats from collisions with the tower and turbine blades. As a result of the potential impacts from wind projects, DEC requires developers to conduct post-construction bird and bat monitoring to determine mortality rates associated with large scale wind projects.[117]

As of spring 2012, post-construction studies conducted at New York wind projects have demonstrated at least some level of bird and bat mortality from the operation of the projects. The data from 18 post-construction bid/bat surveys at 11 different projects have shown a range of bird mortality from 0.66 to 9.59 birds/turbine during the survey period, which is typically mid-April to mid-November. These bird mortality rates are generally consistent with predicted estimates. Although wind turbines are not the largest known source of mortality for bird species in New York, projects must still be sited appropriately to avoid unnecessary collision-risk to birds, particularly to listed and sensitive species.

The above referenced surveys show higher mortality rates for bats than for birds. The studies have shown a mortality range of 0.5 to 40.4 bats/turbine. The mortality rates appear to be unrelated to project site location. Migratory tree-roosting bats and cave bats are both impacted by wind turbines, though the three tree bat species constitute over 70 percent of the total bat kills. Wind turbines are the largest, most pervasive

117. *Guidelines for Conducting Bird and Bat Studies at Commercial Wind Energy Projects.* http://www.dec.ny.gov/docs/wildlife_pdf/finwindguide.pdf known source of mortality for tree bats.[118] Although a smaller portion of turbine-killed bats are cave bats, populations of most of these six species have recently been decimated by white-nose disease.[119] Of particular concern are the impacts from turbines that further exacerbate the losses caused by white-nose disease.

The installation of offshore wind turbines that require underwater placement of tower structures and interconnection cables have impacts similar to those of land-based wind turbines and may also impact sea bed and marine habitats.

Impact of Hydroelectric Facilities

Hydroelectric facilities impact fish and wildlife resources due to the creation of dams and reservoirs and due, in part, to the manner in which the hydroelectric facility is operated. In particular, hydroelectric dams fragment rivers and stream systems preventing upstream and downstream movement of fish and aquatic organisms; they also fragment riparian habitat for semi-aquatic organisms. As a result, DEC requires protective conditions in Federal Energy Regulatory Commission (FERC) licenses and issues water quality certificates (WQCs) to restore water quality and minimize associated environmental impacts without causing significant energy losses. Examples include:

- Restoring adequate base flows in rivers thereby facilitating navigation and dampening the impact of fluctuating water levels on aquatic organisms, vegetation and wetlands
- Restoring minimum river flows and fish passage flows in main stem reaches that are bypassed by penstocks or power canals, thereby eliminating water quality violations and restoring an acceptable, though impacted, aquatic ecosystem
- Reducing impoundment fluctuations, especially during fish spawning seasons. Generally, projects are required to operate in "run of river" mode where the outflow equals the instantaneous inflow

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118. Cryan, Paul M., and Barclay Robert M.L. Causes of Bat Fatalities at Wind Turbines: Hyposthesis and Predictions. *Journal of Mammalogy.* 2009: 1330-1340.

119. Since 2009, many thousands of bats have died in caves or abandoned mines in New York as a result of this disease which presents as a white fungus around the bat's nose. Indiana bats, a State and federal endangered species, are perhaps the most vulnerable and half of the estimated 52,000 Indiana bats that hibernate in New York are located in one former mine that is now affected with white-nose syndrome. Eastern pipistrelle, northern long-eared and little brown bats, are also dying; and little brown bats, the most common hibernating species in New York, have sustained the largest number of deaths DEC. *Fish, Wildlife & Marine Resources.* 2012.

- Reducing fish impingement and entrainment mortality through appropriately sized trash racks and fish bypass systems.

The DOS also reviews FERC applications and relicensing proposals for consistency with the enforceable policies of the New York State Coastal Management Program (CMP) and, where applicable, those of approved Local Waterfront Revitalization Programs (LWRP). The consistency review addresses reasonably foreseeable effects on coastal uses and resources from all portions of the proposed action.

Finally, Article XIV of the State Constitution prevents the siting of new hydropower facilities on Forest Preserve, certain reforestation and wildlife management areas, and the State Nature and Historical Preserve. The Wild, Scenic, and Recreational Rivers Act (Environmental Conservation Law [ECL] Article 15, Title 27) prohibits the construction of hydropower facilities on designated rivers and development of hydropower facilities on these lands requires appropriate Constitutional or statutory amendments.

Hydrokinetic energy is an emerging renewable power source that harnesses energy from tides, waves, and currents by using underwater turbines. The potential impacts from hydrokinetic energy are largely unknown and relate to the potential injury and destruction of fish and other aquatic life due to rotating turbine blades. Because of the difficulties associated with visual monitoring, the impacts of underwater turbines may need to be assessed in controlled laboratory experiments. Impacts to be examined include: blade strikes from rotating blades, blade avoidance by larger fish, blade avoidance by juvenile forage fish that could make them more vulnerable as prey, and the ability of fish to navigate a field of turbines at elevated current speeds, e.g., spring flow event.

Invasive Species

Invasive species are non-native species that can cause harm to the environment or human health. Invasive species come from all around the world; the rate of invasion is increasing along with the increase in international trade that accompanies globalization. Two recent examples of the impact of invasive species since 2009 are the Emerald Ash Borer and the Didymo (rock snot). The Emerald Ash Borer attacks North American ash species and has caused the destruction of over 50 million ash trees in the Northeast since its discovery. Didymo is a non-native algae that grows in streams and threatens aquatic habitat.

Shipping ballast water, recreational boating, nurseries and landscaping activities, pet trade and food markets as well as transportation and utility right-of-ways (ROWs) have been identified as critical pathways for the spread of invasive species. ROWs provide open corridors by which the seeds of invasive species can easily travel and spread to uninfested areas. Opportunities exits in all sectors including the transportation and utility corridors to adopt practices that control and manage the spread of invasive species. In ROW's, this managed approach requires careful planning of construction and maintenance activities.

Habitat Fragmentation

Habitat fragmentation occurs when large areas of a habitat are split or divided into smaller, non-contiguous blocks. Habitat fragmentation may occur when new generation facilities, transmissions lines and pipelines, and wind projects are constructed. The development of miles of access roads and utility ROWs at a wind project can split valuable habitat that have a significant impact on the species dependent on that habitat. The potential impacts of habitat fragmentation include the reduction in biodiversity due to the difficulty of some species to find food. Some species that require forest areas for cover are more prone to predation and since forests act as filters, the removal of trees adjacent to streams can cause water quality impacts. Continued fragmentation can lead to deforestation and contribute to global warming by releasing carbon stored in trees.[120]

Land and Soil

The landscape of New York also consists of a wide range of soils that are important for agricultural and nonagricultural uses. These soils are used to produce a variety of agricultural crops including pasture, field crops, vegetables, and fruits. Between 2001 and 2010, land in farms in New York decreased from approximately 7.6 to 7.0 million acres.[121] Energy generation and transmission can result in temporary disturbance and permanent loss of agricultural land. Temporary disturbances occur during construction and include erosion, mixing of topsoil and subsoil, soil compaction, and changes in soil drainage. These impacts can result in reduced productivity and degradation of water quality. The permanent loss of agricultural land can result from the construction of access roads, wind turbines, and other greenfields generation facilities.

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120. EPA. *Forest Fragmentation Fact Sheet*. October 2003. http://www.epa.gov/mrlc/pdf/forest-factsheet.pdf

121. U.S. Department of Agriculture. *New York State Agriculture: Annual Bulletin: National Agriculture Statistics Service/United States Department of Agriculture*. 2011. http://www.nass.usda.gov/Statistics_by_State/New_York/Publications/Annual_Statistical_Bulletin/2011/2011 Bulletin.pdf

Impacts of Biofuels

In 2008, the New York Lieutenant Governor's Renewable Energy Task Force called for a Renewable Fuels Roadmap (Roadmap) and Sustainable Biomass Feedstock Supply to provide policymakers with an assessment of the potential positive and negative impacts from increased use and production of renewable fuels in the State. The Roadmap, which focused on the production of liquid biofuels for transportation purposes, concluded that potentially negative environmental effects, including deteriorated air quality, soil erosion, impaired water quality, acidification of water and soil, and reduced biodiversity, may result. The Roadmap also recognized that implementing appropriate best management practices in growing and harvesting the feedstocks would minimize some of these adverse effects and recommended development of ecologically sustainable practices for producing biofuels feedstock as a crucial first step.

Public Health

Energy use and energy production have innumerable public health benefits. Energy is necessary for controlling indoor temperature, which can reduce morbidity and mortality associated with extreme cold or hot weather. Fuels are used in emergency vehicles to rapidly transport people to medical care. Health facilities depend on transportation of medical supplies and require electricity and emergency backup power supplies. Energy is required for mechanized agriculture and irrigation to meet the dietary needs of New York's population. Energy is also required for food transportation and preservation. Treatment of drinking water and wastewater is an essential public health action that depends on the use of energy.

Access to electricity has been identified as a prerequisite for achieving good health and lack of access to it as "one of the principal barriers to the fulfillment of human potential and well-being."[122]

Energy use and production can also have health risks. These risks can arise from routine operations, accidents, and catastrophic events. Health risks resulting from routine energy use and production can range from local to global in scale and examples include degradation of air quality due to the combustion of fossil fuels for transportation uses and electricity production, climate change from the release of GHGs from fossil fuel combustion, and potential risks of noise, e.g., associated with turbines and compressors. Accidents can include fires, fuel oil spills, explosions and other occupational and non-occupational accidents associated with energy production, storage, distribution and use. Possible catastrophic events associated with energy use can include a major radioactivity release from a nuclear facility, a natural gas pipeline explosion or a rupture of a large dam used for hydropower. The State has programs in place to mitigate most of the health risks that accompany energy production and use, although some risk remains.

Communities in New York have raised concerns about potential health impacts associated with energy production, use, distribution and storage including, in addition to the above, electromagnetic field radiation associated with electric transmission lines and noise, visual impacts, and overall quality of life concerns attributable to vehicle traffic hubs like bus stations. Communities can provide valuable insight from a unique perspective for energy initiatives and proposals.

Summary of Health Status of New Yorkers for Selected Health Outcomes

The Department of Health's Prevention Agenda 2013-2017 sets five statewide public health priority areas and asks others including local health departments, hospitals, and other community partners to work together to address them to foster healthy communities and improve the health of New Yorkers.[123] This initiative focuses on primary prevention strategies to promote healthy environments and behaviors that lower the risk of disease, and on secondary prevention that emphasizes early detection of diseases and conditions to enable better outcomes. The

122. Markandya, Anil. *Energy and Health 2 – Electricity Generation and Health*. Lancet. 370: 979-990. 2007.

123. DOH. *Prevention Agenda 2013-2017 New York State's Health Improvement Plan*. 2013. http://www.health.ny.gov/prevention/prevention_agenda/2013-2017/index.htm

Prevention Agenda highlights many health conditions in the priority areas, including asthma and cardiovascular disease. These conditions can be affected by energy policies including those that influence air pollution emissions from energy production and use.

Asthma is a major health problem nationally and in New York. One in 11 New Yorkers (1.3 million adults and 475,000 children) were estimated to have asthma in 2008.[124] Children in New York were reported to have missed more than 1.9 million days of daycare, pre-school, or school due to asthma each year, and adults with asthma were unable to work or carry out usual activities because of asthma on approximately 7.6 million days.[125] Asthma hospitalization rates in New York are higher than national rates for all age groups.[126] The total cost of asthma hospitalizations in New York in 2007 was approximately $535 million.[127]

Substances that can trigger asthma attacks include tobacco smoke, pollen, mold, indoor and outdoor air pollutants, upper respiratory infection, animal dander, and dust mite and cockroach debris.[128] Four components of air pollution, ozone, SO_2, NO_X, and particulate matter (PM), are known to exacerbate asthma and to cause eye and respiratory tract irritation, cough, shortness of breath, and reduced lung function.[129] Researchers have shown that higher air pollution levels are associated with higher rates of hospitalization and emergency department visits due to asthma.[130] Research has also shown that children living in areas with higher levels of some air pollutants had significant deficits in lung growth and development.[131] Reduction of pollution associated with energy use could help New York make progress toward reducing the burden of asthma.

Cardiovascular disease is the leading cause of death nationally and in New York, with almost 59,000 New Yorkers dying of cardiovascular

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124. DOH. *New York State Asthma Surveillance Summary Report*. 2009. http://www.health.state.ny.us/statistics/ny_asthma/pdf/2009_asthma_surveillance_summary_report.pdf

125. DOH. *National Asthma Survey- New York State Summary Report*. 2005. http://www.health.ny.gov/statistics/ny_asthma/pdf/national_asthma_survey_nys.pdf

126. DOH. *New York State Asthma Surveillance Summary Report*. 2009. http://www.health.state.ny.us/statistics/ny_asthma/pdf/2009_asthma_surveillance_summary_report.pdf

127. DOH. *New York State Asthma Surveillance Summary Report*. 2009. http://www.health.state.ny.us/statistics/ny_asthma/pdf/2009_asthma_surveillance_summary_report.pdf

128. DOH. *Environmental Asthma Triggers*. 2011. http://www.health.ny.gov/publications/4955/

129. EPA. EPA/600/p-99/002aF-Bf: *Air Quality Criteria Document for Particulate Matter*. 2004.

130. Samet, M., Jonathan. *The National Morbidity, Mortality, and Air Pollution Study. Part II: Morbidity and Mortality from Air Pollution in the United States*. Research Report Health Effects Institute. 2000. 94(pt 2):5-70, 71-79.

131. Gauderman, W. James. *Association between Air Pollution and Lung Function Growth in Southern California*. American Journal of Respiratory Critical Care Medicine. 2000. 162(4Pt1):1383-1390.

disease in 2008.[132] The total cost for cardiovascular disease in New York, defined as direct costs plus lost productivity due to illness or death, was estimated to be $32.6 billion in 2008, based on extrapolation from national data.[133] Research studies have shown an association between exposure to air pollutants such as PM, NO_X, SO_2, CO, and ozone, and increased hospitalization rates and mortality from cardiovascular disease.[134] Environmental factors other than air pollution can also influence cardiovascular disease. Lack of physical activity can increase the risk for obesity and diabetes, which increase the risk for cardiovascular disease. Certain features of the built environment can encourage physical activity, such as bike paths, public parks, recreational sites, and walkways. Planning using smart growth principles, which encourage expansion of public transportation and creation of "walkable" neighborhoods, can reduce reliance on fossil fuels in transportation. Thus, energy use policies that reduce pollutant emissions and facilitate healthy behaviors could help to reduce cardiovascular outcomes.

Communities with Health Disparities

In New York, as well as other parts of the U.S., significant disparities in health outcomes exist for certain groups by race, ethnicity, and socioeconomic status. Disparities are observed in life expectancy and rates of diabetes, cancer, heart disease, asthma, infant mortality, and low birth weight.[135, 136] Asthma hospitalization rates in New York are higher in children than in adults, are higher in Black non-Hispanics and Hispanics than in Whites, and are higher in low-income areas than in higher income areas.[137, 138] Asthma hospitalization rates are higher in New York City than in the rest of the State, with New York City residents accounting

132. DOH. *Vital Statistics of New York State: 2008 Tables.* http://www.health.state.ny.us/nysdoh/vital_statistics/2008/

133. DOH. *Cost of Cardiovascular Disease.* http://www.health.state.ny.us/diseases/cardiovascular/heart_disease/

134. Brook, Robert. *Air Pollution And Cardiovascular Disease: A Statement for Healthcare Professionals from the Expert Panel on Population And Prevention Science for the American Health Association.* Circulation: Journal of the American Health Association. 109:2655-2671. 2004.

135. CDC. *Health Disparities and Inequities Report, United States. Morbidity and Mortality Weekly Reports.* January 14, 2011.

136. DOH. *New York State Minority Health Surveillance Report: Public Health Information Group.* 2007. http://www.health.state.ny.us/statistics/community/minority/docs/surveillance_report_2007.pdf

137. Lin, Shao, Fitzgerald, Edward, Hwang, Syni-An. *Asthma Hospitalization Rates and Socioeconomic Status in New York State 1987-1993.* Journal of Asthma. 2002. 36:239-251.

138. DOH. New York State Asthma Surveillance Summary Report. 2009. http://www.health.state.ny.us/statistics/ny_asthma/pdf/2009_asthma_surveillance_summary_report.pdf for 66 percent of all asthma hospitalizations in New York during 2005 to 2007. Studies in New York have found that asthma death rates and hospitalization rates are higher among low-income and minority residents than White, higher-income residents.[139, 140] In addition, mortality and hospitalization rates due to diseases of the heart are highest in Black non-Hispanics among all racial and ethnic groups in New York. Nationally and in New York, there are disparities in heart disease mortality and stroke mortality by race. Rates are highest in Black non-Hispanics among all race and ethnic groups.[141, 142] Hospitalization rates for heart disease are also highest in Black non-Hispanics.[143] DOH released the Minority Health Surveillance Report in 2007, 2010 and 2012.[144, 145, 146]

In addition, studies of the distribution of potential sources of air emissions (e.g., industrial facilities, inactive hazardous waste sites, high traffic roadways, power plants, and waste transfer stations) have found that these facilities are more likely to be located in low-income and minority areas.[147, 148] The disproportionate representation of industrial facilities in low-income and minority areas and the siting of new facilities are key concerns of DEC's Office of Environmental Justice and environmental justice advocacy groups.

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139. Claudio, Luz. Socioeconomic *Factors and Asthma Hospitalization Rates in New York City. Journal of Asthma*. 1999. 36:343-350.

140. Lin, Shao. *Asthma Hospitalization Rates and Socioeconomic Status in New York State 1987-1993. Journal of Asthma*. 1999. 36:239-251.

141. DOH. *New York State Minority Health Surveillance Report*. 2012. http://www.health.ny.gov/statistics/community/minority/docs/surveillance_report_2012.pdf

142. CDC. *CDC Health Disparities and Inequalities Report*. 2011. http://www.cdc.gov/minorityhealth/CHDIR/2011/CHDIR2011.html.

143. CDC. *CDC Health Disparities and Inequalities Report*. 2011. http://www.cdc.gov/minorityhealth/CHDIR/2011/CHDIR2011.html.

144. DOH. *New York State Minority Health Surveillance Report: Public Health Information Group*. 2007.

145. DOH. *New York State Minority Health Surveillance Report*. 2010. http://www.health.ny.gov/statistics/community/minority/docs/surveillance_report_2010.pdf

146. DOH. *New York State Minority Health Surveillance Report*. 2012. http://www.health.ny.gov/statistics/community/minority/docs/surveillance_report_2012.pdf

147. Maantay, Julianna. Mapping Environmental Injustices: Pitfalls and Potential of Geographic Information Systems in Assessing Environmental Health and Equity. Environment Health Perspective. 2002. 110 (Suppl. 2):161-171.

148. Morello-Frosch, Rachel. *Environmental Justice and Regional Inequality in Southern California: Implications for Future Research. Environment Health Perspective*. 2002. 110 (Suppl. 2):149-154.

Health Effects of Pollutants Associated with Carbon-based Fuels

Exposure to pollutants released or formed when carbon-based fuels are burned, including PM, SO_2, NO_X, CO, volatile organic chemicals, chlorinated dibenzodioxins and furans, polycyclic aromatic hydrocarbons, and metals can have direct effects on human health. The likelihood of effects will depend on the ability of each pollutant to cause health effects; the amount, frequency and duration of exposure; and an individual's health status. The text below and Table 5 summarize the direct and indirect human health effects that are associated with GHG emissions, climate change, and exposure to some "criteria pollutants" and other "non-criteria pollutants" commonly associated with carbon-based fuel combustion.[149]

149. "Criteria pollutants" (ozone, particulate matter, carbon monoxide, nitrogen oxides, sulfur dioxide and lead) are those pollutants which EPA regulates with human health-based air quality standards. "Non-criteria pollutants" are those pollutants for which there are no federal air quality standards.

Table 5 | Health Effects Associated with Carbon-based Fuel Combustion Pollutants

AIR POLLUTANT	HUMAN HEALTH EFFECTS
Greenhouse Gases[a]	Indirect climate-related effects on morbidity and mortality e.g., increased mold and pollen allergy incidence and severity, heat stress, heart-related mortality, vector-borne disease
Carbon Monoxide[b]	Effects on existing cardiovascular disease
Nitrogen Oxides[c]	Increased symptom severity with respiratory infections, increased airway inflammation and responsiveness, asthma exacerbation, other respiratory effects
Ozone[d]	Eye, nose and throat irritation, decreased lung function, respiratory effects, e.g., shortness of breath, coughing, asthma exacerbation, effects on existing cardiovascular disease, mortality
Particulate Matter[e] **PM_{10}**	Chronic bronchitis
Particulate Matter[e] **PM_{10} and $PM_{2.5}$**	Nose irritation, respiratory effects e.g., coughing, difficulty breathing, asthma exacerbation, premature mortality (cardio-pulmonary)
Particulate Matter[e] **$PM_{2.5}$**	Cardiovascular effects
Sulfur Dioxide[f]	Respiratory tract irritation, asthma exacerbation, difficulty breathing/shortness of breath, cough, premature mortality
Metals[g]	Effects vary depending on specific metal
Polycyclic Aromatic Hydrocarbons[h]	Cancer (not all polycyclic aromatic hydrocarbons)
Volatile Organic Compounds (VOCs)[i]	Effects vary depending on the specific chemical. Some examples are: Central nervous system effects, liver and/or kidney toxicity, eye, skin, and respiratory tract irritation, cancer

Sources:

a. Basu, Rupa, Samet, J.M. *Relation Between Elevated Ambient Temperature and Mortality: A Review of the Epidemiologic Evidence.* Epidemiol Review. 24:190-202.2002. Bell, M.L., Davis, D.L., Cifuentes, L.A., Krupnick, A.J., Morgenstern, R.D., Thurston, G.D. Ancillary Human Health Benefits of Improved Air Quality Resulting from Climate Change Mitigation. Environ Health 7:41. 2008.

b. EPA. Office of Research and Development. 2000.

c. EPA. *EPA/600/R-08/071: Integrated Science Assessment for Oxides of Nitrogen – Health Criteria,* 2008.

d. EPA. *EPA /600/R-05/004aF-cF: Air Quality Criteria for Ozone and Related Photochemical Oxidants.* 2006.

e. EPA. *EPA/600/p-99/002aF-bF: Air Quality Criteria Document for Particulate Matter, Volumes I & II.* 2004.

f. EPA. *EPA/600/R-08/047F.: Integrated Science Assessment for Sulfur Oxides- Health Criteria.* 2008.

g. Agency for Toxic Substances and Disease Registry (ATSDR), U.S. Department of Health and Human Services. *Toxicological Profiles for Specific Metals.* http://www.atsdr.cdc.gov/toxprofiles/index.asp

h. ATSDR. Toxicological Profiles for specific PAHs: http://www.atsdr.cdc.gov/toxprofiles/index.asp

i. ATSDR. Toxicological Profiles for specific VOCs: http://www.atsdr.cdc.gov/toxprofiles/index.asp

Climate Change: Carbon Dioxide and Other Greenhouse Gases

Climate change attributable to the growth in GHG emissions may impact human health in many ways that are only beginning to be fully understood. For example, episodes of increased ambient temperature and humidity in summer may lead to increased incidence of heat-related morbidity and mortality.[150, 151, 152] Increased frequency of storms and flooding will likely result in increases in associated mortality.[153] Episodic higher summer temperatures also can increase the natural emissions of ozone precursors and accelerate the reaction rate of formation of ozone and photochemical smog, resulting in additional impacts on morbidity and mortality.[154] Although warmer winters could result in reduced cold-weather mortality,[155] this reduction is estimated to be less than or equal to increases associated with warmer summer temperatures.[156, 157] Indirect impacts of gradual climate change on health are also possible. For example, increased temperatures and humidity may increase health risks through changes in vector-borne disease incidence. Health risks to people may arise due to impacts on water supplies and food production. Prevalence of or severity of symptoms due to allergies to mold, pollen, and others may increase.

Criteria Pollutants

Emissions from energy use (including transportation) and production are the most significant source of criteria pollutants, CO, NO_X, ozone, PM, and SO_2. One way to consider risks at ambient concentrations is to compare them to the NAAQS. The health-based NAAQS values are presented in Table 4. Although the State is in compliance with most of

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150. Basu, Rupa. *Relation between Elevated Ambient Temperature and Mortality: A Review of the Epidemiologic Evidence.* Epidemiol Rev. 2002. 24(2):190-202.

151. Knowlton, Kim. *The 2006 California Heat Wave: Impacts on Hospitalizations and Emergency Department Visits. Environmental Health Perspective.* 2009. 117: 61-67.

152. Lin, Shao. *Extreme High Temperatures and Hospital Admissions for Respiratory/Cardiovascular Disease for New York City.* Epidemiology. 20(5):738-46 2009.

153. NYSERDA. *Responding to Climate Change in New York State: the ClimAid Integrated Assessment for Effective Climate Change Adaptation in New York State.* 2011.

154. Bell, Melanie L. *Climate Change, Ambient Ozone, and Health in 50 U.S. Cities. Climatic Change.* 2007. 82:61-76.

155. Anderson, Brian. *Weather-Related Mortality: How Heat, Cold and Heat Waves Affect Mortality in the United States.* Epidemiology. 2000. 20:205-213.

156. Medina-Ramon M, Schwartz J. Temperature, temperature extremes, and mortality: a study ofacclimatization and effect modification in 50 US cities. Occup Environ Med. 2007; 64:827–833.

157. Anderson, B. G., Bell, M.L. Weather-Related Mortality: How Heat, Cold and Heat Waves Affect Mortality in the United States: Epidemiology 20:205-213. 2009.

these standards, 64.3 percent of the State's population (based on the 2012 Census) resides in the 10 counties that are not in attainment for ozone.[158]

Some of the NAAQS are based on risk estimates derived from the collective findings of epidemiological studies which have reported increased rates of morbidity and mortality associated with pollutant concentrations. Risk estimates derived from specific time periods, populations, baseline effect incidence rates, and pollution concentration changes can be applied with some increase in uncertainty to other populations, time periods, baseline effect incidence rates and pollution concentration ranges (increases or decreases) to estimate impacts or benefits of specific scenarios of interest. For example, considering the Queens population in the year 2000 (2,229,379) and an initial annual non-accidental mortality (15,639) rate, and using the range of the standardized risk estimates (6 to 13 percent) (found in Appendix 4, Table 10), a benefit range of approximately 2,400 to 5,000 avoided deaths can be estimated from an expected total non-accidental mortality of 150,500 for the change in $PM_{2.5}$ concentration for Queens County from 2001 to 2010 (a reduction in mortality over that time period of approximately 1.6 percent).[159]

Non-Criteria Pollutants

Many VOCs, for example toluene, can cause central nervous system effects and some, like benzene, are carcinogens.[160, 161] In addition to VOCs and GHGs (discussed earlier), non-criteria pollutants that can be emitted from fuel combustion include chlorinated dibenzo-p-dioxins, chlorinated dibenzofurans, polycyclic aromatic hydrocarbons, and various metals, particularly mercury from coal combustion. Exposure to high levels of chlorinated dioxins and furans is associated with cancer and effects on the liver and skin.[162, 163] Health effects associated with exposure to metals vary with the metal.[164] For example, mercury, particularly after being transformed to methylmercury in the environment and entering the food chain, can cause effects on the nervous system, especially for children

158. The ten counties are Bronx, Chautauqua, Nassau, New York, Queens, Kings, Richmond, Rockland, Suffolk and Westchester.

159. DOH. *Statistics and Data*. 2012. http://www.health.ny.gov/statistics. For this calculation, non-accidental mortality was defined as total mortality minus the sum of total accident mortality, homicides and legal interventions and suicides.

160. ATSDR. *Toxicological Profile for Toluene*. 2007.

161. ATSDR. *Toxicological Profile for Benzene*. 2007.

162. ATSDR. *Toxicological Profile for Chlorodibenzofurans (CDFs)*. 1994.

163. ATSDR. *Toxicological Profile for Chlorinated Dibenzo-P-Dioxins*. 1998.

164. ATSDR. *Toxicological Profiles for Specific Metals*. 2008.

and fetuses.[165] Exposure to high levels of some polycyclic aromatic hydrocarbons (PAHs) is associated with lung cancer.[166] Ambient air concentrations are evaluated by comparison to health-based criteria.

Health Concerns by Energy Sector

Electricity Generation

Central and distributed electricity generation can rely on a number of primary energy sources.[167] New York laws and regulations contain requirements to protect public health when many kinds of facilities, including those that generate electricity, are sited. Health risks associated with generation of electricity from some of these primary energy sources, as well as risks associated with electricity distribution, are discussed in the following sections.

Examples of currently viable sources of electricity for New York are combustion of carbon-based fuels, nuclear power, hydropower and hydrokinetic energy, solar energy, wind, and importation from out of state. Specific public health risks and concerns for each source of electricity are discussed below.

Carbon-based Fuels

A number of carbon-based fuels are burned to generate electricity including coal, fuel oil, and natural gas. Biofuels, refuse, and other waste materials are also used. To quantitatively evaluate the health risks or health impacts of fuel use (primarily due to emissions from combustion) for electricity generation, resulting incremental air quality impacts and human exposures have to be estimated. Such estimates, even for a single emission source, require sophisticated mathematical models that take into account many site-specific factors. Characterizing incremental increases in air concentrations, human exposures and risks in such a way as to be representative of different carbon-based fuel electricity generation scenarios for New York is beyond the scope of this Plan. Emissions levels are typically the primary determinants of incremental air concentration increases and therefore ambient air exposures. For this reason, we can draw preliminary conclusions from relative statewide emissions as a surrogate for exposure and risk associated with different energy use sectors, fuels, and source categories.

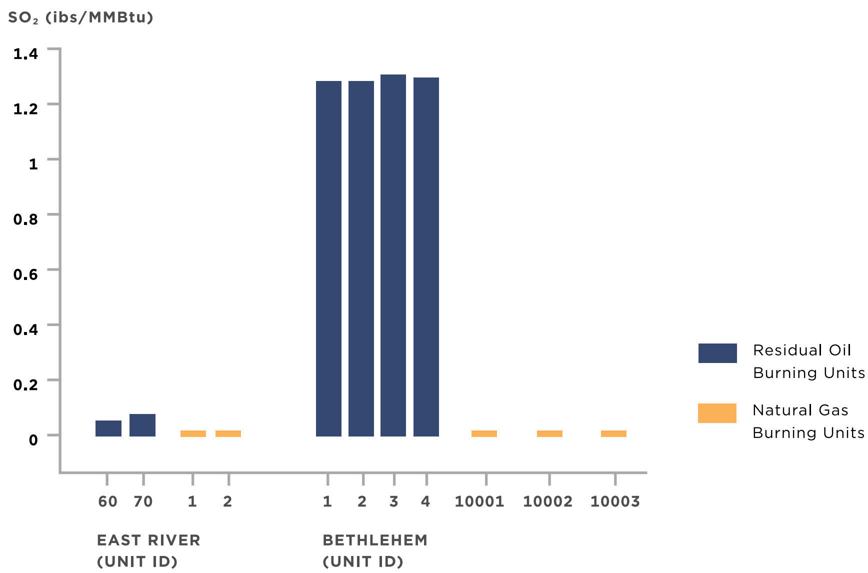
165. ATSDR. HHS. *Toxicological Profile for Mercury*. 1999.

166. ATSDR. *Toxicological Profile for Polycyclic Aromatic Hydrocarbons (PAHs)*. 1995.

167. Primary energy refers to un-transformed energy used by the major energy use sectors, i.e., electric, transportation, and buildings.

Illustrated in Figure 9 is the difference between SO_2 emissions from older units and newer units at two repowered older facilities. For the Bethlehem Energy Facility, newer gas-burning units with advanced combustion technologies, e.g., dry low NO_X burners and controls such as selective catalytic reduction, have very low NO_X and SO_2 emission rates compared to 2004 emission rates for the oil-burning units that they replaced. For the East River energy facility, 2005 emissions rates for SO_2 and NO_X from new gas-burning units are significantly lower than those from only moderately older oil-burning units brought on line in 1995. Emissions for CO_2 were also lower for the new units of both facilities, though the difference was less substantial than for the other pollutants.

Figure 9 | Emission Rate Comparison for SO_2 Between Older Residual-Oil Burning Units and New Natural Gas-Burning Units (East River and Bethlehem)



Source: DEC, Division of Air Resources. All emissions data are from 2005, with the exception of the older Bethlehem units, for which 2004 emissions data are used.

Of the electricity need met by burning of carbon-based fuels, increasing the fraction met by fuels associated with lower emissions versus those with higher emissions (e.g., natural gas versus coal) will, in general, decrease health risks. Re-powering or retrofitting older facilities with improved control technologies will reduce emissions and hence reduce health risks.

Nuclear Power

The primary health concern for nuclear power generation is exposure of the public to radiation in the event of a major accident. Significant radiation exposures can cause acute health effects such as cataracts, burns, sterility, and even death.[168] Radiation is a known carcinogen and mutagen. According to an approach often used by regulatory agencies to estimate cancer risk at low doses, the risk of developing a radiation-induced cancer is approximately one-in-one-million per millirem of exposure and the risk of developing a radiation-induced fatal cancer is approximately half as much.[169] For reference, the current overall lifetime risk of dying from cancer in the U.S. is 21 percent or about one in five.[170] In the absence of an accident, the contribution of radiation from nuclear power plants to an American's average radiation exposure is minimal.[171]

Recent events at the Fukishima reactors in Japan have increased community concern with the operation of nuclear power reactors. Potential radiological consequences from an accident where an earthquake is the initiating event are not different from potential consequences of an accident caused by any other initiating event. Still, accident responses may differ because of infrastructure damage associated with a natural disaster. The U.S. Nuclear Regulatory Commission (NRC) is currently re-evaluating plant safety requirements in light of lessons learned from the Fukishima accident and has issued a report with recommendations in the areas of: clarifying regulatory framework, improving protection, enhancing mitigation, strengthening emergency preparedness, and improving the efficiency of NRC programs.[172] Two plant workers were hospitalized with radiation burns

168. One method of evaluating the degree of acute hazard from exposure is to define the amount of exposure or dose that would cause death in 50 percent of the population within a certain time period. The dose that would cause death in 50 percent of the population within 60 days ($LD_{50,\ 60}$) without treatment for radiation exposure is approximately 350,000 millirem. Berger, M.E. , Leonard, R.B., Ricks, R.C., Wiley, A.L., Lowry, P.C., Flynn, D.F. Hospital Triage in the First 24 Hours After a Nuclear or Radiological Disaster. 2008. http://orise.orau.gov/files/reacts/triage.pdf

169. NRC. *Biological Effects of Ionizing Radiation. Health Risks from Exposure to Low-levels of Ionizing Radiation*. 2006.

170. Ries, Lyn A.G. *SEER Cancer Statistics Review*. 2009.

171. NCRP. *Report No. 160: Ionizing Radiation Exposure of the Population of the U.S.* 2009.

172. NRC. *Recommendations for Enhancing Reactor Safety in the 21st Century: The Near Term Task Force Review of Insights from the Fukushima Dai-Ichi Accident*. 2011. http://www.psr.org/assets/pdfs/recommendations-for-enhancing-reactor-safety.pdf during the Fukushima disaster[173] but longer term impacts have not been identified to date.[174]

Given the lack of combustion emissions from nuclear power facilities, an increase in nuclear generating capacity could lead to less emissions of pollutants including CO_2 than carbon-based fuel. Still, the risks associated with a potential major radioactive release and the need to have a long-term disposal plan for radioactive wastes are important issues to consider.

Importation of Electricity from Out of State

In 2011, 15 percent of New York's electricity needs were met by net importation of electricity from out of state.[175] New York imports electricity from 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. While importation of electricity may have no direct health concerns for New Yorkers (other than those regarding transmission discussed below), out-of-state sources of electricity can have associated health risks for New York's residents. For example, the majority of mercury deposited in New York comes from coal plant emissions from energy facilities to the Southwest, upwind of the State. Similarly, levels of regional pollutants such as fine particulates, ozone, NO_X, and SO_2 in New York have significant components derived from transport from the Midwestern states.[176, 177] This is largely due to the fuel mix of these downwind states. In 2010, electricity generation fueled by coal in Ohio, Kentucky, Indiana, and West Virginia was 87, 93, 95, and 98 percent respectively, with 49 percent of the total generation of the 14 PJM Interconnect states fueled by coal.[178] Thus, decisions about new interconnects between New York and other control areas may have the potential of increasing capacity factors for

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173. Bloomberg News. *Reactor Core May be Breached at Damaged Fukushima Plant*. March 25, 2011. http://www.bloomberg.com/news/2011-03-22/nuclear-plant-s-fuel-rods-damaged-leaking-into-sea-tokyo-electric-says.html

174. An initial round of 80,000 medical checks of residents who were 18 or younger at the time of the disaster has only resulted in a single diagnosis of thyroid cancer which is believed to be unrelated to the disaster. Thyroid cancer is not expected to be detectable for the first 4 to 6 years following radiation exposure. Additional checks of 280,000 individuals organized by the Fukushima Prefecture Government panel on health impacts from the nuclear crisis are pending. Japan Times. *Fukushima Finds First Child Throid Cancer after 3/11*. September 13, 2012. http://www.japantimes.co.jp/text/nn20120913b7.html

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

176. DEC. *Buffalo/Niagara Falls Metropolitan Area Classification and Boundary Determination. Meteorological Influences.* 2011. http://www.dec.ny.gov/chemical/40759.html

177. EPA. *Cross-State Air Pollution Rule (CSAPR)*. http://www.epa.gov/crossstaterule/whereyoulive.html.

178. PJM Interconnection. *Coal Capacity at Risk for Retirement in PJM: Potential Impacts of the Finalized EPA Cross State Air Pollution Rule and Proposed National Emissions Standards for Hazardous Air Pollutants.* 2011.

generation in those states and therefore emissions and ambient levels of air pollutants and associated health impacts in New York.

Considering the significant impacts on New York's ambient air levels of some air pollutants, efforts to reduce emissions from out-of-state energy facilities upwind of New York could be pursued. Strong federal and regional programs could address these emissions in other states and bring them more in line with New York energy facility emissions.

Non-Combustion Renewable Electricity

The kinds of health risks associated with the combustion of carbon-based fuels (e.g. risks from exposure to combustion emissions and combustion waste products) or nuclear power generation, are not associated with solar energy, wind, and hydroelectric power. While the use of these means of producing electric power is not risk-free, increasing the fraction of electricity need met by wind, solar, and water will, in general, decrease health risks associated with electricity production.

In terms of hydropower, some potential health risks accompany development and use of dams and reservoirs. In spite of progress made to improve dam safety, dam failure and earthquakes by reservoir-induced seismicity are still the major catastrophic hazards associated with hydroelectric generation and these concerns increase with reservoir size.[179, 180] According to the Dam Safety Section of DEC, as of Spring 2012, there were 207 federally regulated hydroelectric dams in the State and five applications for new hydroelectric development at dams. Thirty-four percent of the existing federally regulated dams are classified as having a high hazard potential due to dam height, reservoir capacity, downstream activities, and other factors. Nevertheless, according to DEC no catastrophic hydroelectric dam failure has occurred in New York in at least the last 20 years.

Hydrokinetic energy is another form of hydropower and includes wave and in-stream tidal energy and other ocean energy. As of August 2013, seven preliminary permits were issued by FERC for proposed hydrokinetic projects using tides, waves, or river currents in New York. Specific direct or indirect health risks of hydrokinetic energy have not been identified.[181]

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179. Uddin, Nasim. *Lessons Learned: Failure of a Hydroelectricpower Project Dam. Journal of Performance of Constructed Facilities.* 2005. 19:69-77.

180. Lamontagne, Maurice. *Reservoir-induced Earthquakes at Sainte-Marguerite-3, Quebec, Canada. Canadian Journal of Earth Sciences.* 2006. 43:135-146.

181. Cada, Glen. *Potential Impacts of Hydrokinetic and Wave Energy Conversion Technologies on Aquatic Environments. Fisheries.* 2007. 32:174-181.

Further, public documents have suggested that there can be physical safety concerns for wind turbines including tower collapse, blade throw, and ice shedding.[182] Health risk related to blade throw and ice shedding could be mitigated through the choice of appropriate minimum setbacks (the minimum allowable distances between turbines and roads, property lines, or structures). Tower collapse can pose risks, but it is uncommon.[183]

The relationship between noise from wind turbines and health effects is not well understood. Recent reviews of available information have found that noise from wind turbines may be more noticeable, annoying, and disturbing than other community or industrial sounds of the same level. Wind turbine noise may cause annoyance because it tends to fluctuate in loudness as the blades rotate, and may cause sleep disturbance because it may not decrease predictably at night. Other than finding that annoyance and sleep disturbances may be associated with wind turbine noise, no other direct effects of wind turbine noise on health were found to be sufficiently documented.[184, 185] Article 10 (Exhibit 19) of New York's Public Service Law and associated regulations require that applications to construct include a study of the noise impacts of construction and operation. The study must consider baseline and future A-weighted decibel (dBA) sound levels and evaluate impacts to sensitive sound receptors, residences, hospitals, and schools.

Wind turbine blades can create alternating levels of light intensity, referred to as shadow flicker, when rotating turbine blades cast shadows on nearby buildings or people. There has been some concern that shadow flicker might trigger seizures in people with photosensitive epilepsy, but recent reviews found that the low flicker rate from wind turbines is unlikely to trigger such seizures.[186]

Electric Transmission Lines

Extremely low frequency (ELF) electromagnetic fields (EMF) are present along all alternating current (AC) power transmission lines. The International Commission on Non-Ionizing Radiation Protection (ICNIRP) is the international standard setting body for protecting human

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182. Steuben County Industrial Development Agency. *Draft Generic Environmental Impact Statement*. 2005.

183. NYSERDA. *Public Health and Safety. Power Naturally*. 2005.

184. Oregon Health Authority. *Strategic Health Impact Assessment on Wind Energy Development in Oregon*. 2012.

185. Massachusetts Department of Public Health and Department of Environmental Protection. *Wind Turbine Health Impact Study: Report of Independent Expert Panel*. 2012.

186. Massachusetts Department of Public Health and Department of Environmental Protection. *Wind Turbine Health Impact Study: Report of Independent Expert Panel*. 2012.

health from non-ionizing radiation exposure.[187] In 2010, the ICNIRP published updated guidelines for exposure to EMF including a reference level for general public exposure to prevent acute effects from the exposure since their analysis of the available data determined that there was no compelling evidence of a causal relationship between exposure and chronic effects.[188] The ICNIRP noted that this finding contradicted the 2002 determination of the International Agency for Research on Cancer (IARC), which classified these fields as a "possibly carcinogenic to humans."[189] However, research into the potential association with childhood leukemia continues and, in 2010, a pooled analysis of studies published after 2000 found an association between magnetic fields and childhood leukemia, supporting IARC's previous assessment that magnetic fields are possibly carcinogenic.[190]

The PSC stated that all future transmission systems will be designed, constructed, and operated to ensure that a magnetic field, measured at one meter, will not exceed 200 milligauss at the edge of the public right-of-way, or one-tenth the level established by the ICNIRP to protect the public from acute effects from exposure.[191] DOH staff routinely handles six or seven citizens' questions per month about EMF health effects, State regulations, and exposure reduction strategies. Concerns have focused on children's health, a safe distance from a power line for a house, and how to shield or block EMF. DOH provides an overview of radiation principles, information on State, federal and international exposure limits and scientifically based answers to health questions. Concerned citizens are advised to exercise "prudent avoidance," e.g., minimize potential risk when the magnitude of risk is unknown, and given suggestions for approaches to minimize exposure to EMF.

In certain individuals, exposure to ELF fields (magnetic or electric) can produce faint flickering visual sensations called "phosphenes," which are not necessarily considered an adverse health effect, but are considered an indicator of an induced electric field in the central nervous system. Individuals with a diagnosis or family history of seizure or those

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187. International Commission on Non-Ionizing Radiation Protection. *News Focus*. 2012. http;//www.icnirp.de/

188. PJM Interconnection. *Coal Capacity at Risk for Retirement in PJM: Potential Impacts of the Finalized EPA Cross State Air Pollution Rule and Proposed National Emissions Standards for Hazardous Air Pollutants*. 2011.

189. ICNIRP. *International Commission on Non-Ionizing Radiation Protection*. 2010.

190. Kheifets, Leeka et. al. Pooled analysis of recent studies on magnetic fields and childhood leukemia. *British Journal of Cancer*. 2010. 103:1128-1135. www.bjcancer.com.

191. PSC. *Statement of Interim Policy on Magnetic Fields of Major Electric Transmission Facilities*. 1990.

on medications that reduce seizure threshold may be more susceptible to induced electric fields. The scientific evidence supporting an association of ELF fields with neuroendocrine, neurodegenerative, immunological, hematological, cardiovascular, reproductive and developmental effects, and with other cancers in adults or children, was considered by the panel as either inadequate, or as sufficient to indicate no association.[192]

Reliability

Reliable electricity production is critical to maintain good public health in our energy-dependent society. Increasing the reliability of the electric grid can reduce health effects during high temperatures, when air conditioning is the principal means to prevent heat-related morbidity and mortality. To gain a better understanding of the health impacts of power outages, DOH conducted a study of the health effects of the Northeast blackout of 2003, focusing on the resulting air conditioning loss, and finding that mortality and respiratory hospital admissions in NYC increased significantly (two- to eight-fold) during the blackout, but cardiovascular and renal hospitalizations did not. The most striking increases occurred among elderly, female, and chronic bronchitis admissions. In contrast to the pattern observed for comparably hot days, higher socioeconomic status groups were more likely to be hospitalized during the blackout.[193]

During summer, power outages pose specific health-related impacts such as: (1) increased digestive tract illness due to consumption of spoiled meat and seafood; (2) spoiled vaccines due to loss of refrigeration; and (3) potential for increased rodent populations as a result of large amounts of discarded perishables.[194, 195, 196] Electricity outages can also render furnaces inoperable in winter, resulting in risks of cold weather mortality and morbidity. Winter outages also pose specific risks to public health such as carbon monoxide (CO) poisoning due to the improper use of gasoline or

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192. WHO. *Extremely Low Frequency Fields. Environmental Health Criteria Monograph 238.* 2007.
193. Lin, Shao; Fletcher, Barabara; Luo, Ming; Chinery, Robert; and Hwang, Syin-An. *Health Impact in New York City during the Northeastern Blackout of 2003.* Public Health Reports. 2011. 126(3):384-93.
194. Bell, K.N. *Risk Factors for Improper Vaccine Storage and Handling in Private Provider Offices .* *Pediatrics*. 2001. 107(6): art-e100.
195. Marx, A. Melissa. *Diarrheal Illness Detected Through Syndromic Surveillance after a Massive Power Outage: New York City, August 2003.* American Journal of Public Health. 2006. 96:547-553.
196. Beatty, Mark. *Blackout of 2003: Public Health Effects and Emergency Response. Public Health Reports.* 2006.

diesel generators.[197, 198] During a 2006 winter storm in Western New York, 264 people were hospitalized for CO poisoning.[199] After Hurricane Sandy, 80 CO poisoning cases were reported to the Center for Disease Control and Prevention.[200]

Power outages affect private drinking water sources (wells) and may also affect public water supplies and waste water treatment plants. In New York, approximately 88 percent of the total population (18.9 million, 2000 census) receives water from public water systems. Some systems are required to have a dedicated standby power system so that the water can be treated and/or pumped to the distribution system during power outages to meet demands. Some systems have alternate methods of providing water during short power outages. Systems serving a population greater than 3,300 are required to have emergency plans that address power outages. Power outages lasting one to two days should have minimal impact but longer power outages are likely to interrupt services for some systems.

Transportation

Health effects from energy use by the transportation sector include accidental injuries and death (not discussed further in this chapter) and increases in morbidity and mortality associated with air emissions. For the transportation sector, mobile source emissions are usually concentrated at ground level, often in densely populated areas, resulting in a tendency toward higher levels of exposure for more people than emissions associated with other energy use sectors. The criteria and non-criteria pollutants emitted are associated with an increased risk of respiratory and cardiovascular effects, among others, as detailed in Table 5.

The increases in risk of these effects have been investigated by numerous studies that have looked at the relationship between traffic patterns or associated pollutant levels and health endpoints. For example, studies have found associations between asthma exacerbation

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197. Daley, W. Randolf. *An Outbreak of Carbon Monoxide Poisoning after a Major Ice Storm in Maine.* The Journal of Emergency Medicine. 2000. Vol. 18, No. 1, pp. 87–93.

198. Muscatiello, Neil, Babcock, G., Jones. R., Horn, E., and Hwang, S.A. *Hospital Emergency Department Visits for Carbon Monoxide Poisoning Following an October 2006 Snowstorm in Western New York*. Journal of Environmental Health. 2010. Volume 72, Number 6, pages 43-48.

199. Graber, Judith M. *Results from a State-Based Surveillance System for Carbon Monoxide Poisoning. Public Health Reports.* 2007. 122:145-154.

200. Center for Disease Control and Prevention. Notes from the Field: *Carbon Monoxide Exposures Reported to Poison Centers and Related to Hurricane Sandy — Northeastern United States.* 2012 Morbidity and Mortality Weekly Report. 66(44);905-905.

or emergency room visits for respiratory illness and transportation-related factors such as traffic proximity or traffic density[201, 202, 203] and, in particular, diesel traffic density.[204]

Fuel Use

Currently, most mobile source emissions result from combustion of gasoline and traditional petroleum-based diesel fuel. Aggregate PM emissions from the transportation sector and associated potential health risks could be reduced through an accelerated shift away from traditional diesel fuel and less controlled diesel sources toward more use of ULSD and diesel emissions control technologies, or cleaner alternative fuels.

When compared with petroleum-based fuels, biodiesel and alcohol-based fuels have higher levels of combustion emissions of respiratory irritants and some ozone-precursors such as acrolein and carcinogens formaldehyde and acetaldehyde.[205, 206] A recent health impact assessment study has suggested that regional replacement of gasoline with the 85 percent ethanol-gasoline blend (E-85), which is currently available for millions of flex-fuel vehicles in the U.S., could result in increased ozone concentrations and ozone-related mortality in the Northeast U.S. and other regions.[207] Work conducted as part of the New York "Renewable Fuels Roadmap" discusses research that suggests that replacing gasoline with ethanol reduces emissions of carcinogenic benzene and butadiene but increases emissions of formaldehyde, and acetaldehyde that have other health impacts.[208]

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201. Lin, S., Munsie, J.P., Hwang, S.A., Fitzgerald, E., Cayo, M.R.. *Childhood Asthma Hospitalization and Residential Exposure to State Route Traffic*. Environmental Research. 2002. Section A (88): 73-81.

202. Lwebuga-Mukasa, James S. *Traffic Volumes and Respiratory Health Care Utilization among Residents in Close Proximity to the Peace Bridge Before and After September 11, 2001.* Journal of Asthma. 2003. 40(8): 855-864.

203. Kim, Janice. *Residential Traffic and Children's Respiratory Health*. Environmental Health Perspectives. 2008. 16(9):1274-9.

204. McCreanor, James. *Respiratory Effects of Exposure to Diesel Traffic in Persons with Asthma*. New England Journal of Medicine. 2007. 357(23):2348-58.

205. Corrêa, Sergio M. and Arbilla, G. *Formaldehyde and Acetaldehyde Associated with the Use of Natural Gas as a Fuel for Light Vehicles.* Atmospheric Environment 39. 2005. 4513-4518.

206. Tang, Shida. *Unregulated Emissions from a Heavy-Duty Diesel Engine with Various Fuels and Emission Control Systems.* Environmental Science and Technology. 2007. 41:5037-5043.

207. Jacobson, Mark. *Effects of Ethanol (E85) Versus Gasoline Vehicles on Cancer and Mortality in the United States.* Environmental Science and Technology. 2007. 41:4150-4157.

208. NYSERDA. *Renewable Fuels Roadmap and Sustainable Biomass Feedstock Supply for New York*. April 2010. http://www.nyserda.ny.gov/Publications/Research-and-Development-Technical-Reports/Biomass-Reports/Renewable-Fuels-Roadmap.aspx

Transportation Planning

Transportation planning has the potential to influence health risks associated with emissions from fuel use as well as the potential to reduce risks for obesity, diabetes, and cardiovascular disease by providing more or fewer opportunities for physical exercise. The way different land uses — residential, commercial, recreational, natural, public, civic, and cultural — are arranged affects the distance between them, and can affect the degree to which automobiles are relied upon to access those destinations. Planning for compact, mixed-use, inter-connected communities, i.e., Smart Growth, has the potential to reduce dependence on automobiles, overall transportation fuel consumption, and pollutant emissions while encouraging low-energy alternative travel modes, such as walking and biking. In recent years, studies have begun to examine the relationship between neighborhood "walkability" and physical activity levels and/or body mass index.[209]

A low level of physical activity is a risk factor for diabetes and obesity (along with high blood pressure and family history).[210] The number of New Yorkers with self-reported diabetes has nearly doubled since 1997, and obesity has reached epidemic proportions. New York's Prevention Agenda 2013-2017 includes an objective to reduce the percentage of children and adults who are obese by 5 percent by the end of 2017.[211]

Health risks associated with transportation emissions can be reduced with a shift toward the use of cleaner carbon-based fuels, increased implementation of effective emission control technologies, transportation technologies that do not rely upon carbon-based fuels, and the enhancement of public transportation systems. Widely used public transportation results in considerably less fuel use and air contaminant

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209. A Columbia University Study of 13,102 adults in New York City found that neighborhood walkability along with socioeconomic status were significant predictors of body mass index. Rundle, Andrew. *Personal and Neighborhood Socioeconomic Status and Indices of Neighborhood Walk-ability Predict Body Mass Index in New York City.* Social Science and Medicine. 2008. 67:1951-1958. Another study of 448 U.S. counties and 83 metropolitan areas found that residents of "sprawling counties" were likely to walk less during leisure time and weigh more than residents of "compact counties." Ewing, Reid et. al. *Relationship Between Urban Sprawl and Physical Activity, Obesity, and Morbidity.* The Science of Health Promotion. 2003. Vol. 18, No.1: 47-56. Summaries of multiple studies came to the conclusion that community attributes can play a role in encouraging physical activity. Durand, C.P. et al. *A Systematic Review of Built Environment Factors Related to Physical Activity and Obesity Risk: Implications for Smart Growth Urban Planning.* Obesity Reviews. 2011. 12:173-182. Sivam, Alpana et. al. *Does Urban Design Influence Physical Activity in the Reduction of Obesity? A Review of Evidence.* The Open Urban Studies Journal. 2012. 5:14-21.

210. DOH. *Diabetes.* 2012. http://www.health.ny.gov/diseases/conditions/diabetes/index.htm

211. DOH. *Prevention Agenda 2013-2017 New York State's Health Improvement Plan.* 2013. http://www.health.ny.gov/prevention/prevention_agenda/2013-2017/index.htm emissions per person-mile traveled than other modes of transportation such as personal cars.[212] Therefore, targeted geographic and temporal expansion of public transportation availability could reduce health risks associated with transportation emissions. Car-pooling can also reduce fuel use and associated health risks, and both of these mechanisms can be supported through integrated local and regional transportation planning.

An acceleration of the shift toward more fuel-efficient vehicles is a mechanism by which fuel use, associated emissions, and health risks can be decreased. Increased use of electric vehicles would affect significant net reductions in the emissions of CO and VOCs.[213] Emissions and health risks can also be reduced through vehicle idling reduction programs. Although anti-idling regulations exist on the State and municipal level, awareness of and compliance with the regulation could be improved. The fuel use and resulting emissions from the transportation sector can also be controlled and reduced through maintaining and improving the overall energy efficiency of the transportation system. Upgrading roads and bridges can reduce traffic bottlenecks and allow more energy-efficient travel speeds, resulting in reduced public health risks from exposure to air contaminants and reduced risks of traffic accidents and possible injuries or deaths.

Reductions in fuel use and emissions can also be achieved through Smart Growth planning that facilitates establishment of more “walkable” communities, with sidewalks and bike lanes and bike paths.[214, 215, 216] “Active transport”–walking and cycling–for shorter journeys has both the benefits of reduced emissions and exercise leading to reduced risk for obesity, cardiovascular disease, and other health endpoints.[217, 218] Nevertheless, in spite of the emission reductions associated with bicycling and walking for transportation and the health benefits of exercise, exercising in polluted air can also have health impacts,

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212. Woodcock, James. *Energy and Transportion*. Lancet. 2007. 370:1078-1088.
213. DeLuchi, M.A., Wang, Q., Sperling, D. (1989). *Electric vehicles: performance, life-cycle costs, emissions and recharging requirements.* The University of California Transportation Center, University ofCalifornia, Berkeley, CA.
214. Woodcock, James. *Energy and Transportion*. Lancet 2007. 370:1078-1088.
215. Davison, K. Kristen. *Children’s Active Commuting to School: Current Knowledge and Future Directions: Preventing Chronic Disease*. 2008. http://www.cdc.gov/pcd/issues/2008/jul/07_0075.htm
216. Watson, M. *Investment in Safe Routes to School Projects: Public Health Benefits for the Larger Community: Preventing Chronic Disease*. 2008. http://www.cdc.gov/pcd/issues/2008/jul/07_0087.htm
217. Ewing, Reid et. al. *Relationship Between Urban Sprawl and Physical Activity, Obesity, and Morbidity.* The Science of Health Promotion. 2003. Vol. 18, No.1: 47-56.
218. Mills, Nicholas. *Ischemic and Thrombotic Effects of Dilute Diesel-Exhaust Inhalation in Men with Coronary Heart Disease*. New England Journal of Medicine. Sept 13. 2007. 357(11):1075-1082.

especially for vulnerable populations.[219] For this reason, air quality, particularly in areas of heavy traffic, should also be considered in the choices made for siting of bicycle lanes and paths.[220]

Department of Transportation and other entities such as the Thruway Authority consider community concerns, including health concerns, in developing Draft Environmental Impact Statements pursuant to the State Environmental Quality Review Act (SEQRA). Concerns expressed by the public include air emissions and pollution (lead, idling diesel locomotives, buses and construction vehicles near schools and residences), soil and water pollution (oil releases, pesticides, and road salt), and noise and light pollution. Community concerns have contributed to development of anti-idling regulations, limitations on activities at transportation hubs, rerouting of trucks around residential neighborhoods, and the expansion of public transportation. In addition, since the 2002 State Energy Plan, many NYS Metropolitan Planning Organizations (MPOs) have been reporting GHG and other emissions in their Transportation Plans and Transportation Improvement Plans (TIPs).

Residential, Commercial, and Industrial Energy Use

For the residential sector, individual source emissions can be close to ground level, with relatively little opportunity for dilution, and can affect local air quality. In addition, residential energy use can pose special risks, e.g., home heating systems were the primary cause listed among the 15,000 CO poisonings resulting in emergency department visits in the U.S. annually.[221] In New York alone, there are approximately 2,000 emergency department visits for CO poisoning annually.[222]

Fossil Fuels

In New York City, the Bloomberg Administration enacted regulations to phase out the use of specific types of heating oil to improve air quality. Under the rule, buildings burning #6 fuel oil (residual) must switch to #4 fuel oil (a mid-grade commercial) upon boiler permit renewal

219. Mittleman, Murray A. *Air Pollution, Exercise and Cardiovascular Risk*. New England Journal of Medicine. Sept 13. 2007. 357(11):1147- 9.

220. Hertel, Ole. *A Proper Choice of Route Significantly Reduces Air Pollution Exposure – A Study on Bicycle and Bus Trips in Urban Streets.* Science of the Total Environment. 2008. 389(1):58-70.

221. CDC. *Nonfatal, Unintentional, Non Fire Related, Carbon-Monoxide Exposures-U.S*. 2008.

222. Bureau of Environmental and Occupational Epidemiology, Center for Environmental Health, DOH. *Based on Analysis of Statewide Planning and Research Cooperative System (SPARCS) Hospital Outpatient Emergency Department data*. http://www.health.ny.gov/statistics/sparcs/datareq.htm (between July 2012 and July 2015). Also buildings burning #4 or #6 fuel oil must switch to #2 fuel oil or natural gas whenever the boiler or burner is replaced. By 2030, all buildings still burning #4 fuel oil will need to have been converted to the cleaner fuel. Approximately 10,000 buildings will be affected by the phase out of higher sulfur content fuel with an estimated cost of $10,000 to convert a boiler to burn low-sulfur heating oil. The Mayor's office reports that one percent of New York City buildings still burning #4 and #6 fuel oil account for 86 percent of the soot pollution.[223, 224, 225]

According to the New York City Mayor's Office, these regulations will reduce the amount of fine particles emitted from heating buildings by at least 63 percent, and could lower the overall concentration of fine particles in the City's air from all sources by 5 percent upon full implementation. The NYC Department of Health and Mental Hygiene estimated that these air quality improvements could prevent some 200 deaths, 100 hospitalizations, and 300 emergency room visits for diseases caused by air pollution each year. The initiative is expected to also reduce CO_2 by approximately one million metric tons.[226]

Biomass and Biofuels

Biomass and biofuels (derived from biomass) are burned in New York for heat and combined heat, power for the residential, commercial, and industrial sectors. Of these energy use sectors, the use of biomass is greatest in the residential sector where it may be increasing over recent years, as residents increasingly turn to biomass (primarily wood, but also corn pellets) to heat their homes.[227]

Replacement of fossil fuel-burning technologies with those for combustion of biomass or biofuels can help reduce our dependence on fossil fuels and mitigate climate change if fuel is sustainably grown and harvested and burned efficiently to reduce black carbon emissions. However, emissions of some pollutants from wood burning exceed those for some fossil fuels (e.g., ultra- low sulfur fuel oil and natural gas) and

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223. New York Times. *City Issues Rule to Ban Dirtiest Oils at Buildings.* 2011. http://www.nytimes.com/2011/04/22/nyregion/new-york-city-bans-dirtiest-heating-oils-at-buildings.html

224. NYC DEP. *NYC Clean Heat Regulations.* 2011. http://www.nyccleanheat.org/content/regulations

225. Department of Environmental Protection. *Promulgation of Amendments to Chapter 2 of Title 15.* 2011. http://www.nyc.gov/html/dep/pdf/air/heating_oil_rule.pdf

226. NYC Mayor's Office. *Mayor Bloomberg and DEP Commissioner Holloway Propose New Home Heating Oil Regulations to Clean the Air New Yorkers Breath.* January 28, 2011. http://www.nyc.gov/html/om/html/2011a/pr034-11.html

227. Barlyn, Suzanne. *Burning Issue: As Wood Stoves Gain Popularity, Air-Quality Concerns Rise.* The Wall Street Journal. 2008.

there is potential for human health to be adversely affected with the rise in use of biomass fuels. Adverse health effects associated with exposure to wood smoke are consistent with those identified for fine particulate matter (a major component of wood smoke) including exacerbation of respiratory symptoms (e.g., asthma), and cardiovascular symptoms (e.g., chest pain, heart rhythm changes, heart attack, stroke). The elderly, people with heart and lung diseases, people of low economic status, and children are particularly vulnerable to the effects of fine particle exposures in wood smoke.

Wood smoke is found in both rural and urban areas of the State and in some areas (rural, valleys) the wintertime smoke impacts are significant. DOH found elevated PM levels near five of six conventional OWBs studied.[228] DOH receives health and "quality of life" complaints about smoke from wood burning devices, and provides resources and technical assistance to local health partners addressing wood smoke complaints.

Opportunities for Renewable Energy

Emissions and potential health risks associated with primary (and secondary) energy use in these sectors can be reduced through increased use of non-carbon-based energy sources. For example, geothermal or "ground source" heat pumps can be used for heating in the winter and cooling in the summer. Impacts of secondary energy consumption (grid-based electricity) can be reduced during peak demand by "electric thermal storage" (for heating) and reduced overall by increased use of distributed energy technologies such as solar power. Grid-based electricity may also provide an energy source for heating that has lower impacts than some on-site carbon-based technologies.

As demand for wood from the residential sector increases, it is increasingly important to encourage sustainable growth and harvesting of wood so that net reduction of GHG emissions can be achieved. A shift from burning wood in uncertified wood stoves and in fireplaces to burning wood in EPA-certified wood/pellet stoves or to other energy sources could substantially reduce statewide emissions of PM and other pollutants. Reduction of the potential health risks associated with local emissions from outdoor wood boilers can be achieved through emission controls, proper sizing, and encouraging replacement or retirement of existing inefficient, high-emitting units.

228. DOH. *Fine Particulate Matter Concentrations in Outdoor Air Near Outdoor Wood-fired Boilers*. 2013. http://www.health.ny.gov/environmental/outdoors/air/owb/

Biomass burning in the industrial and commercial sectors is also a significant source of emissions of pollutants and public health benefits could be achieved by reducing these emissions (through use of high efficiency, low emitting pellet devices, proper sizing/siting, and thermal storage as incentivized through New York State Cleaner, Greener Communities), although emissions from these units exceed those from ultra-low sulfur oil and natural gas devices. Emissions from the commercial sector could also be reduced through a shift from oil combustion (particularly residual oil) to natural gas.

Also, educating people about responsible wood burning (i.e., burn only split, seasoned wood) can reduce emissions and improve efficiency. Bulk storage of wood chips and pellets has been found to create unsafe levels of CO in some situations. Avoidance of pellets containing construction and demolition waste, including pressure treated and painted wood, and other additives that impact performance and air quality is advisable.[229]

Efficiency

Some energy efficiency improvements in residential and commercial buildings can impact indoor air quality (IAQ) as well as other aspects of indoor environmental quality (IEQ) (e.g., noise and glare). The New York State Building Code and Property Maintenance Code designate minimum air ventilation rates for new and existing buildings that generally minimize the occurrence of IAQ problems. However, problems still can arise when an older building is updated to make it more energy efficient without addressing the need for adequate ventilation. This is true in all buildings where there are pre-existing sources of air contaminants such as solvents, radon gas, dust, allergens, excess water or humidity (increasing chances for mold growth), CO, and CO_2. Radon, for example, is a carcinogen and dust can exacerbate asthma. NYSERDA has programs to use industry-accrediting organizations to set standards and best practices for conducting energy efficiency upgrades. Program requirements concerning source removal, ventilation systems, minimum ventilation rates, and sizing and installing of HVAC systems help avoid and alleviate IAQ problems in existing buildings. NYSERDA also strives to support advanced sustainability standards and tools by partnering with organizations like Collaborative for High Performance Schools, DOE, EPA, and the U.S. Green Building Council.

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229. Chandrasekaran, S.R., Hopke, P., Rector, L. Allen, G., Lin, L. 2012. *Chemical Composition of Wood Chips and Wood Pellets*. Energy Fuels. Vol. 26: 4932-4937.

Fuel Production and Transport

Fuel Oil Spills

Potential public health impacts are also associated with accidental fuel oil spills. Of the approximately 15,000 petroleum-related spills that occur in New York each year, many are associated with residential, commercial, or industrial fuel use. For example, in 2010, more than 4,500 heating fuel spills occurred in the State, 3,000 of which occurred at private residences and 1,000 at commercial, educational, governmental or industrial properties.[230] The most common sources of these spills are accidents during transport and delivery of fuel and leaks from storage tank, piping, and filters. Any leaks and spills of fuel oil can result in human exposure through contamination of drinking water, indoor air, soils, and physical property. Under New York State Public Health Law Section 206 (1q), DOH and local health units respond to more than 300 residential fuel oil spills per year by conducting on-site investigations to evaluate potential public health impacts. In the April 2011-March 2012 fiscal year, DOH staff recommended temporary relocation for individuals in 28 affected residences, and in the most recent fiscal year which included spills related to Superstorm Sandy, DOH staff recommended temporary relocation for 53 residences.

The number of residential fuel oil spills and associated potential health risks may be reduced by educational outreach efforts for fuel oil consumers or heating contractors and fuel suppliers pointing out the common causes of spills.

Natural Gas Fuel Production

In 2011, 31.1 billion cubic feet of natural gas were produced in New York, representing a decrease of 13 percent since 2010. Drilling and production activities are governed by DEC permits and regulations that are designed to prevent or minimize impacts on environmental media (soil, groundwater, air) and public health. DEC's regulatory program was the subject of a Generic Environmental Impact Statement (GEIS) that was finalized in 1992, with a finding that issuance of a standard oil and gas drilling permit does not have a significant environmental impact. In 2008, DEC began work on a Supplemental GEIS (SGEIS) to address high-volume hydraulic fracturing. Public comments on the draft SGEIS have included concerns about potential risks to human health for on-site workers and residents living near drilling operations. DOH is

230. DEC. *Chemical and Petroleum Spills*. 2012. http://www.dec.ny.gov/chemical/8428.html evaluating these concerns in its review of the draft supplemental generic environmental impact statement prepared by DEC. Safety of on-site workers is also addressed by the federal Occupational Safety and Health Administration.

Issues and Opportunities for Considering Health in Energy Planning

As discussed throughout this chapter, energy production and use has impacts on the health of New Yorkers. In general, known health risks that result from energy use and production are mitigated through federal and State regulatory processes and oversight mechanisms. Ongoing public health research and evaluations of emerging risks are necessary to provide insights into the potential effects of energy use. New York collects data on health outcomes, and this data can be used in epidemiological studies and considered in the siting of energy-related projects and facilities. Methods that can be used to evaluate health risk related to energy that can be helpful for energy planning are discussed in the following sections.

In response to economic forces and efforts to achieve energy goals related to improved efficiency, lower emissions, and diversification of sources, new energy technologies may emerge (or re-emerge) and the distribution of energy technologies in use will likely change. In order to anticipate and plan for unanticipated consequences of emerging technologies, innovative environmental public health research must be conducted together with the development and deployment of emerging technologies. Safety, health benefits, and risks should then be considered in energy planning and regulation, with findings communicated to the public and the research community.

Methods to Evaluate Health Risks, Quantify Health Impacts and Consider Health Status

The field of environmental public health is concerned with the potential impacts on human health and well-being of all aspects of the environment. The environment is generally considered to include both the natural and "built" environments, but can even be more broadly defined as including the physical, psychological, social, and aesthetic environment.[231] Health risk assessment is one tool that can be used in environmental public health

231. Corburn, Jason. *Health Impact Assessment in San Francisco: Incorporating the Social Determinants of Health into Environmental Planning.* Journal of Environmental Planning and Management. 2007. 50:323-341.

to estimate human health risks associated with existing or proposed, conditions or actions–such as the siting of an electric generating facility. Another tool can be used to estimate potential population health impacts of broad policy scenarios (often called quantitative impact assessment).

While risk for a single source of exposure, e.g., a facility, is often evaluated for hypothetical individuals intended to be representative of an exposed population or sub-population,[232] risk can also be evaluated for a potentially impacted population as a whole, considering its size and other characteristics.[233, 234] Quantitative assessment of health impacts on the population level can help evaluate government programs, regulations, or other actions.[235, 236, 237] Quantitative impact assessment can consider population-specific baseline prevalence of a disease and the estimated excess relative risk for that disease per unit of exposure to an environmental risk factor.[238] Excess relative risks for air pollution are usually based on concentration-response functions described in epidemiological studies (such as those considered in developing the $PM_{2.5}$ NAAQS).[239, 240, 241, 242] These kinds of assessments can estimate impacts as excess or avoided cases of disease or premature death, years of reduced or increased life expectancy, and other measures. In cost-benefit analysis, these kinds of impacts can be translated into economic terms by considering information such as medical expenses, lost productivity and other costs.[243] For example, an asthma-related event requiring hospitalization cost an average of $14,107 in New York in 2007, without

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232. EPA. *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities*. 2005.
233. NRC. *Science and Judgment in Risk Assessment: Committee on Risk Assessment of Hazardous Air Pollutants, Board on Environmental Studies and Toxicology, Commission on Life Sciences*. 1994.
234. Kajihara, Hideo. *Population Risk Assessment of Ambient Benzene and Evaluation of Benzene Regulation in Gasoline in Japan*. Environmental Engineering and Policy 2:1-9. 2000.
235. WHO. *Evaluation and Use of Epidemiological Evidence for Environmental Health Risk Assessment: WHO Guideline Document*. 2000.
236. Scott-Samuel, Alex. *Health Impact Assessment – Theory Into Practice*. Journal of Epidemiology and Environmental Health. 1998. 52:704-705.
237. National Research Council. *Improving Health in the United States: The Role of Health Impact Assessment*. 2011. www.nap.edu
238. WHO. *Evaluation and Use of Epidemiological Evidence for Environmental Health Risk Assessment: WHO Guideline Document*. 2000.
239. EPA. *EPA/600/R-08/139F: Integrated Science Assessment for Particulate Matter*. 2009.
240. EPA. *Air Quality Criteria for Ozone and Related Photochemical Oxidant*. 2006.
241. EPA. *EPA/600/R-08/07: Integrated Science Assessment for Oxides of Nitrogen – Health Criteria*. 2008.
242. EPA. *EPA/600/R-08/047: Integrated Science Assessment for Sulfur Oxides- Health Criteria*. 2008.
243. Arrow, Kenneth. *Is there a Role for Benefit-Cost Analysis in Environmental, Health And Safety Regulation?* Science. 1996. 272:221-222.

consideration of lost productivity.[244] Monetized population impacts can be considered along with other costs and benefits associated with a proposed action, regulation, or program.[245]

Health Outcome Data

Health outcome data are counts and rates of health-related events in a population, for example, deaths due to cardiovascular disease, hospitalizations for asthma, new diagnoses of cancer, or births of premature infants. DOH collects information on many health outcomes on an ongoing basis and maintains a variety of databases.

In 2012, DOH launched the Maximizing Essential Tools for Research Innovation and Excellence (METRIX) project creating a streamlined process for researchers and others to access to health outcome data.[246, 247, 248] These Community Health Data are grouped into eighteen health-related sections. In epidemiological studies, which test specific hypotheses, health outcome data are used along with environmental data or other surrogate measures of exposure to examine the effect of environmental factors on health. For example, two DOH studies conducted through New York's Environmental Public Health Tracking (EPHT) program examined the relationship between different components of air pollution (e.g., ozone, PM) and asthma hospitalizations using ambient air monitoring data and Statewide Planning and Research Cooperative System (SPARCS) data.[249] DOH has also studied the effects of traffic on asthma hospitalization and temperature on respiratory disease hospitalization.[250, 251] It is important for New York to continue to maintain

244. The highest rate of hospitalization for any age group was for children four years old and under; the average hospitalization stay in 2007 was 3.6 days; the total cost of asthma hospitalization based on hospital billing data in New York in 2007 was $535 million.

245. A number of computer models have been developed to translate estimated changes in air emissions associated with different emission scenarios to monetized health impacts. For example, models developed by EPA include the Co-benefits Risk Assessment Tool (COBRA) and the Environmental Benefits Mapping and Analysis Program (BenMAP). EPA has used quantitative impact assessment and cost-benefit analysis to evaluate the impacts of a number of environmental statutes and regulations, e.g., the Clean Air Act. EPA. *The Benefits and the Cost of the Clean Air Act 1990 to 2010*. 1999.

246. DOH. *Statistics and Data*. 2012. http://www.health.ny.gov/statistics

247. DOH. *Prevention Agenda 2013-2017 New York State's Health Improvement Plan*. 2013. http://www.health.ny.gov/prevention/prevention_agenda/2013-2017/index.htm

248. DOH. *METRIX DOH*. August 6, 2012. http://www.health.ny.gov/metrix/

249. Lin, S., Liu, X., Le, L., Hwang, S.A. *Chronic Exposure to Ambient Ozone and Asthma Hospital Admissions Among Children*. Environmental Health Perspective. 2008.

250. Lin,S., Munsie, J.P., Hwang, S.A., Fitzgerald, E., Cayo, M.R. *Childhood Asthma Hospitalization and Residential Exposure to State Route Traffic*. Environmental Research. 2002. Section A (88): 73-81.

251. Lin,S., Luo, M., Walker, R.J., Liu, X., Hwang, S.A., Chinery, R. *Extreme High Temperatures and Hospital Admissions for Respiratory/Cardiovascular Disease for New York City*. Epidemiology. 2009.

and improve understanding of the health impacts of decisions related to electricity generation and other uses. DOH studies on extreme heat and respiratory/cardiovascular diseases in New York City, health impacts of the 2003 blackout in New York City, summer temperature on acute renal failure, and climate change trends in New York have been published.[252, 253, 254, 255] Other DOH studies examine the association between temperature variability and respiratory diseases, assess and predict public health burden due to respiratory diseases, and examine the effect of extreme summer temperature on birth defects.[256, 257, 258] DOH has collaborated with EPA on an accountability study examining changes in health outcomes following initiation of EPA's State Implementation Plan to reduce NO_X emissions ("NO_X SIP Call"), which suggests that EPA's NO_X control policy may have had a positive impact on both air pollution statewide and respiratory health in some New York regions. If resources are available, additional studies could be conducted to continue to increase understanding of the health impacts of energy use.

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252. Insaf, T.Z., Lin, S., S.C. Sheridan. *Climate trends in indices for temperature and precipitation across New York State, 1948-2008.* Air Quality, Atmosphere & Health. 2013. 6(1): 247-257.

253. Fletcher, A., Lin, S., Fitzgerald, E.F., Hwang, S.A. *The Effects of Summer Temperatures on Hospital Admissions for Acute Renal Failure and Other Renal Diseases: A Case-Crossover Study.* American Journal of Epidemiology.

254. Lin, S., Luo, M., Walker, R.J., Liu, X., Hwang, S.A., Chinery, R. *Extreme High Temperatures and Hospital Admissions for Respiratory/Cardiovascular Disease for New York City.* Epidemiology. 2009.20(5):738-746.

255. Lin, Shao; *Fletcher, A. Barabara; Luo, Ming; Chinery, Robert; and Hwang, Syin-An. Health Impact in New York City During the Northeastern Blackout of 2003.* Public Health Reports. 2011. 126(3):384-93.

256. Von Zutphen, A.R., Lin, S., Fletcher, B.A., Hwang, S.A. *A population-based case-control study of extreme summer temperature and birth defects. Environmental Health Perspectives. 2012.* 120(10):1443-9

257. Lin, S., Hsu, W.H., Van Zutphen, A.R., Saha, S., Luber, G. Hwang, S.A. *Excessive Heat and Respiratory Hospitalizations in New York State: Estimating Current and Future Public Health Burden Related to Climate Change.* Environmental Health Perspectives. 2012. 120(11):1571-7

258. Lin, S., Insaf, T.Z., Luo, M., Hwang, S.A. *The Effects of Ambient Temperature Variation on Respiratory Hospitalizations in Summer in New York State.* International Journal of Occupational and Environmental Health. 2012. 18(3):188-97

Health Outcome Data in the DEC Permitting Process

DOH has worked with DEC to incorporate the review of health data into environmental permitting to address environmental justice issues. In 2003, DEC issued its policy on Environmental Justice and Permitting (CP-29).[259] Staff members from DOH participated on the Health Outcome Data (HOD) Work Group, which was charged with identifying reliable sources of human health data and recommending to DEC ways to incorporate these data into the environmental permitting process. In its report, the HOD Work Group discussed available health outcome data and developed a method to display and review health outcome data for use in DEC's permit review process.[260] The report and a subsequent Guidance Document from DOH describe a method to produce displays of health outcome data to describe the health status of the community of concern and to compare the health data for it to health data for multiple comparison areas.[261]

The Work Group recommended that the health outcome data be considered as part of the permitting process, recognizing that the data provide no information about the causes of any increase or decrease in rates between the community of concern and comparison area populations. If the population of the community of concern has low health status, it may be more vulnerable to the effects of environmental exposures. The health outcome data review and analysis should be used in making a permitting decision along with other considerations such as regulatory standards, environmental impacts, mitigation, benefits, needs, and costs. The significance of the difference between the community and the comparison area populations should be considered in determining which action is appropriate. A list of possible actions is included in the Work Group report and the guidance document.[262, 263]

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259. DEC. *CP-29 Environmental Justice and Permitting*. 2003.

260. DEC and, DOH. *Report of the Health Outcome Data Work Group*. 2006. http://www.dec.ny.gov/docs/permits_ej_operations_pdf/hodreport.pdf

261. DOH. *Guidance for Health Outcome Data Review and Analysis Relating to DEC Environmental Justice and Permitting*. 2008. http://www.health.ny.gov/environmental/investigations/environmental_justice/hod/index.htm. Currently available on DOH's public web site are data at the ZIP code level for asthma hospitalizations and four types of cancer (lung, colorectal, female breast and prostate cancers). Additional types of health outcome data will be available at the ZIP code level in the future; these data can be incorporated into the method as they become available.

262. DEC and DOH. *Report of the Health Outcome Data Work Group*. 2006. http://www.dec.ny.gov/docs/permits_ej_operations_pdf/hodreport.pdf

263. DOH. *Guidance for Health Outcome Data Review and Analysis Relating to DEC Environmental Justice and Permitting*. 2008. http://www.health.ny.gov/environmental/investigations/environmental_justice/hod/index.htm

Community Health Concerns and Engagement

Communities have expressed concerns about potential health risks from proposed electric generating facilities, transmission lines, fuel storage facilities, and transportation. Communities can help identify specific local health concerns for energy use and production, such as electric generating facilities, transportation corridors and activities, and facilities associated with production, storage, transport, transmission, or distribution of energy. Community input is an important consideration for energy-related siting processes. Communities can also help identify and take advantage of opportunities to reduce energy use, for example through land use planning and car-pooling initiatives. Overall, communities are important stakeholders and can provide input from their unique vantage point in the decision-making processes associated with energy use and production.

2 Environmental Justice

Environmental Justice (EJ) is a multifaceted concept that encompasses a number of principles, goals, and ideas including the alleviation and mitigation of inequitable environmental burdens shouldered by communities with a history of negative social and economic impacts, and the notion that those least empowered to advocate for themselves must be afforded the opportunity to participate in the decisions that affect their lives. Thus, one of the primary goals associated with EJ is ensuring meaningful public involvement in governmental decisions that significantly impact the environmental health and quality of life of communities. The EJ movement was born in the 1980s when communities of color became aware of inequitable concentrations of undesirable land uses in their communities.

Executive Order 12,898 signed in 1994 by President William Clinton directed federal agencies to identify and address disproportionately high and adverse human health or environmental effects of its programs on minority populations and low-income populations. The EPA has defined EJ as:

> *...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.* [1]

The DEC developed and implemented a Commissioner's Policy on Environmental Justice and Permitting (Commissioner's Policy 29 or CP-29) in 2003 that continues to provide guidance for incorporating EJ concerns into DEC's environmental permit review process and application of the State Environmental Quality Review Act. CP-29 promotes greater opportunity for EJ communities to review pending permit applications and requires applicants to engage the communities they potentially impact by establishing a dialogue on the permit review process through enhanced public participation. Pursuant to the policy's guidelines, applicants for permits for certain facilities that potentially impact an EJ community develop an enhanced outreach plan, discuss the potential impacts of the project with the community at large and provide additional project clarifying information to assist communities in understanding the proposed project.

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1. EPA. *Basic Information: About Environmental Justice*. 2012. http://www.epa.gov/compliance/ej/basics/ejbackground.html

DEC adopted this definition in 2003 as part of its Commissioner's Policy 29 on Environmental Justice and Permitting (CP-29).[2] Since the implementation of CP-29, DEC has entered into an ongoing dialogue with community stakeholders on decisions on issues that impact their daily lives. To achieve EJ, all communities must enjoy equal protection from environmental and health hazards, and disenfranchised communities must be afforded meaningful opportunities to understand, review, and respond to those actions and decisions that potentially impact the environment in which they live, learn, work, and play.

While EJ issues principally revolve around negative impacts associated with burdens such as polluting facilities or lack of open space, EJ stakeholders define their areas of focus and concerns quite broadly. They are concerned with maintaining the health, vibrancy, and integrity of the communities where they "live, work, and play." Accordingly, their concerns span a range of issues and topics that are connected to and synergistic with the environmental burdens that plague their communities, including the potential regressive economic impacts of energy pricing and policies, access to clean and green energy, sustainable housing, and the availability of healthy foods.

Low-income communities and communities of color have historically been overburdened by air pollution from energy-generating facilities, from small stationary sources, and from traffic congestion and transportation infrastructure. Efforts to address these issues have, in the past, been hindered by complaints regarding the adequacy of mitigation related to the siting of power plants in such neighborhoods, and by the lack of access to the regulatory process that govern them. High asthma hospitalization rates in poorer neighborhoods have been correlated with the density of air polluting facilities, industrial facilities, and truck routes.[3, 4] Other impacts associated with the siting and operation of a power plant include potential loss of open space, degrading of water quality, oil spills, visual impacts, and increased truck traffic.

Since the 2009 State Energy Plan, the implications for EJ communities of energy-related decisions made by State agencies and authorities have been more formally considered and incorporated into relevant analytical and decision-making processes, including

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2. DEC *Commissioner Policy 29. Environmental Justice and Permitting.* March 2003.

3. Coburn, J., Osleeb, J., Porter, M. *Urban Asthma and the Neighborhood Environment in New York City.* Health & Place. 2006. 12: pp.167-179.

4. Maantay, Juliana. *Asthma and Air Pollution in the Bronx; Methodological and Data Considerations in Using GIS for Environmental Justice and Health Research. Health & Place.* 2007. 13: pp. 32-56.

in the reauthorized Article 10 of the Public Service Law and DEC's implementing regulations in Part 487, which establish a formal framework for EJ review. To further the development of a robust and effective set of EJ-related energy policies, and programs, the State will continue to examine issues such as the impacts of power generation and siting on overburdened communities, the implications of climate change and energy prices for low-income households, and enhance public participation from EJ stakeholders in relevant agency planning, review and permitting processes.

The EJ section provides a broad discussion of key EJ concerns raised in the context of energy siting, production, and service. It will consider ways to improve the participation of community stakeholders in energy decision-making and discuss potential disparities that may result from existing or planned energy facilities, energy policies and practices, and disparities in energy services and regulation. For the purpose of this analysis "impacts" are defined as any actions or changes that affect a community's or a household's environment, which may include economic and social effects identified as significant by community stakeholders. "Environment" is defined as the conditions that will be affected by a proposed action including intangible aspects such as community character and the social and economic dimensions of the various environmental burdens affecting a community. The environment is generally considered to encompass both the natural and "built" environments, but can be more broadly defined to include the psychological, social, and aesthetic environment.[5]

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5. Corburn, Jason. *Health Impact Assessment in San Francisco: Incorporating the Social Determinants of Health in Environmental Planning.* 2007.

Consideration of Environmental Justice in Permitting

In the last decade, in an effort to reduce the risk of overburdening communities of color and low-income, the siting of power plants under the State Environmental Quality Review Act (SEQRA) has included procedures for participation of concerned stakeholders in the decision-making processes through implementation of State Environmental Justice policy.[6] In 2011, Governor Cuomo brokered an historic agreement with the Legislature to reform the power plant siting procedures to incorporate in statute deliberate comprehensive public participation by communities affected by power plants, especially in EJ communities. Today, the reauthorized Article 10 of the Public Service Law and the implementing EJ regulations in 6 NYCRR Part 487 direct the evaluation of EJ considerations in the project review and incorporate early and meaningful participation of community stakeholders.[7] As part of the Article 10 process, measures to avoid, minimize, and offset significant and adverse disproportionate environmental impacts must be considered during the project review in EJ areas.

Article 10 and Part 487 require the groundbreaking evaluation of "significant and adverse disproportionate environmental impacts," incorporating an EJ analysis in the review of proposed energy projects of 25 MW or more. As directed by the Act, DEC developed regulations requiring applicants to provide an evaluation of any potential significant and adverse disproportionate environmental impacts of the proposed project resulting from its construction and operation.[8] The EJ regulations incorporate the use of an impact study area and comparison areas as part of the analysis. Going forward, pursuant to the regulation in 6 NYCRR Part 487, applicants will need to evaluate a broad range of EJ considerations, including a proposed facility's impacts on open space and available parklands, waterfront access, visual and aesthetic resources,

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6. In the last decade New York, and specifically New York City, saw a drastic increase in energy demand with very few new electric generators coming on-line. In response to this increased demand, the New York Power Authority (NYPA) built 11 simple cycle turbines. These turbines were built in low income communities and communities of color in New York City and on Long Island, in heavily industrial zoned areas where there was existing infrastructure that could support their construction within the limited time available. As mitigation for the 11 simple cycle turbines, NYPA implemented a set of initiatives to offset related impacts, including retrofitting sanitation vehicles with emission control devices, the installation of pollution control systems on 1,000 school buses, and establishing the Bronx Initiative on Energy and the Environment (BIEE) which uses NYPA funding to provide zero interest loans for projects that encourage the implementation of energy savings measures and environmental technologies; improve air and water quality and, reclaim contaminated land to further economic development in the Bronx.
7. The predecessor to Article 10 was former Article X, which expired in 2003.
8. 6NYCRR Part 487, *Analyzing Environmental Justice Issues in Siting of Major Electric Generating Facilities Pursuant to Public Service Law Article 10*. Effective July 12, 2012.

and historical and cultural resources. The reauthorization of Article 10 and implementation of 6 NYCRR Part 487 will result in enhancing public participation and public review of environmental assessments of proposed major electric generating facilities that affect EJ areas and will reduce disproportionate environmental impacts in overburdened communities.

Analyzing Environmental Justice Issues in Siting of Major Electric Generating Facilities Pursuant to Public Service Law Article 10. 6NYCRR Part 487 requires:

- Consideration of cumulative environmental and health impacts, including an Environmental Justice analysis with specific cumulative impact analysis of air quality for projects with the potential to impact an EJ area.
- Early and meaningful opportunities for public participation, including the availability of intervenor funding during the pre-application process and at the application stage of the project review, and the publication of communications and notices in languages other than English which are spoken by a significant portion of the potentially impacted community.
- A specific evaluation of any significant and adverse disproportionate environmental impacts which may result from the proposed project or which the proposed project may contribute to during its construction or operation.
- If the New York State Board on Electric Generation Siting and the Environment (Siting Board) finds that a project would result in or contribute to a significant and adverse environmental impact, the Siting Board must also find that the project applicant has avoided, minimized, or offset those impacts to the maximum extent practicable.

Why Environmental Justice should be considered in Energy and Environmental Planning

Environmental Justice areas, low-income communities, and communities of color have historically been overburdened with air pollution from various sources associated with energy production, including the operation of energy-generating facilities, small stationary and mobile sources, and dense traffic. In addition, these communities also bear additional burdens of higher rates of diseases such as asthma, diabetes, cardiovascular disease, and childhood lead poisoning. To minimize the further burdening of these populations, future energy-related decisions made by State agencies and authorities must not only consider the environmental and health impacts of a project, but the added burden that agency decisions might contribute to the EJ communities and communities at large.

The NYISO forecasts that after years of fluctuation, usage will continue a slow, steady increase in 2012 and beyond.[9] As the statewide demand for energy increases, there will always be a resulting impact and added burdens to communities caused by energy production. Meeting this demand may disproportionately cause negative impacts on those communities that are most vulnerable, those located closest to the distribution grid, those who have little input into the process, and those that are impacted by a wide range of existing environmental burdens. Reliability will always be a driving force for most energy-related decisions; however, factors such as public health, sustainability, consumer cost of energy, aging housing stock, and mobile sources such as transportation, considered in tandem with EJ must be considered to develop balanced energy policies and programs.

Burdens Affecting New York's Environmental Justice Communities

Often, low-income communities and communities of color are host to a spectrum of facilities and infrastructure such as power plants, substations, refineries, roadways, ports, airports, waste transfer stations, cement kilns, sewage treatment plants, and other facilities that collectively release a wide range of pollutants. Some of these releases have the potential to have a negative effect on the health of individuals living in the community and the community's natural environment.

Because of the industrial nature of these polluting facilities, their presence also contributes to increased truck traffic and, in many cases, lowers property values and dampens efforts toward sustainable positive economic development. Low-income communities, especially in urban areas, typically have less open space or waterfront access, and limited access to other resources such as adequate health care, nutritious food, and adequate housing.

Although the State alone cannot alleviate all environmental and economic burdens in these overburdened communities, it can promote individual and private sector efforts to address the negative environmental effects polluting facilities have on these areas. Energy-related burdens, such as the presence of power plants, are one of a myriad of issues affecting these communities. In the future, EJ considerations must be reflected in agency actions. Clean energy jobs, urban renewal, sustainable

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9. NYISO. *Power Trends 2012*. 2012. http://www.nyiso.com/public/webdocs/media_room/publications_presentations/Power_Trends/Power_Trends/power_trends_2012_final.pdf development, environmental remediation, smart growth infrastructure, and economic justice are just a few of the many goals that could be promoted and accomplished when State agencies and authorities consider EJ issues.

Identifying Environmental Justice Areas

New York has identified potential EJ areas (PEJAs) based on demographic information from the 2000 U.S. Census data. DEC currently classifies potential EJ areas based on location of low-income and minority populations. PEJAs are those populations within U.S. Census blocks that, in the 2000 U.S. Census, met one or more of the criteria identified in DEC Commissioner's Policy CP-29 Environmental Justice and Permitting.

In identifying the burdens attributed to PEJAs GIS data analysis and mapping are important tools because they provide information necessary to identify the communities of concern and illustrate the burdens faced by those communities. Maps provide a visual representation of the distribution of environmental hazards, health outcomes, and other factors and are capable of showing the spatial variations in quality of housing stock, land use, and transportation patterns. The development of corresponding maps paints a picture that contrasts these communities and the burdens to the population of the State at large (see Figure 10 below).

In cooperation with other State agencies, DEC is assembling data sets for use in mapping applications to enable detailed GIS analyses to evaluate potential disproportionate impacts of existing environmental and health burdens. Available data used in community mapping for projects at DEC indicates that many of the PEJAs, 1) have a higher density of facilities or facility pollution; 2) have high asthma rates or suffer from higher health disparities; 3) are located in non-attainment areas for Clean Air Act criteria pollutants; 4) have higher truck traffic or vehicle miles traveled (VMTs); and 5) have less open space per capita than comparative areas such as the county, town or State.

Figure 10 | Queens County Map of Potential Environmental Justice Areas and Density of Facilities, including Title V Emission Sources

This computer representation has been compiled from supplied data or information that has not been verified by NYSDEC. The data are offered here as a general representation only and are not to be used for commercial purposes without verification by an independent professional qualified to verify such data or information.

NYSDEC does not guarantee the accuracy, completeness, or timeliness of the information shown and shall not be liable for any loss or injury resulting from reliance.

Data Source for Potential Environmental Justice Areas:
U.S. Census Bureau, 2000 U.S. Census

For questions about this map contact:
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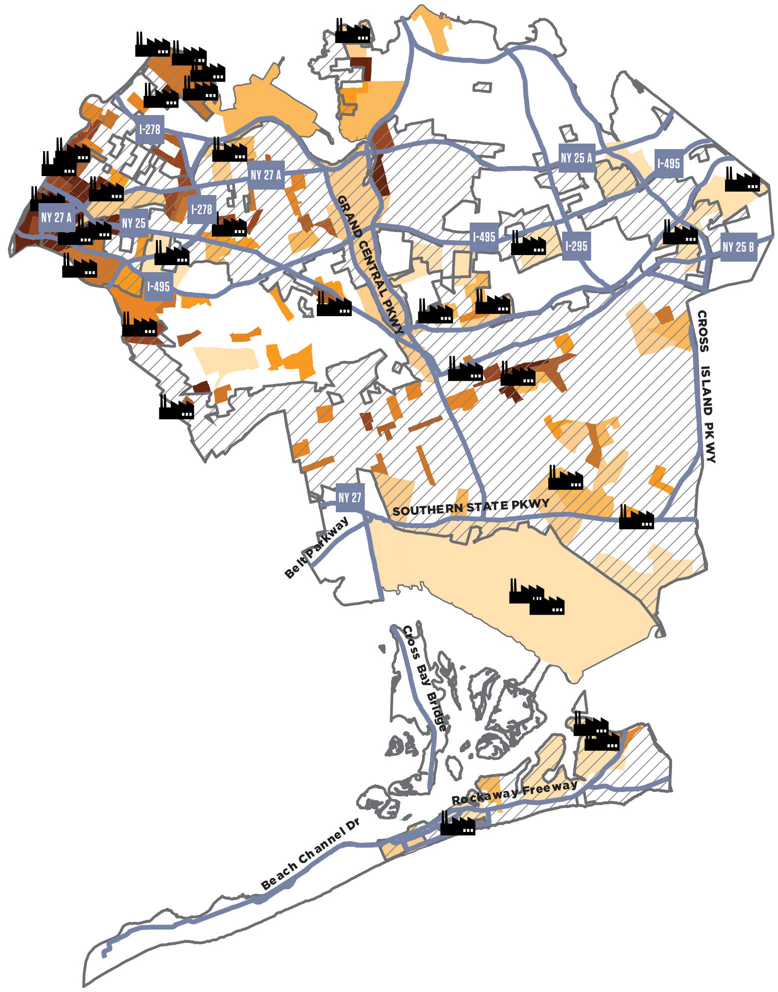

Legend

- Title V Facility
- Potential EJ Areas
- Major Roads

Facilities per sq. mile (10th percentiles)

- 0.00
- 0.01 - 3.41
- 3.41 - 4.87
- 4.88 - 7.72
- 7.73 - 11.62
- 11.63 - 13.16
- 13.17 - 15.47
- 15.47 - 17.70
- 17.71 - 25.68
- 25.68 - 62.69

0 1 2 3 4 5 MILES

Scale: 1:150,000

Source: DEC. *Office of Environmental Justice*. 2012

Access to the Regulatory Process

Significant strides have been made by incorporating public participation in energy siting and permitting through CP-29. These efforts will be further advanced through implementation of the EJ provisions of Article 10 and 6 NYCRR Part 487 regulations. However, even when there is opportunity for the public to participate in the process, there are often constraints that impede meaningful participation. These constraints include limited English language proficiency, inadequate access to computers and the internet, limited comment periods, formalized and relatively ineffective public notice practices, and a lack of community capacity to review and comprehend vast amounts of technical and scientific information in brief time frames. Newly developed regulations like 6 NYCRR Part 487 encourage communication early, prior to application, and throughout the review of a proposed electrical generating facility. In addition, the regulations adopted by the Board on Electric Generation Siting require that applicants implement a comprehensive public participation plan and provide public notice in languages other than English in areas where a significant portion of the population is non-English speaking, and provide intervenor funding during both pre-application and application stages to enable local communities to obtain legal and technical assistance to ensure they can meaningfully participate in the siting process.

Health and Air Quality

One of the risks associated with energy use and production is the potential for adverse health effects from air pollution resulting from the burning of carbon-based fuels. Many of New York's EJ communities are located in the New York City metropolitan area (see Appendix 5).[10]

Some studies have also found that that low-income and minority children are more likely to live near major roadways or in high traffic density areas.[11, 12] Low-income communities and communities of color may have greater exposure to air pollutants due to a greater presence of air pollutant emissions sources in these communities, and low-income

10. DEC. *County Maps of Potential Environmental Justice Areas.* 2012. http://www.dec.ny.gov/public/899.html

11. Gunier, Robert. Traffic Density in California: Socioeconomic and Ethnic Differences among Potentially Exposed Children. Journal of Exposure Science & Environmental Epidemiology. 2003. 13:240-246.

12. Chakraborty, Jayajit. *Children at Risk: Measuring Racial/Ethnic Disparities in Potential Exposure to Air Pollution at School and Home.* Journal of Epidemiology Community Health. 2007. 61:1074-1079.

and minority populations are known to experience some health outcomes at greater rates. A number of studies that have used GIS techniques to map industrial facilities and to examine the demographics of the areas where the facilities are located have concluded that inactive hazardous waste sites and facilities that are listed on the Toxic Release Inventory (TRI) are more likely to be located in low-income minority areas.[13, 14]

It is difficult to identify the individual sources of local air pollution and to assign, with certainty, the potential health impacts exclusively caused by energy use (including traffic) and production alone. The relationship between adverse health impacts and facility emissions depends on the amount of emissions, the toxicity of the emitted chemicals, exposure levels, and the health conditions of exposed populations. The toxicity of chemicals emitted varies among different permitted facilities.

Health Disparities

EJ areas in the U.S. and New York are burdened by higher rates of certain diseases and health conditions. African American/Black, non-Hispanics have the highest rate of diabetes hospitalization and morality; the highest rates of female breast cancer mortality, prostate cancer incidence and mortality; and the highest colorectal cancer incidence and mortality. In addition, individuals in this population also had above average rates among all groups for maternal mortality, infant death and low-birth weight, as well as new HIV cases, heart disease hospitalizations and mortality, and teen and unwanted pregnancies.[15] Hispanic New Yorkers have higher mortality rates due to asthma and diabetes than non-Hispanic Whites. Income disparities are associated with differences in the occurrence of asthma, elevated blood-lead levels, low birth weight, and heart disease.[16]

Asthma disproportionately affects low-income communities and communities of color. The age-adjusted asthma death rate among non-Hispanic Blacks was more than four times higher than that among

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13. Maantay, Juliana. *Mapping Environmental Injustices: Pitfalls and Potential of Geographic Information Systems in Assessing Environmental Health and Equity.* Environmental Health Perspectives. 2002. 110 (Suppl 2):161-171.

14. Morello-Frosch, Rachel; Pastor, Manuel; Porras, Carlos; and Sadd, James. *Environmental Justice and Regional Inequality in Southern California: Implications for Future Research.* Environmental Health Perspectives. 2002. 110(Suppl 2):149-154.

15. DOH. *New York State Minority Health Surveillance Report.* 2012. http://www.health.ny.gov/statistics/community/minority/

16. U.S. Department of Health and Human Services. *Healthy People 2010: Understanding and Improving Health.* 2010. http://www.healthypeople.gov/2010/

non-Hispanic Whites in New York during 2005 to 2007.[17] Current asthma prevalence is highest in the lowest household income category: 15.2 percent for households in New York with income less than $15,000 compared with 6.8 percent for households with incomes of $75,000 or more during 2007 to 2008.[18]

Asthma hospitalization rates are much higher in non-Whites than in Whites and in low-income communities than in higher income communities. During 2005 to 2007, asthma hospitalization rates in non-Hispanic Blacks and Hispanics in New York were almost five times higher than for non-Hispanic Whites.[19] Asthma hospitalization rates in New York during 1987 to 1993 were found to be higher in areas of higher poverty and unemployment.[20] Hospitalization for asthma is considered a potentially preventable hospitalization[21] by the Agency for Healthcare Research and Quality, which is part of the U.S. Department of Health and Human Services (HHS), because proper ongoing treatment of asthma on an outpatient basis can potentially prevent the need for hospitalization.[22]

Asthma hospitalization and emergency department visit rates vary geographically across New York, with New York City having the highest asthma hospitalization and emergency department visit rates among the regions of the State.[23] Asthma hospitalization rates in New York City are highest in the ZIP codes with the lowest neighborhood income.[24] These health disparities in asthma, diabetes, heart disease, and other outcomes are thought to result largely from the complex interaction of economics, and biological, behavioral, and environmental factors. Low-income and minority communities face additional burdens. For example,

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17. DOH. *New York State Asthma Surveillance Summary Report*. 2009. http://www.health.state.ny.us/statistics/ny_asthma/pdf/2009_asthma_surveillance_summary_report.pdf

18. DOH. *New York State Asthma Surveillance Summary Report*. 2009. http://www.health.state.ny.us/statistics/ny_asthma/pdf/2009_asthma_surveillance_summary_report.pdf

19. DOH. *New York State Asthma Surveillance Summary Report*. 2009. http://www.health.state.ny.us/statistics/ny_asthma/pdf/2009_asthma_surveillance_summary_report.pdf

20. Lin, Shao. Fitzgerald; Edward; and Hwang, Syni-An. et al. *Asthma Hospitalization Rates and Socioeconomic Status in New York State*. Journal of Asthma.1987-1993. 36:239-251, 1999.

21. CDC. *Potentially Preventable Hospitalizations – United States, 2004-2007.* 2011. http://www.cdc.gov/mmwr/preview/mmwrhtml/su6001a17.htm

22. Agency for Healthcare Research and Quality. *Asthma Admission Rate (Area-Level): Rate per 100,000 Population.* 2011. http://www.qualitymeasures.ahrq.gov/content.aspx?id=38549

23. DOH. *New York State Asthma Surveillance Summary Report*. 2009. http://www.health.state.ny.us/statistics/ny_asthma/pdf/2009_asthma_surveillance_summary_report.pdf

24. New York City Department of Health and Mental Hygiene (NYCDOHMH). *Asthma hospitalization tables and figure, 2006-2008.* 2010. http://home2.nyc.gov/html/doh/downloads/pdf/asthma/asthma-hospital.pdf . Asthma hospitalization and emergency department visit rates for ZIP codes in New York are available at the DOH public web site. DOH. *Asthma Hospital Discharge Data in New York State by County and ZIP Code. Asthma Emergency Department Visits in New York State by County and ZIP Code.* 2011. http://www.health.ny.gov/statistics/ny_asthma/index.htm poor nutrition, limited access to health care, and substandard housing conditions may make children living in poverty less resilient to toxins present in the natural environment.[25, 26] In addition to disparities in health outcomes, EJ communities face disparities in many factors that can influence health, such as limited education and income, inadequate and unhealthy housing, unhealthy air quality, and limited or no health insurance coverage.[27]

Asthma and Studies Related to Air Pollution

Researchers have used GIS techniques to examine the distribution of environmental factors, the occurrence of health outcomes, and the race/ethnicity and income of the residents. In some GIS studies, different types of facilities that emit air pollutants are grouped together, so it is not possible to look specifically at the contribution of power plants and other sources of electricity generation, or to separate out the contribution from traffic. While other factors that may influence the rate of asthma hospitalization (such as access to and type of medical care and use of maintenance medication) are not taken into account, these studies do contribute information on the disproportionate presence of sources of air emissions in low-income and minority communities and the potential for greater exposure to air pollutants.

A study of asthma hospitalizations in the Bronx identified the location of Toxics Release Inventory facilities and major stationary point sources of air pollutant emissions (including power plants, major housing complexes, medical centers, and industries that emit criteria pollutants or listed hazardous air pollutants), as well as major industrial zones, limited access highways, and truck routes. The study found residents within buffer zones around the polluting sources were more likely to be hospitalized for asthma than those living outside the buffers, and also were more likely to have low-income, minority status, and that asthma hospitalization rates increased with the actual levels of pollution.[28]

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25. O'Neill, M., Jerett, M., Kawachi, I., Levy, J.I., Cohen, A.J., Gouveia, N., Wilkinson, P., Fletcher, T., Cifuentes, L., Schwartz, J. *Health, Wealth, and Air Pollution: Advancing Theory and Methods.* Environmental Health Perspectives. 2003. 111:1861-1870.

26. Hynes, Patricia and Lopez, Russ. *Cumulative Risk and a Call for Action in Environmental Justice Communities.* Journal of Health Disparities Research and Practice. 2007. 1:29-57.

27. CDC. *Health Disparities and Inequities Report – United States, 2011.* January 14, 2011. www.cdc.gov/mmwr/pdf/other/su6001.pdf

28. Maantay, J., Tu, J., Maroko, A.R. *Asthma and Air Pollution in the Bronx: Methodological and Data Considerations in Using GIS for Environmental Justice and Health Research.* Health & Place. 2007.13:32-56; Maantay, Juliana. *Loose-Coupling an Air Dispersion Model and a Geographic Information System (GIS) for Studying Air Pollution and Asthma in the Bronx, New York City.* International Journal of Environmental Health Research. 2009.19:59-79.

Another study of asthma hospitalization using GIS techniques identified four neighborhoods in New York City with consistently elevated asthma hospitalization rates in children.[29] The study found that residents of the high asthma hospitalization areas were almost twice as likely to be African-American or Latino as are residents living outside of these areas. The study also found that asthma hospitalization rates were correlated with the percentage of dilapidated or deteriorated housing, density of air polluting facilities, density of polluting land uses, and density of truck routes.

The relationship between ambient air quality and asthma has also been studied, with elevated air pollution levels found to be related to increases in asthma symptoms, emergency department visits, and hospitalizations.[30, 31]

In one study in the Bronx, increased risk of asthma symptoms was associated with elevated levels of the diesel "soot" fraction of air pollution, and the researchers concluded that traffic-related emissions may be a significant contribution to children's exposure in dense urban areas.[32] Long-term elevated ambient exposure to particulates has been associated with reduced lung function growth in children[33] and constitutes a risk factor for premature respiratory morbidity during later life.[34]

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29. Corburn, J., Osleeb, J., Porter, M. *Urban Asthma and the Neighborhood Environment in New York City.* Heath & Place. 2006. 12:167-179.

30. EPA. *EPA/600/p-99/002aF: Air Quality Criteria Document for Particulate Matter, Volumes I & II.* 2004.

31. EPA. *EPA/600/R-05/004bF: Air Quality Criteria Document for Ozone and Related Photochemical Oxidants*. 2006.

32. Spira-Cohen, Ariel. *Personal Exposures to Traffic-Related Air Pollution and Acute Respiratory Health Among Bronx School children with Asthma.* Environmental Health Perspectives. 2011. 119:559-65.

33. EPA. *EPA/600/p-99/002aF: Air Quality Criteria Document for Particulate Matter, Volumes I & II*. 2004.

34. A NYSERDA study of asthma emergency room visits and ambient air quality in area of the South Bronx and lower Manhattan with comparable air quality found that daily variation in asthma emergency room visits was significantly associated with daily variation in several ambient air pollutants (fine particles, ozone, sulfur dioxide, nitrogen oxides) in the Bronx, but not in Manhattan. These results suggest that other factors can modify the effect of general air quality on asthma exacerbations, possibly including access to preventive asthma medical care, nutrition, housing, and proximity to local pollution sources. NYSERDA. *A Study of Ambient Air Contaminants and Asthma in New York City*. 2006. http://www.nyserda.ny.gov/Publications/Research-and-Development-Technical-Reports/Environmental-Reports/EMEP-Publications/-/media/Files/Publications/Research/Environmental/EMEP/Ambient-Air-Contaminants-Asthma-NYC.pdf

Green Space Mitigation

The siting of power generation historically impacted EJ communities with the development and expansion of facilities resulting in a loss of open space, obstruction of view sheds, and limiting access to the water. One study demonstrated that, "health differences in residents of urban and rural municipalities are to a large extent explained by the amount of green space." Residents living near green space reported higher levels of perceived physical health and well-being than residents with less access to green space.[35]

Because they often suffer from a scarcity of green space, EJ communities favor policies that ensure that efforts to site energy infrastructure do not threaten the green space they do have. Green space, including green roofs, is important not only due to its connection with public health, but also because the trees and vegetation in natural areas capture CO_2, therefore compensating for some of the CO_2 emissions from power sources such as coal-fired power plants. Green space is also invaluable in reducing heat island effect and other air pollution loads such as ozone, particulate matter, NO_2, and SO_2. If the proposed location of a new energy source will potentially decrease green space in a community with an already low amount of natural area, Part 487 provides a mechanism whereby an applicant could create new green space in the same neighborhood to mitigate the loss of neighborhood natural space caused by the new energy source as a strategy to offset a burden articulated by community members during the siting process.

Aging Housing and Energy Considerations

In addition to the challenge to afford adequate heat and electricity, EJ communities are disproportionately burdened with inadequate and unhealthy housing. In the 2009 American Housing Survey of the U.S. Census Bureau, Hispanics and non-Hispanic Blacks reported inadequate housing at a rate 2 to 2.3 times higher than non-Hispanic Whites. In addition, reporting of inadequate housing by those in the lowest income bracket was 3.8 times higher than those in the highest bracket.[36] Living in deteriorated housing can contribute to asthma and childhood lead poisoning.

35. Jolanda, Maas. *Green Space, Urbanity, and Health: How Strong is the Relation? Journal of Epidemiology and Community Health*. 2006. 60: 587-592 http://jech.bmj.com/cgi/content/full/60/7/587

36. CDC *Health Disparities and Inequities Report – United States, 2011*. January 14, 2011. www.cdc.gov/mmwr/pdf/other/su6001.pdf

Addressing the relative energy inefficiency of the aging housing stock prevalent in New York's EJ communities is a pressing issue that will only become more urgent within the context of climate change. In general, very low-income households (as defined by the federal government) pay a far higher share of their incomes for home energy and are much more likely to live in less efficient homes. Indeed, homes in the Northeast built prior to 1970 use 30 percent more energy per square foot than homes built since 1990.[37]

Policy initiatives, incentives, and programs designed to increase the energy efficiency of rental and owner-occupied homes have been in existence for decades. These include weatherization initiatives, federal housing policies, energy-efficient mortgages, and local utility programs. Despite these ongoing efforts, the vast majority of very low-income households remain relatively energy inefficient, resulting in significant regressive impacts on their disposable income when energy costs increase. When energy prices increase, very low-income households are left with little option but to pay the extra costs and suffer the attendant impact on their buying power and economic well-being.

Phase Out of High Sulfur Fuel

At the local level, energy-related policies, initiatives, and technological innovations that could have significant impacts on household energy costs must be evaluated carefully to determine their overall impacts and forestall unintended negative consequences on low-income communities. For example, New York City has mandated the phase out of the use of #4 and #6 fuel oils in the thousands of buildings that still make use of these high sulfur fuels in their boilers. Exposure to fine particulate matter (soot) have been linked to exacerbated asthma, lung and heart disease and premature death.[38] The New York City Department of Health and Mental Hygiene has estimated that the phase-out could prevent 200 deaths, 100 hospitalizations, and 300 emergency room visits each year. However, while the public health benefits are clear and widespread, the cost of converting a boiler to burn the new low sulfur heating oil, estimated at approximately $10,000, may be borne disproportionately by the low- and middle-income households who live in the older apartment buildings in need of boiler upgrades.

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37. Joint Center for Housing Studies of Harvard University. *Foundations for Future Growth in the Remodeling Industry*. 2007.

38. EPA. *EPA/600/R-08/139F: Integrated Science Assessment for Particulate Matter*. December 2009.

Smart Grid Technologies

Certain Smart Grid technologies have raised concerns amongst advocates for the poor, because of concerns that the improved metering that will enable “dynamic pricing” will have regressive impacts on low-income households that are unable to shift their usage away from periods of peak load. "Smart" metering for electricity consumers is intended to dramatically improve communication between utilities and customers by conveying “real time price signals” to residential customers based on short term or spot market prices, leading to improved demand response and load shifting away from peak price time periods.

Large households with young children and/or elderly, or households with individuals who are temporarily or chronically housebound may not be able to shift their usage away from high-cost, peak demand time periods for health and safety reasons. In addition, many very low-income customers are renters who live in older, energy inefficient structures and often rely on older and less energy efficient appliances. These households are the least able to take cost saving actions in response to the price signals provided by smart metering.[39]

Selecting Energy Service Companies and Energy Plans and Challenges to Selection

New York’s households with incomes below 50 percent of the Federal Poverty Level pay more than 40 percent of their annual income for home energy, whereas households above 150 percent of the Federal Poverty Level pay more than 6 percent.[40] With high electric utility costs, the promise of savings through selection of competitive energy providers, known an energy service companies (ESCOs), may be particularly enticing to low-income residents such as those in EJ communities.[41] In 1996, the New York State Public Service Commission (PSC) approved plans to allow customers the option of buying their own electricity and natural gas from sources other than the traditional utility companies by

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39. Oakridge National Laboratory. *Smart Meters, Real Time Pricing and Demand Response Programs: Implications for Low-income Electric Customers.* 2007.

40. Fisher, Sheehan & Colton. *Home Energy Affordability in New York: The Affordability Gap (2008-2010)*. June 2011. http://www.nyserda.ny.gov/Energy-Data-and-Prices-Planning-and-Policy/Program-Planning/Low-Income-Forum-on-Energy/LIFE-Research/The-Energy-Affordability-Gap.aspx?p=1

41. New York ranks second in the nation in terms of residential cost and the State’s electricity cost at 18.26 cents per kWh is much higher than the national average of 11.58 cents per kWh. EIA. *Electric Power Monthly with Data for March 2013.* May 2013. http://www.eia.gov/electricity/monthly/current_year/may2013.pdf. While New York’s average annual wholesale electric costs have declined significantly from 2008 to 2011 and continue to trend downward in 2012, retail energy costs have increased over that same period.

enacting regulations that encouraged the development of a competitive market for ESCOs. Within a few years after restructuring, complaints against ESCOs were lodged with State and consumer protection agencies, primarily concerning not receiving promised savings and marketing tactics. The number of ESCO-related complaints received by DPS's Office of Consumer Services increased from 35 in 1997 to 1,918 in 2002.[42]

Over the years, changes have been made to the Uniform Business Practice (UBP) to strengthen regulation of ESCOs. Other modifications have established standard and acceptable ESCO marketing practices. In June 2003, the PSC voted to implement provisions requiring ESCOs to provide the same consumer protection measures to residential customers as those offered by traditional utilities under the New York State Home Energy Fair Practices Act.[43] In December 2007, the New York State Consumer Protection Board (CPB)[44] and the New York City Department of Consumer Affairs (DCA) petitioned the PSC to strengthen its regulation over the marketing practices of ESCOs selling electricity and natural gas services to residential and small commercial consumers. The petitioners requested establishment of enforceable rules rather than the voluntary statement of principles in practice at the time. Based on complaints received from both agencies, CPB and DCA, media reports and anecdotal information, continued problems of misleading and deceptive marking tactics used by ESCOs have been reported.[45] In October 2008, the PSC expanded consumer protections concerning the marketing of competitive ESCOs' service offerings. The new marketing standards required a consumer disclosure statement on the first page of every sales agreement and revised the UBP to provide tools for responding to lapses in ESCO marketing practices.[46]

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42. DPS. *Office of Consumer Services 2011*. 2012. http://www3.dps.ny.gov/W/PSCWeb.nsf/All/448C499468E952C085257687006F3A82?OpenDocument

43. PSC. *Case 0304:. Commission Implements Consumer Protections in Energy Market- New Law Protects All Residential Customers in the Competitive Market*. 2003. http://www3.dps.ny.gov/pscweb/WebFileRoom.nsf/ArticlesByCategory/DD93E8663764856A852572C80061DD00/$File/pr03041.pdf?OpenElement

44. PSC. *Case 0304:. Commission Implements Consumer Protections in Energy Market- New Law Protects All Residential Customers in the Competitive Market*. 2003.

45. PSC. *Case 07-M-1514: Petition of the New York State Consumer Protection Board and the New York City Department of Consumer Affairs Regarding the Marketing Practices of Energy Service Companies*. April 18, 2008. http://www3.dps.ny.gov/W/PSCWeb.nsf/ca7cd46b41e6d01f0525685800545955/894332838f65998885257696006d4a73/$FILE/CPB.pdf

46. PSC. *Case 98-M-1343: Commission Expands Consumer Protections – ESCO Customer Safeguards Strengthened and Improved*. October 15, 2008. http://www3.dps.ny.gov/pscweb/WebFileRoom.nsf/0/058D8F31D7BED9A5852574E3005A45E3/$File/pr08108.pdf?OpenElement

In December 2010, PSC approved an order implementing measures to further strengthen consumer protection by implementing additional standards and principles for ESCO marketing practices in the UBP.[47] A significant change in the marketing practices is the requirement that any written materials, including contracts, sales agreements, marketing materials, and the ESCO Consumer Bill of Rights, must be provided to the customer in a language in which the customer is fluent. A concern for the EJ community is whether low-income individuals and those of limited English proficiency have been disproportionately burdened by deceptive marketing practices. DPS's Office of Consumer Policy provided initial complaint data for 2010 through 2011 by ZIP code to evaluate whether EJ communities experienced a higher rate of complaints potentially associated with targeted deceptive marketing practices by ESCOs.[48] The complaint data were summarized by DEC's PEJAs. Although 37 percent of the State's residents live in a PEJA, 55 percent of the complaints are from residents in a PEJA.

The process of selecting an ESCO aside from responding to direct marketing is very challenging for individuals with limited English proficiency and/or limited computer skills. DPS provides an online tool, *Power to Choose,* which assists individuals in selecting an ESCO,[49] but the tool is only available in English and does not provide a side-by-side comparison for evaluating all costs for each ESCO. Because of its sophisticated nature, it is unlikely to be useful for individuals with dialup internet connection or those without a computer at all, which are more likely to be low-income households.[50]

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47. PSC. *Case 98-M-1343: Order Implementing Chapter 416 of the Laws of 2010*. December 17, 2010.

48. DPS has two measures of complaints. All 'initial' complaints are recorded and forwarded to the utility for resolution directly with the customer. If the customer informs DPS that the utility failed to satisfy their complaint the matter is 'escalated' for further handling and investigation by staff. Although consumer protections have been strengthened, the number of ESCO initial complaints for 2011 appears to be higher than the number in 2010 but lower than 2009. As of October 2011, 1,161 initial complaints have been lodged In 2009 and 2010, the numbers of initial complaints made were 1,444 and 987, respectively. The trend for escalated complaints is similar. In 2009, 2010 and 2011, the numbers of escalated complaints were 298, 120, and 124 respectively. DPS. *Office of Consumer Services 2011*. 2012. http://www3.dps.ny.gov/W/PSCWeb.nsf/All/448C499468E952C085257687006F3A82?OpenDocument

49. PSC. *New York Power to Choose*. 2011. http://www.newyorkpowertochoose.com/

50. In New York, according to 2010 figures, only 69 percent and 64 percent of urban and rural households, respectively, have broadband internet access. One-quarter of the households in the State have no computer. Nationwide, lower income families, people lacking a high school diploma or college degree, those with disabilities, minorities and rural residents had a lower adoption percentage of broadband and computer use. Department of Commerce. *Exploring the Digital Nation Computer and Internet Use at Home*. 2011. http://www.ntia.doc.gov/files/ntia/publications/exploring_the_digital_nation_computer_and_internet_use_at_home_11092011.pdf

In October 2012, PSC instituted a proceeding and began the process of seeking comments regarding the operation of the ESCO market in New York. In 2012, DPS staff reviewed the performance of the retail electricity and natural gas markets, particularly for residential and small non-residential customers, and found that many ESCO customers paid a higher price than they would otherwise have paid as a full-service utility customer. For at least one utility, customers participating in low-income assistance programs were more likely to be obtaining their electricity from a ESCO.[51] These results raise the concern that the current operation of the retail energy markets may not be completely transparent. DPS is currently reviewing the UBPs to determine if additional consumer protections and/or more stringent ESCO marketing standards are required. DPS is also working with utilities to establish web-based tools that allow ESCO customers to compare their energy bill with what they would have paid had they purchased energy from the utility.

Socio-Economic Impacts

In the U.S., there are more than 25 million households with annual combined incomes of $25,000 or less. This income level comports with the federal housing policy definition of "very low-income" and is approximately equivalent to 50 percent of the national median income and 150 percent of the federal poverty level for a family of three. [52] Since 1998, home energy costs have increased 33 percent for very low-income households, far outstripping any increase in income. Families eligible for federal home energy assistance spend one-fifth of their income on home energy bills – six times more than the level other income groups spend.[53]

Very low-income households are often forced to make desperate tradeoffs between heat or electricity and other basic necessities. Research has found that 47 percent of households that received federal home energy assistance over a five-year period went without medical care, 25 percent failed to fully pay their rent or mortgage, and 20 percent went without food for at least one day as a result of home energy costs.[54] These numbers starkly illustrate the vulnerability of these households to acute

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51. PSC. *Order Instituting Proceeding and Seeking Comments Regarding the Operation of the Retail Energy Markets in New York State.* Case 12-M-0476, Case 98-M-1343, Case 06-M-0647. October 19, 2012

52. Enterprise Community Partners. *Bringing Home the Benefits of Energy Efficiency to Low-Income Households.* 2008.

53. American Gas Association. *The Increasing Burdens of Energy Costs on Low-Income Consumers.* 2007.

54. National Energy Assistance Directors Association. *2005 National Energy Assistance Survey.* 2005.

and gradual rises in the direct and indirect costs of energy, especially within the context of the relative energy inefficiency of their homes.

At the community level, the historic concentration of energy generation, storage, and transmission infrastructure in EJ communities has a variety of significant socio-economic impacts including more limited options for local economic development, less open space, green space and access to waterfronts, and increased risk of and concern about catastrophic accidents and events that will have long-term consequences for residents.

Energy Citing Considerations: New York Energy Efficiency Proceedings

As part of the Energy Efficiency Portfolio Standard (EEPS) proceedings, PSC specifically directed staff to consider EJ concerns in energy efficiency program designs. In June 2008, PSC issued an Order establishing standards and programs for EEPS. The Order put into place immediate implementation of energy efficiency programs and directed specific utilities to collect funds to support these programs. At the request of EJ stakeholders, a working group was convened to consider how demand response could be integrated with energy efficiency and how these specific EJ concerns could be addressed.

The outcome of the work group's efforts was the development of programs to reduce peak electric demand and emissions. In October 2009, PSC issued an Order adopting demand response programs in New York City, specifically the service territory (Zone J) of Consolidated Edison Company (Con Ed). The Order sought to create programs that would reduce electric generation system coincident peak, network peaks, and reduce operation of generating units in EJ areas. The Order prohibited the use of diesel-fired distributed generation within one-half mile of generating stations located in EJ communities and limited the use of diesel-fired units outside these areas. In January 2011, PSC issued an order modifying Con Edison's demand response programs with a goal of increasing enrollment. The new demand response programs have been designed to be more competitive and in 2011, the participation level increased from 1 MW to 46 MW and significantly more in 2012 to 93 MW. As part of its decision to approve funding for 2012 EEPS programs, the PSC increased funding for low-income natural gas programs administered by NYSERDA by $19 million, resulting in approximately $75 million annually directed toward low-income electric and natural gas programs statewide.

Addressing Burdens Affecting New York's Environmental Justice Communities

Fair and Meaningful Involvement

Increasing opportunities for public participation in the decision making process would allow for greater transparency in agency decision making, and would reduce the likelihood that communities will be excluded from the decision making process. Fair and meaningful public involvement provides an opportunity for community stakeholders to comment on an agency action, have their comments weighted equally with other stakeholders, e.g. government and industry, and have the opportunity to discuss the agency's reaction to those comments.

The practices by which fair and meaningful involvement can be fostered include using information that the community finds readily available and easily decipherable, establishment of local document repositories or a website to house information and data used in decision making, and provide for transparency in the agency's process such as the development of process flow charts, routinely scheduled information sessions, early consultation and collaboration.

The reauthorization of Article 10 provided an opportunity for discussion of regulatory criteria among State agencies, EJ stakeholders and the energy industry. The resulting process and final 6 NYCRR Part 487 regulations clearly demonstrate how community involvement can influence a regulatory frame work. The requirements for a pre-application process and early community outreach in Article 10 and 6 NYCRR Part 487, as well as the implementing regulations adopted by the Electric Generation Siting Board, will measurably increase community confidence in agency decisions. These measures will provide a checkpoint in the process to ensure that community concerns and their possible solutions are addressed early in the review of a project.

State agencies greatly benefited from work with the Interagency Task Force on Environmental Justice that began open dialogues in 2010 with community-based organizations to determine priorities to be considered in the agencies' planning and policy development. Encouraging and participating in community centered discussions led to the establishment of an environmental justice/energy liaison or coordinator who will work to improve community involvement in a majority of the agencies. Having an EJ point person on staff can ensure that EJ communities are involved in future decision making processes and fosters greater trust between the community and the regulatory agencies. Now commonplace are standard mechanisms to engage communities such as disseminating information through list-serves, interested-party alerts, posting notices on the internet and at local repositories, and the translation of documents into multiple languages where necessary. Increased community involvement provides greater potential for addressing community concerns in energy siting decisions before disputes arise, improves agency relations with communities throughout the State, and helps New York move towards environmental equity.

Environmental Burdens from Energy Facilities

While Article 10 provides a mechanism for participation in and stakeholder funding for involvement in the regulatory process for new facilities, it does not address the disproportionate impact of the existence of energy facilities and the over abundance of peak energy units in EJ neighborhoods. The county with the most number of energy facilities and peak energy units is Queens and nearly all facilities in Queens are located in EJ neighborhoods. Future strategies should be explored to address the EJ community concerns about facility emissions, in particular from peak energy generating units used during high demand electricity periods. Although most energy facilities use natural gas that is a cleaner fuel, attention should be paid to the loss of open space and the aesthetics burden. A mechanism for exploring a resolution and resolving community concerns could be achieved through the Interagency Task Force on Environmental Justice.

Plant Retirement and Repowering

EJ stakeholders have raised concerns that the payments generators receive through capacity markets can create a strong disincentive to retire less efficient, higher-emitting generating capacity, even within the context of proposed repowering projects. Evaluating how capacity payments and peak demand response approaches influence the retention and operation of older generating units in EJ communities could assist policymakers to more effectively weigh the overall costs and benefits of these efforts to preserve the reliability of the electric system.

Economic Effects of Energy Costs

Because the cost of energy has a regressive impact on lower income households, special care must be taken to protect these households from any direct and indirect negative impacts caused by spiking energy prices. Currently, in New York, lower income households receive bill credits to offset the costs of energy. The amount of credits available to lower income households vary from utility to utility. The variation often depends on the inclination of the utility and how the issue is approached in PSC rate cases. Establishing a more substantial bill discount, such as California's 20 percent,[55] uniformly throughout the State would help protect lower income households from the economic burden of energy prices.

Selecting Energy Service Companies and Energy Plans

Although the vast majority of large industrial and commercial utility customers purchase their electricity and natural gas from ESCOs in lieu of purchasing directly from their local utilities, most residential utility consumers continue to purchase their electricity and natural gas service from their local utilities. As of August 2011, only 20.4 percent of residential customers elected to purchase electricity through an ESCO and as of March 2011, the rate was 17.7 percent for residential natural gas.[56] The proportion of residential consumers receiving service through an ESCO is low and may be attributable to the following reasons. First, for residential consumers, little or no savings (and, in some cases, higher bills) result from use of alternative providers. Second, the material describing this alternative way to purchase the utility is time-consuming to understand and selection process often requires internet access. Third, consumers may be reluctant to sign contracts with alternative suppliers since there is no guarantee of savings after the first two months and new data shows that many alternative supplier customers paid more for supply than they would have paid had they remained full service customers of their utilities.[57]

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55. The California Alternate Rates for Energy (CARE) program provides a monthly discount on energy bills for income-qualified households and housing facilities. Low-income customers that are enrolled in the CARE program receive a 20 percent discount on their electric and natural gas bills. CARE. *California Alternate Rates for Energy- Low Income*. http://www.cpuc.ca.gov/PUC/energy/Low+Income/care.htm

56. PSC. *Electric & Natural Gas Retail Access Migration Archives*. 2012. http://www3.dps.ny.gov/W/PSCWeb.nsf/All/441D4686DF065C5585257687006F396D?OpenDocument

57. PSC. *Cases 12-M-0476/98-M-1343/06-M-0647: Order Instituting Proceeding and Seeking Comments Regarding the Operation of the Retail Energy Markets in New York State*. October 19, 2012.

To overcome the major impediments preventing members of EJ communities from benefitting from potential electricity savings through retail choice, local governments and community-based organizations (with government funding and encouragement) could take leadership roles in negotiating lower prices or better terms with ESCOs. This could be facilitated and encouraged under PSC's Aggregation Programs.[58] Local governments and community-based organizations would be in a better position to develop the expertise to negotiate the best possible terms and conditions more readily than an individual customer. An ESCO may need to prove documented savings and robust customer protections may need to be guaranteed, prior to local governments or community-based organizations taking leadership roles in negotiating ESCO contracts with EJ community members.

Other modifications that may improve the selection process and reduce consumer complaints may be achieved through enhancements to the DPS online tool *Power to Choose* and increased transparency in the process. The online tool could be offered in other languages and may benefit from a reordering to enhance readability.[59] Most beneficial would be a directly comparable bill calculator, which would allow customers to make informed and transparent decisions about their ESCO selection.[60] For example, the calculator could provide the past twelve months rate information for the ESCO and delivery utility, and it should be a side-by-side comparison with the selected ESCOs. Pilot programs to provide that information are currently underway at two utilities. These programs should be evaluated and if appropriate, adopted by other utilities.

To improve transparency, reporting the number of initial and escalated complaints for each ESCO and whether any legal actions have been taken against the company in the online tool would help customers make informed decisions. Implementation of the translation requirements of Executive Order 26 may help to reduce the number

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58. PSC. *Aggregation of Energy Customers,* 2006. http://www.askpsc.com/askpsc/page/?PageAction=renderPageById&PageId=8f28056ead015c03d7d25d064708cfae

59. Other tools to enhance readability include acronym tags. Plain language mouse-over explanations should be explored. For example, the meaning of this mouse-over explanation is not clear: "Sort by Offer name image up." To facilitate navigation and understanding of overall tool structure, section headings with distinct levels that are clear and concise would help orient the user.

60. Canada's Ontario Energy Board provides a utility calculator that allows people to select different utility companies: http://www.ontarioenergyboard.ca/OEB/Consumers/Electricity/Your+Electricity+Utility and District of Columbia's Public Service Commission provides comparisons across electric companies: http://www.dcpsc.org/pdf_files/customerchoice/electric/Electric_Bill_Comparison.pdf of complaints.[61] Finally, there could be a structure in place to offer an alternate selection process and aid for individuals with limited computer access and/or skills. For example, selection could be made with the help of social service programs such as Home Energy Assistance Program (HEAP), which is administered by the New York State Office of Temporary and Disability Assistance.

Transportation Impacts

Mobile sources provide supplies and delivery to energy sites, whether by water or land, impact EJ communities. In New York, concerns are raised because many low-income populations are more likely to experience high traffic volume, particularly from heavy-duty diesel vehicles as a result of their proximity to traffic routes, traffic hubs, and major thoroughfares. Traffic congestion contributes to air pollution and to air quality that potentially may exceed national air quality standards designed to protect public health. High traffic volumes cause noise pollution and impact pedestrian safety and accessibility. Further exacerbated by proximity to industrial facilities, major transportation routes and traffic hubs contribute to localized environmental burdens. Heavy-duty vehicles emit roughly ten times the number of particulate matter (PM) as gasoline passenger cars and contribute to extremely high ultra-fine particle concentrations near major roadways, impacting the air quality of nearby communities.

New York has the following programs to combat particulate pollution

Public Heavy-Duty Vehicle Retrofit Efforts

The New York State Diesel Emissions Reduction Act requires the phased-in use of "best available" retrofit technologies in heavy duty vehicles used by various State agencies, State public authorities, regional public authorities and their prime contractors on State contracts.

Clean Fueled Bus Program

NYSERDA makes available incentive funds to State and local transit agencies, municipalities, and schools for the incremental vehicle cost of a clean-fueled bus and for directly associated infrastructure projects. NYSERDA funding of over $10.2 million, has helped the New York City

61. Executive Order 26 also requires each agency must develop a language access plan and provide interpretation services.

Transit Authority purchase 192 compressed natural gas (CNG) buses and 91 diesel hybrid-electric buses. These buses will reduce emissions of 1,850 tons of NO_X, 100 tons of PM_{10} and 144,434 tons of CO_2 over the vehicles' lifetime.

Clean Fleets: DOT and New York City Department of Transportation
Support investments in emissions reduction strategies including purchases of clean vehicles for municipal fleets, incentives for purchasing clean vehicles for private fleets, provides vouchers for purchasing medium and heavy duty electric trucks, and incentives for purchasing CNG buses for transit fleets. Current contributions total more than $34 million.

Transportation Conformity Process
Through the transportation conformity process, DOT ensures that transportation projects will not cause or contribute to violations of the National Ambient Air Quality Standards. DOT has also encouraged metropolitan planning organizations to perform a "Build/No Build" emission reduction test in addition to the minimum emissions test required by the State and federal transportation conformity rules. NYSDOT and New York city also supports investments in emissions reductions strategies including purchases of clean vehicles for municipal fleets, incentives for private fleets, voucher programs for purchasing medium and heavy duty electric trucks, and incentives for purchasing CNG buses for transit fleets. Current contributions total more than $34 million.

DOT Green Construction Practices
Since 2010, DOT incorporated Green Construction Practices into contract specifications for all projects, including use of ULSD in all non-road diesel construction equipment, banning idling of diesel-powered construction equipment, restricting diesel exhaust fumes from facilities such as schools, hospitals, and housing, and including more measures to control dust at project site. The adoption of these practices was a specific item identified in DOT's action plan to address pollution reduction and air quality concerns in EJ communities.

Steps have been taken to improve the overall efficiency of the transportation networks which will reduce the traffic impacts within EJ communities. Travel Demand Management measures which focus on commuter patterns to reduce the use of single occupant vehicles and alter congestion periods help alleviate traffic volume and congestion. These efforts include providing express bus and vanpool services in major transportation corridors, and encouraging more efficient parking and use of carpools and public transportation. Further, DOT provides real-time traffic and travel information via its 511NY services that can help travelers to avoid congestion and plan trips using ridesharing or transit.

Efforts have been made to increase EJ community representation and access to the transportation decision making process throughout the State. As per federal guidelines, Metropolitan Planning Organizations (MPOs), responsible for developing the transportation plans and programs within urbanized areas with a population greater than 50,000, have undertaken efforts to identify demographic profiles of underrepresented groups and develop outreach strategies to ensure participation of underrepresented groups in the planning process. For example, DOT and the Syracuse Metropolitan Transportation Council recently began a process to engage a broad cross section of community members for identifying, developing, and evaluating options for the future of the Interstate 81 corridor in the Syracuse area. Over the last few years, DOT has also provided the Federal Highway Administration's EJ training to regional and MPO staff in order to help illustrate how agency activities impact EJ communities and to reinforce that the benefits and burdens of the transportation system should be equitably distributed.

Climate Change

Increasing EJ stakeholders view the issue of climate change predominantly through a social justice lens with a particular emphasis on public health impacts. The consequences associated with climate change are intertwined with the impacts and future of the industrial facilities and public sector infrastructure located or proposed to be located in their communities.

They place particular emphasis on the failings and consequences of a fossil fuel economy that externalizes negative economic and environmental impacts, thereby minimizing or discounting the significant human and natural costs associated with modern industrial society.[62]

62. Rachel Morello-Frosch, Ph.D., MPH., Manual Pastor, Ph.D., James Sadd, Ph.D., Seth B. Shonkoff, MPH. *The Climate Gap: Inequalities in How Climate Change Hurts Americans & How to Close the Gap*. 2009. http://www.barrfoundation.org/files/The_Climate_Gap.pdf "Climate change will dramatically reduce job opportunities or cause major employment shifts in sectors that predominately employ low-income people of color." For example, in California, agriculture and tourism, where the majority of people of color hold jobs, are two of the sectors that will be significantly impacted by climate change.

A single poll in a few cities indicated that people of color are more likely to support strong environmental and climate policies than Whites.[63] This result may reflect the fact that that the poor and people of color already live in the most polluted communities across the nation, so they consciously or perhaps intuitively understand that they will bear the brunt of any negative impacts associated with climate change.[64] Given the fact that EJ communities historically have shouldered a disproportionate share of the burdens related to powering and maintaining the electrical grid in this country, they stand to benefit substantially from a more sustainable energy future.[65]

As part of the desired transition to a clean energy future being promoted by the State Energy Plan, it is critical to understand that climate change and environmental injustice are often seen by EJ stakeholders as indicators of a larger, systemic problem. EJ activists are concerned with the full spectrum of pollutants that are hazardous to human health. Strategies to reduce carbon emissions should be developed in the context of existing efforts to fight for public health and environmental safety, and at a minimum, should not undermine that work.[66]

Effective adaptation to climate change in the context of energy planning presents a different set of challenges. For practical and economic reasons, New York's energy infrastructure, from petroleum bulk storage to power generation and transmission facilities, are often located on the water and are in or near EJ communities. This concentration of land uses poses particular risks for surrounding residential areas in the event of incremental climate-related impacts such as sea level rise or acute climate shocks such as coastal storms, extreme precipitation, tornadoes, and heat waves. Because households in EJ communities tend to lack adaptive

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63. Fairbank, Maslin, Maullin, Metz & Associates. *Key Findings from National Voter Survey on Conservation among Voters of Color*. 2009.

64. Commission for Racial Justice United Church of Christ. *Toxic Wastes and Race in the United States*. 1987. http://www.ucc.org/about-us/archives/pdfs/toxwrace87.pdf. United Church of Christ Justice and Witness Ministries. *Toxic Wastes and Race at Twenty: 1987–2007*. 2007. http://www.ucc.org/justice/pdfs/toxic20.pdf. Congressional Black Caucus Foundation Incorporated. *Redefining Progress, African Americans and Climate Change: An Unequal Burden*. 2004. http://rprogress.org/publications/2004/CBCF_REPORT_F.pdf

65. Morello-Frosch, Rachel; Pastor, Manuel; Sadd, James; and Shonkoff, Seth. *How Climate Change Hurts Americans and How to Close the Gap*. 2009.

66. Some EJ leaders across the country have questioned the fairness, effectiveness, cost, and potential for unintended environmental impacts of proposed greenhouse gas emissions trading schemes. In RGGI, however, New York has incorporated environmental justice considerations, including outreach to environmental justice communities to increase penetration of funded programs. NYSERDA's Operating Plan has an explicit focus on reducing "disproportionate cost burden[s] and harmful environmental impacts on low-income families and environmental justice communities."

capacity such as substantial personal savings, adequate insurance coverage, and contingency plans in case of loss of livelihoods or shelter, such communities are not sufficiently climate resilient. As New York's energy infrastructure continues to age, the dangers and risks faced by the host communities for these facilities will only increase, requiring a continued focus on comprehensive disaster readiness and climate adaptation planning.

Community and Climate Outcomes

Actions that move the total energy system – generation, distribution and consumption – away from dependence on carbon-based fuels can meet communities' immediate needs, reduce future climate change, and also achieve substantial co-benefits in health, economy, and community well-being. Table 6 illustrates how considering both community needs and energy system sustainability expands options for avoiding, minimizing, and offsetting environmental impacts, meeting the needs of environmental justice communities, reducing GHG emissions, and promoting climate adaptation.

Table 6 | Community and Climate Outcomes of Measures that Avoid, Minimize, or Offset Community Environmental Impacts from Energy-Related Projects

MEASURE	LOCAL COMMUNITY BENEFITS	GHG/CLIMATE BENEFITS
Weatherizing residences, public buildings, businesses and industrial facilities within the community **Upgrading appliances**	Reduces pollution associated with combustion space heating Increases property values Lowers heating and electricity bills Reduces pollution from power generators Increases resilience	Reduces GHG emissions from boilers and electricity generation Reduces current and future electricity demand Reduces need for additional electric generation facilities
Replacing boilers **Fuel switching to natural gas**	Reduces air pollution associated with diesel oil fuel combustion Fuel diversity reduces exposure to outages Reduce oil spills during flooding	Reduces GHG emissions from boilers
Retrofitting school buses and other community vehicles **Reducing local traffic congestion**	Reduces local air pollution associated with transportation May reduce vehicle fuel use	Reduces black carbon[a] emissions from vehicles
Expanding local public transportation (wherever possible, this should include transit oriented development and other smart growth measures)	Reduces local pollution associated with transportation Increases transportation options for residents, especially when fuel supplies are constrained May reduce transportation cost	Reduces VMT and vehicle emissions of GHGs
Demand management measures (e.g. Smart Grid)	Reduces pollution from peaking power generation Lowers heating and electricity bills Enables more effective restoration of services after storm events	Reduces GHG emissions Reduces current and future electricity demand Reduces need for additional electric generation facilities
Developing or expanding local open space or parkland	Provides opportunities to engage in activities that promote health and well-being Increases attractiveness of community May enhance resilience to storm events	Increases biological carbon uptake
Supplementing fossil fuel combustion with wind or solar energy generation in populated areas **Promoting distributed generation, combined heat and power**	Reduces local air pollution associated with fossil fuel power generation Increases energy supply resilience during outages	Reduces GHG emissions from fossil fuel electricity generation

a. Black carbon is tiny, carbon-based particles emitted to that atmosphere as a by-product of incomplete/inefficient fossil fuel combustion. Black carbon is the most strongly light-absorbing component of particulate matter and has significant warming potential.

3 Smart Growth

Closely related to the efficiency of transportation systems are the land use patterns in the communities these systems serve. The way we develop our communities has a significant impact not only on greenhouse gas emissions, but also on quality of life and the affordability and desirability of communities. Smart Growth principles require integrating land use and transportation planning as it encourages growth in developed areas to sustain existing infrastructure, particularly municipal centers, downtowns

("Main Streets"), urban cores, hamlets, historic districts, and older first-tier suburbs. Smart growth involves developing/re-developing priority growth centers; minimizing the distance between daily destinations; and generally developing in a pattern that makes it easy for residents to use transit.

Compact, mixed use development, which could be encouraged through Priority Growth Centers, offers significant savings in GHGs emitted for daily travel, along with co-benefits from improved public health and air quality and better mobility through access to additional travel options; such development is associated with lower building energy use.

In many ways, current and projected shifts in demographics and home/community preferences will make it easier for communities to adopt efficient development policies. Population projections see an increase in more than 1 million residents in the urban areas downstate by 2030. The projected increase in the over-65 population, the number of childless households, single parent households, and young, single professionals will increase the demand for smaller dwelling units in walkable/bikeable, transit-friendly, mixed-use communities, particularly in municipal centers.

This section addresses the effect that land use and development patterns have on the use of petroleum and other forms of energy, and offers Smart Growth solutions as a means to reduce energy consumption – primarily by reducing automobile dependence secondarily by more efficiently heating and cooling buildings, and by promoting green infrastructure water management systems as an alternative to more energy-intensive conventional "gray" infrastructure.

What is Smart Growth?

Smart Growth is sustainable, efficient growth that integrates economic development/job creation with community quality-of-life by preserving and enhancing the built and natural environments, and by creating livable, socio-economically equitable and sustainable communities and regions. Through this integrated, holistic approach to land use planning, Smart Growth promotes what are known as the "Three Es" – Economic Development, Equity, and Environmental Stewardship; its energy benefits allow us to add a fourth E – Energy sustainability.

Within this broad approach to land use planning and community-building, Smart Growth promotes a set of neighborhood, municipal, and regional planning principles that determine where (location) and how (design) communities choose to grow. Regarding location, Smart Growth encourages development and redevelopment in previously-developed areas with existing infrastructure to sustain it, sometimes referred to as priority growth areas – e.g., municipal centers, downtowns "Main Streets", urban cores, village centers, hamlets, historic districts, and older first-tier suburbs. Focusing development – and supportive infrastructure – inward toward existing communities offers an effective antidote to the outward expansion of sprawl, and its inefficient use of energy. It also helps revitalize communities that are typically already planned or zoned for compact, mixed-use growth, or that are more amenable to Smart Growth planning and zoning.

In addition to location, Smart Growth espouses several land use and neighborhood design principles that affect energy use – density; mixed-use zoning; infill development; transportation connectivity; walkable/bikeable streetscapes ("Complete Streets"); safe and accessible public spaces; a variety of housing types and prices; access to transit/Transit-Oriented Development (TOD); coordination between land use and transportation infrastructure planning (ideally on the regional level) and strategically-preserved greenspaces, designed to serve both natural and human needs ("green infrastructure").

These Smart Growth principles offer energy efficiencies – primarily in the transportation sector, but also secondarily in the building, energy production/delivery, and water infrastructure sectors.

Smart Growth and Transportation Energy Use

The two broad, guiding Smart Growth principles discussed above (namely, sustainable location and neighborhood design) create what is known as "Location Efficiency", i.e., greater proximity, accessibility, and connectivity among land uses; they also offer low-/no-energy mobility alternatives to automobile travel, such as walking, biking, and transit. In effect, the way we arrange different land uses – residential, commercial, recreational, natural, public, civic, and cultural – affects the distance between, and accessibility among, our daily destinations, and more generally the degree to which we depend on automobile travel to access those destinations.

Within the transportation sector, energy efficiencies can be achieved in three ways (often referred to as a "three-legged stool") – clean fuels, fuel-efficient vehicles, and land use patterns that reduce vehicle miles traveled (VMT); each leg of the stool is equally important in achieving meaningful overall transportation energy reduction. Smart Growth land use patterns reduce energy consumption and climate impacts in the transportation sector – relative to conventional post-war suburban development patterns, or sprawl – by arranging land uses in a way that reduces automobile dependence and VMT, thus reducing petroleum consumption.

Vehicle Miles Travelled

VMT is a measure of the amount of miles we drive in our vehicles to move both people and goods; all else being equal, an increase in VMT translates into an increase in transportation energy use, primarily petroleum. VMT can be broken down into two categories: Residential VMT, which includes in-state car trips for commuting, working, shopping, socializing, running daily errands, and other personal and work-related trips; and Non-Residential VMT, which includes commercial trips, primarily freight movement, tied directly to economic activity made by trucks and buses, municipal fleets, and thru-travel. Smart Growth strategies focus most directly on reductions in Residential VMT, but can impact both types.

Density, Mixed-Use, and Connectivity

Generally, land use patterns that are inter-connected, proximate, and easily accessible to one another require fewer and shorter automobile trips to reach our daily destinations; they also enable alternative modes of travel, including transit, walking, and bicycling.

Compact development (density), for example, reduces travel distance between buildings and land uses. Mixed-use zoning places a variety of life's daily needs and destinations – home, work, recreation, retail, civic – within close and accessible proximity to one another, thus further reducing the miles we travel and the number of car trips necessary to access these amenities; this allows more "trip-bundling" – basically, accessing many destinations in one or two stops, thus minimizing trips.

Conversely, sprawling development patterns – dispersed low-density, single-use, disconnected development – tend to increase travel distances and accessibility among daily destinations, which increases automobile dependence, VMT, and transportation energy use. Lower densities increase the distance between land uses and encourage dispersed municipal and regional development patterns; single-use zoning separates different land uses – residential, commercial, civic, cultural, natural, public – into isolated pods, accessible largely by automobile. (Researchers estimate that 50 to 60 percent of increases in VMT since 1950 are attributable to sprawling development patterns.)[1] And unlike Complete Streets, roads and traffic systems are designed almost exclusively for automobile travel.

Greater roadway connectivity offers more travel route options, quicker and more direct access to our daily destinations, and generally less traffic congestion. Connectivity is defined as "a system of streets with multiple routes and connections serving the same origins and destination." An area with high connectivity has multiple points of access around its perimeter as well as a dense system of parallel routes and cross-connection within the area.[2]

Complete Streets

Adding pedestrian- and bike-friendly transportation infrastructure to a connected street system – e.g., wide and continuous sidewalks, narrower streets, well-designed cross-walks, roundabouts, landscaped medians, street trees, shorter block lengths, generous bike lanes, safe and accessible transit stops, to name a few – enhances and complements street connectivity and provides low-/no-energy mobility options, such as walking, bicycling, and public transit. This principle is supported in New York law and policy by the Complete Streets Act, advanced and signed by Governor Cuomo in 2011. Complete Streets are streets that are designed for all users of the road – pedestrians, bicyclers, transit riders, seniors, children, and people with mobility restrictions. The new law provides for the consideration of complete street design features for projects undertaken by the DOT, municipalities and public authorities that receive both State and federal funding and are subject to DOT oversight.

Transit-Oriented Development

Transit Oriented Development (TOD) is defined as, "more compact development within easy walking distance of transit stations (typically a half mile) that contains a mix of uses such as housing, jobs, shops, restaurants, and entertainment."[3] TODs typically encompass nearly the

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1. Other factors affect VMT. The level of economic activity, for example, significantly affects fluctuations in VMT levels – generally, greater economic activity will contribute to more VMT. Changing demographics also affect VMT – the size of the driving-age population, as well as specific demographic cohorts that show particular favor or disfavor for driving or transit, and the price of gasoline will affect driving levels, travel patterns and VMT.

2. Handy, Susan. *Planning for Connectivity: Getting From Here to There.* Chicago, Illinois: AmericanPlanning Association. 2003

3. Reconnecting America and Center for Transit-Oriented Development. *TOD 101: Why Transit-Oriented Development and Why Now?* 2007. http://reconnectingamerica.org/assets/Uploads/tod101full.pdf entire suite of Smart Growth principles; because of the proximate to, and increased use of, transit, TOD offers the most energy-efficient and sustainable form of Smart Growth.

"Connect Long Island" is a regional effort launched by Suffolk County Executive Steve Bellone to connect several transit areas in a regional, corridor-wide matrix, promote Transit-Oriented Development, and expand North-South bus transit options. The initiative grew out of initial work to create a TOD in Wyandanch and connect with the Route 110 commercial corridor/Republic Airport station.

Jobs/Housing Balance

Density and mixed land uses also help yield a balance between jobs and housing for those who hold those jobs. A disparity between the two – also known as a "spatial mismatch" or a "jobs/housing imbalance" – creates location inefficiencies that affect travel patterns and increase VMT (primarily for commuting purposes). Conversely, a jobs/housing balance creates location efficiencies – e.g., shorter, cheaper, and easier access to work, including public transit – that can reduce VMT, particularly among households least able to afford greater transportation costs.

The Land Use/Transportation Infrastructure Connection

Much of the energy efficiencies made possible through Smart Growth land use patterns are a function of a symbiotic relationship between land use patterns and transportation infrastructure decisions. Our transportation infrastructure – roads, highways, bridges, transit – contribute significantly to development patterns, which in turn affect VMT rates.

But despite this close relationship, land use and transportation planning have largely taken place in separate realms – largely because transportation planning takes place on the regional (through MPOs) and State (through the State Department of Transportation) levels, while land use planning takes place on the local, single-municipal level. Smart Growth promotes an integrated, inter-governmental, coordinated approach to the two disciplines with the goal of sustainable and planned land use outcomes.

Transportation infrastructure and land use development are inextricably tied – they influence one another in a cyclical, mutuallyreinforcing way.[4] Building a new road into an undeveloped greenfield or farmland on the suburban or rural fringe, for example, makes the surrounding land more attractive for sprawling development; as more land is developed, more people use the roads, thus creating more traffic congestion, requiring road widening and improvements that attract more sprawling development. As these communities grow, households choose to move further out to the next wave of sprawl – often called "leap-frogging" development – where the process repeats itself and perpetuates sprawl.

In contrast, re-investing in an existing road and streetscape in a downtown area makes downtown properties more attractive for development and re-development – given their location, this will usually translate into the compact, mixed-use, human-scaled growth that typifies Smart Growth. In other words, a people-friendly streetscape make-over in an urban center (a "Complete Street") will yield a people-friendly development pattern – compact, mixed-use, walkable, vibrant, hip; conversely a wide, high-speed, five-lane highway will not.

With this in mind, transportation infrastructure has significantly influenced and enabled modern, conventional, post-World War II land use and development patterns, commonly known as sprawl.[5] The focus on building more (and wider) roads and highways, for example, allowed people to live further from city and town centers and rely more on cars to get to their destinations; commute times remained low, at least until traffic congestion increased and people moved even further from work. An abundance of land and space for development, combined with more cars and cheap gas, accommodated a new development pattern not available to previous generations: large houses on large lots, separate from one another and other land uses, such as commercial, office, civic, and retail, through low-density, single-use zoning, and wide streets and highways, and dependent on automobiles for nearly all travel.

The result: the rate at which land was developed soon far outpaced population growth, particularly in the Northeast. This dispersed, sprawling development pattern largely determined, and significantly increased, the amount of automobile travel necessary to access daily

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4. The late Senator Daniel Patrick Moynihan said: "Highways determine land use, which is another way of saying they settle the future of the areas in which they built." The American Planning Association went a step further: "No single force has had a greater impact on the pattern of land development in American cities in [the Twentieth] century than highways."

5. Several other factors contributed to sprawl, e.g., pent-up demand for suburban housing; general desire among many to flee the ills of the city; health and safety concerns, among others.

activities and destinations, and thus contributed to a significant increase in VMT after WWII.

In addition to highways themselves, the regional design of the post-World War II roadway system enabled sprawling suburban development patterns and increased auto dependence. Regions abandoned the gridded, linear, inter-connected street patterns of the late 19th and early 20th centuries, which accommodated a compact mix of land uses, homes, stores, theatres, parks, civic buildings, that were readily accessible by foot, bike, or transit. Instead, sprawling post-war suburbs adopted a more disconnected, amorphous, dendritic road system – characterized by an abundance of cul-de-sacs and dead-end streets – that supported and served a low-density, single-use development pattern, accessible primarily by car. Vehicle travel also appeared to increase proportionately with the expansion of this transportation system. An analysis of 228 metropolitan areas in the U.S. between 1983 and 2003, for example, found that a 10 percent increase in lane miles on interstate highways correlated with[6] a 10 percent increase in VMT. These transportation systems – and the sprawling development patterns they enabled – also largely precluded, or at least significantly minimized, opportunities for public transit.

6. Duranton, Gilles and Matthew A. *Turner. The Fundamental Laws of Road Congestion: Evidence from U.S. Cities.* American Economic Review, 101 (2011: 2616 – 2652.

Transportation Energy Impacts

Impact of Sprawling Development Patterns on Transportation Energy Use

VMT, petroleum use, and economic development are closely tied. As the economy grows, demand for travel grows, VMT increases. The transportation sector, in general, is heavily dependent on petroleum as a source of energy and consumes more petroleum than any other sector. For example, in 2011 transportation accounted for 77 percent of petroleum consumption in New York.[7]

The effect of sprawling development patterns on driving rates in the U.S. is well-documented. EPA found that, "While the population roughly doubled between 1950 and 2011, from about 152 million to 312 million people, vehicle travel during this same period increased nearly six-fold, from around 458 billion VMT to nearly three trillion VMT."[8] Since 1980, VMT nationwide have increased three times as fast as the population, and twice as fast as vehicle registrations; between 1970 and 1998, VMT increased 132 percent.[9] Between 1983 and 2001, VMT increased 226 percent while the population increased only 22 percent.[10] Between 1983 and 1995, the average commute increased 37 percent, from 8.6 miles to 12.6 miles.

It should be noted that nationally, VMT began to decline in 2004, and has decreased every year since then, for a total 7.5 percent reduction from 2004 to 2012.[11] The State Smart Transportation Initiative (SSTI) reported a 1.2 percent drop in overall VMT and a 2.1 percent drop in

7. NYSERDA. *Patterns and Trends: New York State Energy Profiles (1997–2011)*. June 2013.
8. EPA. *Our Built and Natural Environments: A Technical Review of the Interactions Among Land Use, Transportation, and Environmental Quality.* June 2013.
9. Smart Growth America. *The Link to Energy Security and Climate Change, Smart Growth America*. 2010.
10. Leinberger, Christopher. *The Option of Urbanism: Investing in a New American Dream*. Washington, D.C.: Island Press. 2008.
11. State Smart Transportation Initiative. *Per Capita VMT Ticks Down for Eighth Straight Year.* February 25, 2012, citing FHWA Office of Highway. Traffic Volume Trends.

per capita VMT from 2010 to 2011.[12] And from 2011 to 2012, per capita VMT dropped 0.4 to 9,363 miles – the lowest level since 1996.[13] A 2006 U.S. DOT report projects VMT growth to slow from its previous pace, predicting a 50 to 60 percent rise in VMT over the period 2001 to 2025, significantly lower than the previous 25-year period of 1977 to 2001 when VMT increased 151 percent.[14] This is in part attributable to higher gas prices and a slow economy, as well as some of the demographic and market trends discussed in the previous section.[15]

New York as a whole has the most energy-efficient transportation system in the nation, and is trending toward even greater energy efficiency. New Yorkers, for example, drove 30 percent less than the typical American driver in 2000, compared with 25 percent less in 1960. Much of this energy efficiency, however, is generated from extensive public transit systems, and dense populations and land use patterns in the New York City metropolitan areas. Many Upstate metropolitan areas experienced sprawl, VMT, and petroleum use increases that more closely parallel national trends. Even among Upstate regions, a relatively wide variation of sprawling development patterns exists: Western New York, for example, sprawled considerably less than Central New York between 1982 and 1997, as measured by population density – Western New York's density dropped only 16 percent, while Central New York's dropped 32 percent.[16] This variety underscores the attention to regional variations manifest in Governor Cuomo's Regional Economic Development Councils and Regional Sustainability Plans.

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12. State Smart Transportation Initiative. *Motor Vehicle Travel Demand Continues Long-Term Downward Trend in 2011*. http://www.ssti.us/2012/02/motor-vehicle-travel-demand-continues-long-term-downward-trend-in-2011/

13. State Smart Transportation Initiative. *Per Capita VMT Ticks Down for Eighth Straight Year*. February 25, 2012, citing FHWA Office of Highway. Traffic Volume Trends.

14. Center for Urban Transportation Research. *The Case for Moderate Growth in Vehicle Miles of Travel: A Critical Juncture in U.S. Travel Behavior Trends*. 2006

15. American Association of State Highway Transportation Officials. *Real Transportation Solutions for Greenhouse Gas Emissions Reductions*. 2009. http://climatechange.transportation.org/pdf/realsolutionsreport.pdf

16. Brookings Institution. *Sprawl Without Growth: The Upstate Paradox*. October 2003. http://www.brookings.edu/~/media/research/files/reports/2003/10/demographics pendall/200310_pendall.pdf

Impact of Smart Growth on VMT and Transportation Energy Use

No single Smart Growth factor will reduce auto dependence and transportation energy use significantly by itself. Rather, a suite of Smart Growth components is necessary to realize meaningful transportation energy use impacts.[17]

While there is little consensus on how much Smart Growth can reduce VMT and transportation energy use, calculations from the land use and transportation sectors are becoming more sophisticated. The U.S. Green Building Council and the Center for Neighborhood Technology, for instance, have developed a Transportation Energy Intensity (TEI) measurement tool – "The TEI of a building is the amount of energy associated with getting people to and from that building, whether they are commuters, shoppers, vendors, or homeowners."[18]

Three high-profile reports estimate that Smart Growth development patterns can reduce VMT by between 5 and 40 percent. At a granular level, the Victoria Transport Policy Institute broke the VMT analysis down into local and regional effects, indicating "that local land use factors (neighborhood density, mix, and design) can reduce per capita vehicle travel by 10 to 20 percent, while regional land use factors location of development relative to urban areas, can reduce automobile travel 20 to 40 percent compared with overall national average values."[19] And more comprehensively, if all housing starts were built in Smart Growth communities, Americans would save 49.5 billion gallons of gasoline, 595 million metric tons of carbon dioxide emissions,[20, 21, 22] and $2.18 trillion in household expenses.

EPA reported that a 10 percent increase in population and employment density results in a 3.5 percent VMT reduction; a 10 percent increase in residential density, jobs per capita, and per capita expenditures on public transit yields a 20 percent decrease in VMT.[23]

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17. Urban Land Institute. *Land Use and Driving: The Role Compact Development Can Play in Reducing Greenhouse Gas Emissions*. 2010.

18. USGBC and the Center for Neighborhood Technology. *Transportation Intensity Calculator.* 2012. http://tei.cnt.org/

19. Victoria Land Transport Institute. *Land Use Impacts On Transport: How Land Use Factors Affect Travel Behavior.* 2010.

20. Burer, Jean; Goldstein, David; and Holtzclaw, John. *Location Efficiency as the Missing Piece of the Energy Puzzle: How Smart Growth Can Unlock Trillion Dollar Consumer Cost Savings.* 2004.

21. After 10 years based on a projected level of 24.3 million housing starts from 2005-2015.

22. The consumer cumulative savings estimates are based on the assumption that the smart growth project and its benefits occur for 100 yrs.

23. EPA. *Our Built and Natural Environments: A Technical Review of the Interaction Among Land Use, Transportation, and Environmental Quality.* June 2013.

In communities built to the U.S. Green Building Council's LEED (Leadership in Energy and Environmental Design) for Neighborhood Development (LEED-ND) standards, VMT has been reduced by between 24 and 60 percent, relative to the region's metropolitan averages.[24] (In Governor Cuomo's Cleaner, Greener NY Phase II implementation grant program, applicants for comprehensive planning grants are advised to use LEED-ND as a guide.)

TOD offers significant potential to reduce VMT growth. One study found that residents of TODs drive 45 percent less than residents of conventional car-dominated neighborhoods, and save approximately 512 gallons of fuel and $1,400 in fuel cost annually.[25] Although most TOD opportunities now exist within the Metropolitan Transportation Authority's service area, opportunities for TOD (particularly around Bus Rapid Transit) are also emerging upstate.

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24. Ewing, Greenwald, Zhang, Boguts. *Predicting Transportation Outcomes for LEED Projects.* Journal of Planning Education and Research, April 2012.

25. Victoria Transport Policy Institute. *Transit-Oriented Development: Using Public Transit to Create More Accessible and Livable Neighborhoods.* 2007. www.vtpi.org/tdm/tdm46.htm

ICF International for the American Public Transportation Association. *Public Transportation and Petroleum Savings in the U.S.: Reducing Dependence on Oil.* 2007.

Smart Growth and Non-Transportation Energy

Green Infrastructure and Energy Use for Water Management Systems

Green infrastructure has been defined as "… an interconnected network of natural areas and other open spaces that conserves natural ecosystem values and functions, sustains clean air and water, and provides a wide array of benefits to people and wildlife."[26] It maintains natural hydrologic patterns as a mechanism to manage, re-use, and treat stormwater and groundwater. Green infrastructure reduces electric and petroleum energy use by avoiding or minimizing the energy required to construct, operate, and maintain conventional "gray" infrastructure facilities, such as water treatment plants.

Exact energy reduction figures are hard to come by for green infrastructure, particularly in the avoidance and/or minimization of traditional gray water treatment infrastructure. An analysis conducted by the Center for Neighborhood Technology (CNT) and American Rivers, calculated energy savings from a hypothetical green roof on a 5,000-square-foot building rooftop in Chicago. The analysis found that annual energy savings from the cooling effect of the green roof to be 1,112 kWh; energy savings from the heating savings were 36,158,750 Btu (calculated at 7,231.75 Btu/square foot); and annual energy savings from reduced water treatment was 110.77 kWh.[27]

The New York State Environmental Facilities Corporation's administers the Green Innovation Grant Program, which provides grants for green infrastructure.[28] The Onondaga County *Save the Rain* program – a model green infrastructure initiative used to address its combined sewer overflow and other stormwater-related issues in a sustainable

26. Benedict, Mark. and McMahon, Edward. *Green Infrastructure: Linking Landscapes and Communities.* Washington D.C.: Island Press. 2006.

27. Center for Neighborhood Technology and American Rivers. *The Value of Green Infrastructure: A Guide to Recognizing Its Economic, Environmental and Social Benefits.* 2010. http://www.watershedconnect.com/documents/files/the_value_of_green_infrastructure_a_guide_to_recognizing_its_economic_environmental_and_social_benefits.pdf

28. Environmental Facilities Corporation. *Green Grants.* 2013.

way – can be used as a model to encourage inter-municipal, county-wide approaches to green infrastructure.[29]

Building Energy Use

Smart Growth also creates building energy efficiencies by clustering and attaching buildings. This often allows for shared heating and cooling through the natural process of heat/cold dispersion between buildings and building units; and through engineered systems that mechanically share and distribute heat/cold among buildings.

Homes in more compact developed areas also tend to be smaller per resident, and thus have fewer square feet per resident to heat and cool than homes in sprawling areas. A high concentration of energy users in one area can help reduce energy losses from the delivery of power to scattered, low-density, sprawling areas. Sprawl has been linked to higher average cost of heating and cooling buildings, compared to denser urban areas. EPA found that household energy consumption—combining housing type and transportation factors – "decreases significantly in smaller housing types located in compact, transit-oriented development when compared to similar housing types in conventional, largely automobile-dependent communities."[30]

Distributed Energy

Smart Growth land use patterns support, and benefit from, community-based distributed energy systems. Like public transit, community/district energy systems rely on a certain proximate market mass. Compact, mixed-use, inter-connected clusters of buildings therefore provide a greater concentration of market mass and demand to support shared energy systems; such increased demand is, in turn, better served by greater proximity between energy production and a concentration of users. In this respect, district energy and Smart Growth land use configurations are mutually supportive.[31]

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29. Natural Resources Defense Council. *Rooftops to Rivers II: Green Strategies for Controlling Stormwater and Combined Sewer Overflows.* 2011. http://www.nrdc.org/water/pollution/rooftopsII/default.asp

30. EPA. *Location Efficiency and Housing Type – Boiling it Down to BTUs.* 2012. http://www.epa.gov/dced/pdf/location_efficiency_BTU.pdf. An attached ENERGY STAR home in a compact transit-oriented development with a green car can consume 67 million BTUs annually, as compared to 240 million BTUs in a detached, single-family home in conventional suburbia without access to transit.

31. Although multi-building systems possess these advantages and opportunities, the challenges of establishing and owners/buyers co-op among the various building owners, and gaining access to rights-of-way for the piping and wiring infrastructure necessary to disperse the energy throughout the community, has led the market to primarily pursue "single-building" distributed energy generation the majority of the time.

Distributed energy holds the potential to reduce energy loss and constraints on the systems delivering electricity. Distributed energy systems reduce dependence on the electricity grid, thus often providing more resilient energy sources during natural and other disasters.[32]

Barriers exist that have prevented full utilization of distributed energy, e.g., establishing owners/buyers co-ops among the various building owners; and gaining access to rights-of-way for the piping and wiring infrastructure necessary to disperse the energy throughout the community. As a result, the market has pursued "single-building" distributed energy generation the majority of the time.

Planning and siting both community/distributive and larger-scale renewable energy systems can be facilitated by their inclusion in local/regional comprehensive plans. Con Edison has implemented a novel "campus-setting," stand-by tariff for a distributed generation system that would serve a complex of buildings owned by one customer; this tariff may serve as a model to overcome some of these multi-building challenges.

Trends That Support Smart Growth

General Population and Building Construction Trends

Population and building forecasts suggest that the next several decades will present a tremendous opportunity to shift New York's land use patterns in a more energy-efficient direction. The American population will increase from 300 million to 400 million between 2006 and 2043; the number of American households will increase to 140 million by 2025. In New York, the population is expected to increase five percent over the next 20 years, from 19.4 million to 20.4 million. [33]

Nationwide, the U.S. will need to build 42 percent (52 million) more housing units between 2005 and 2050; 37 million will be built to replace existing units – that amounts to two-thirds of housing units existing in 2011.[34] As a result of population increases and building conditions, over

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32. Distributed solar power "... provides electricity on-site or near to demand, reducing transmission losses, as well as wear-and-tear on utility equipment by mitigating peak demand. It also eliminates the need to hedge against fuel price swings. A recent study found that these benefits add 3 to 14 cents per kWh to the utility bottom line." *The New Rules Project*. *Democratizing the Electricity System: A Vision for the 21st Century Grid*. 2011. www.newrules.org.

33. Weldon Cooper Center for Public Service, Demographics and Workforce Group. *Observed and Total Population for the U.S. and the States, 2010-2040*. Updated August 2013. http://www.coopercenter.org/demographics/national-population-projections

34. EPA. *Our Built and Natural Environments: A Technical Review of the Interaction Among Land Use, Transportation, and Environmental Quality.* June 2013.

half of the buildings in the U.S. in 2030 will have been constructed or redeveloped between now and then. In other words, we can shape half of the built environment in the next 20 years in a more energy-efficient way; two-thirds by 2050.[35]

New York building forecasts do not offer as extensive an opportunity to shape the built environment as these nationwide figures. A trend analysis conducted by NYSERDA found that New York's housing stock is expected to increase by approximately 500,000 units – or 6 percent – between 2010 and 2030, from 8 million to 8.5 million units. And while 21 percent of New York's housing units in 1990 were built within the previous 20 years, and 15 percent of housing units in 2000 were built within the previous 20 years, projections suggest that 8 to 10 percent of housing units – or 700,000 – in the State in 2030 have yet to be built.[36] Both nationwide and statewide projections present an immediate and long-term opportunity to address energy consumption through Smart Growth land use and development patterns.

Demographic and Market Trends

Several demographic, construction, and markets trends should create more Smart Growth development in the next two decades.

Baby Boomers and their children (Gen Y/Millennials) show a strong preference for communities that include the principles of Smart Growth – walkable/bikeable; transit access; smaller homes; rentals; diverse land uses; parks and open space; accessible amenities; sense of community and place. Seniors prefer walkable communities with access to transit and daily amenities, for reasons related to health, social, and mobility. A rise in immigrant and minority populations will fuel a rise in rental housing – particularly apartments and other attached, multi-unit housing – which tend to be smaller and located in denser, more traditional mixed-use urban-form settings.

Companies are realizing that downtown offices are attractive to the talented workers they employ, and are thus choosing locations in urban or urban-form settings.[37] Many suburban strip malls are failing,

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35. Bartholomew, Keith; Chen, Don; Ewing, Reid; Walters, Jerry; and Winkelman, Steve. *Growing Cooler: The Evidence on Urban Development and Climate Change*. Washington, D.C.: The Urban Land Institute. 2007.

36. New York State Climate Action Council, *Climate Action Plan Interim Report*. November 2010. Chapter 4 Envisioning a Low-Carbon Future - 2050. http://www.dec.ny.gov/docs/administration_pdf/irchap4.pdf

37. Urban Land Institute. *What's Next: Real Estate in the New Economy*. 2011. http://www.uli.org/News/PressReleases/Archives/2011/2011PressReleases/WhatsNext.aspx and real estate professionals predict that such failures will proliferate (vacant strips are referred to as "greyfields"). These concentrations of development, however, present an opportunity for retrofitting according to Smart Growth design and transportation principles, particularly as walkable town centers.[38]

Household size is decreasing – from 3.4 in 1950 to 2.6 in 2010 – and household composition has changed dramatically. In 2011, one-person households reached 28 percent and households with children declined to 29 percent.[39] By 2025, more households will be single person than a family with children.[40] House size has declined between 2007 and 2011, after decades of increasing (with a rise in 2012). The value of large homes on the metropolitan fringe appears to be declining, as evidenced by their performance after the housing bubble burst.[41]

Sustained high gas prices may lead households to move to smaller homes closer to work and other destinations. Transit use is up-Americans took 10 percent more transit trips in 2011 than in 2005.[42]

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38. See, Williamson, June. and Dunham-Jones, Ellen. *Retrofitting Suburbia. Hoboken, NJ: John Wiley & Sons.* 2011.

39. EPA. *Our Built and Natural Environments: A Technical Review of the Interaction Among Land Use, Transportation, and Environmental Quality.* June 2013.

40. Nelson Arthur. *Leadership in a New Era. Journal of the American Planning Association.* 2006. 72:394.

41. William H. Lucy. *Foreclosing the Dream: How America's Housing Crisis is Reshaping Our Cities and Suburbs.* Chicago, IL: American Planning Association Planners Press. 2010.

42. U.S. PIRG/Frontier Group. *A New Direction: Our Changing Relationship with Driving and the Implications for America's Future.* Spring 2013.

Smart Growth Programs and Practices

While immediate and measurable energy benefits can result from individual development projects, Smart Growth should be recognized as a long-term energy and climate change strategy to help New York reach the multiple objectives of the Energy Plan, often showing full benefits 10 to 20 years after programs have begun – a time-frame that comports with local comprehensive planning and the State Energy Plan. And unlike many other aspects of the State Energy Plan, Smart Growth is primarily a locally-driven effort. The State can, however, play an important role by supporting, enabling, and incentivizing communities that have chosen to embrace Smart Growth principles on their own. The State has begun to lead by example by modeling Smart Growth practices in its policies, programs, and spending priorities.

Integration of Governor's Regional Planning Initiatives (and Federal Programs)

Several of Governor Cuomo's REDCs explicitly embraced Smart Growth and downtown revitalization as regional economic development strategies; the Regional Sustainability Plans (RSPs) under Cleaner, Greener NY include Smart Growth as central components; and the NY Rising Communities plans will emphasize resiliency, which naturally includes many of the principles of Smart Growth and sustainability. Already, the RSPs have been required to comport with the REDC plans, and NY Rising will integrate considerably with the REDCs and RSPs. Such inter-plan and inter-disciplinary coordination provides an ideal governance framework for the delivery of Smart Growth/sustainable land use outcomes through State funding and assistance decisions.

The State can enhance these efforts with further integration with the HUD Regional Sustainable Communities Planning Grants awarded to three regions in New York: NY-CT Sustainable Communities Consortium (Lower Hudson Valley, Long Island, New York City, Connecticut MTA New Haven Line service area); Buffalo-Niagara Regional Sustainability Consortium; and Adirondack Sustainable Communities Consortium. Such coordination could help attract federal and other funding to priority projects in these regions.

Since land use and transportation planning are inextricably tied, the State can assist by integrating the two disciplines within the NY Works Infrastructure Fund – using that forum to promote consistency with the Regional Sustainability Plans and Regional Economic Development Plans, and tying funding to appropriate land use/transportation integration.

Priority growth areas are areas designated by localities for a concentration of future development and/or re-development – e.g., municipal centers, downtowns, cities, villages, Main Streets, central business districts, transit locations. Priority growth areas are typically zoned or planned according to Smart Growth principles – i.e., compact, mixed-use, walkable, location-efficient, and transit-accessible. By targeting development and infrastructure investments toward priority growth centers, municipalities can help reverse the outward expansion of sprawl.

Smart Growth Public Infrastructure Policy Act

The Smart Growth Public Infrastructure Policy Act of 2010 (Chapter 433 of the Laws of 2010) requires State agencies and authorities ensure that applications for infrastructure funding meet the Smart Growth criteria in the law, "to the extent practicable." Smart Growth review can be expanded (by law, Executive Order or Agency Policy) to include funding that is not covered by the law, but nonetheless impacts land use – e.g., planning/design grants, land acquisitions, tax incentives. Such enforcement can also be integrated into the work of the Governor's NY Works Infrastructure Initiative.

Smart Growth in Comprehensive Plans

Regional planning efforts are incorporating Smart Growth criteria and providing models for the inclusion of the State Smart Growth criteria (in the Smart Growth Public Infrastructure Policy Act) in municipal comprehensive plans. The Western New York Regional Economic Development Council set as a goal the inclusion of Smart Growth in at least one comprehensive plan in each of its five counties every year; other REDCs that have embraced Smart Growth as an economic development strategy might consider adopting the same metric. Through Phase II implementation funds under the Governor's Cleaner, Greener NY program, the State has encouraged municipalities to include LEED for Neighborhood Development standards into their plans and ordinances.[43]

Two counties in particular – Onondaga and Genesee – have taken steps to promote and reward Smart Growth. The proliferation of such multi-municipal approaches can be beneficial.

Onondaga County Sustainability Plan – "Sustainability Pays": Onondaga County developed a county-wide Sustainability Plan that contains an innovative funding approach called "Sustainability Pays" – in effect, incentives are provided for projects that comport with the plan.

Genesee County Smart Growth Law/Plan: Genesee County designated several priority growth areas – known as "Smart Growth Development Areas" – within the county in an effort to reverse sprawl, revitalize community, and regional centers and preserve agricultural land. The County will not extend water lines to development outside of those areas, unless a waiver is provided by the County Legislature.

43. Natural Resources Defense Council. *A Citizen's Guide to LEED for Neighborhood Development: How to Tell if Development is Smart and Green.* 2012.

Climate Smart Communities

Climate Smart Communities (CSC) is a partnership between the State and local communities to lower greenhouse gases and save taxpayer dollars – including Smart Growth and energy-efficient land use. CSC has developed a certification process for municipalities, beyond simply adopting the CSC Pledge. As a next step, certified communities should receive some form of favorable review and/or bonus points in related State funding programs.

New York State Complete Streets Act

In 2011, Governor Cuomo signed the Complete Streets Act, which requires transportation officials to consider the needs of all road users – pedestrians, bicyclists, transit riders, seniors, children – in the design and construction of road projects.

Transportation Climate Initiative

The Transportation Climate Initiative (TCI) is a mega-regional initiative coordinated by the Georgetown University Climate Center. A TCI team is working with 12 Northeast states to inventory and evaluate State policy to combat climate change and help these states improve and expand their climate change policies. Smart Growth and land use are central components of the initiative.

NYS Department of Transportation (DOT) GreenLITES Program

DOT created a sustainable transportation self-certification program. Similar to LEED certification for green buildings, transportation projects can achieve various levels of sustainability certification by meeting point thresholds on a certification form.[44] A wide variety of sustainable features are added to project designs and best practices are highlighted during an annual awards program.

Industrial Development Agency (IDA) Land Use Incentives

Several IDAs in the State are encouraging incentives for downtown re-development/adaptive re-use. The Erie County IDA, for example, offers tax incentives for re-development of buildings that have been vacant or abandoned for at least three years; are more than 20 years old; are not generating significant income; and are consistent with the region's

44. DOT. *Greenlites*. 2012. https://www.dot.ny.gov/programs/greenlites

"Framework for Regional Growth." This, and other similar initiatives, supports the goals of Smart Growth, as well as the REDCs and Regional Sustainability Plans.

SEQRA Reform – Smart Growth Review

The DEC is revising its regulations to promote approval of Smart Growth projects – certain projects in "municipal centers" that were previously developed would be classified as sustainable development Type II actions. This regulatory amendment can remove what is sometimes a roadblock to development that serves the goals of Smart Growth, which yield local and regional environmental benefits.

Promote Tax Increment Financing (TIF)

TIF is a self-financing economic development tool that has been used with success throughout the country to revitalize urban centers, particularly blighted ones, with an infusion of infrastructure investments. In the 2012-2013 State Budget, Governor Cuomo and the Legislature allowed school districts to participate in and contribute to the TIF funding mechanism, thus removing a previous obstacle to the use of TIF.

Risks to New York's Energy System from Climate Change

Electric Power Generation and Delivery

Most of today's sophisticated energy systems are subject to both direct and indirect impacts from climate change. ClimAID also details information about climate change adaptation strategies for both energy-related and non-energy sectors. Appendix 3 displays ClimAid's table summarizing climate risks to New York's power system, which include:

- Increased flood hazards for power system infrastructure located in flood plains or areas susceptible to flash flooding.
- Increased power demand for air conditioning, cooling, and irrigation during very hot periods, challenging the capacity of the electric grid.
- Reliability challenges from heat effects on grid infrastructure.
- Decreases in power plant efficiency as higher air and water temperatures reduce plants' cooling capacity.
- Seasonal weather impacts on availability of some fuels: hydropower production – low water conditions; solar and wind power – cloud cover and wind speeds; biomass productivity – growing season weather conditions.

Transportation

Climate change challenges both the operational success and the energy efficiency of road, rail, marine, and air transport:

- Over the next few decades, more frequent heavy precipitation events are likely to cause moderate, recurrent transportation problems such as delays in vehicle or mass transit from flooded, icy, or snowy transportation routes.
- Longer ice-free seasons on the Great Lakes are expected to produce more "lake-effect" snow events, especially in western and central New York State; lake effect events are common causes of traffic disruptions.
- As Hurricane Sandy demonstrated, low-lying and underground transportation facilities are vulnerable to flooding from the combination of coastal storms and sea level rise.
- Through federal transportation support, the Northeast Regional Transportation Climate Initiative and Governor Cuomo's Cleaner, Greener Communities program, significant opportunities are becoming available to redesign transportation systems for energy efficiency and climate resiliency.

Stationary Uses (Residential, Commercial, and Industrial)

Protecting and adapting most buildings will be the responsibility of owners and occupants, most of whom will be private individuals and businesses. Incentives from government can help all owners improve the energy efficiency of their buildings and industrial processes; publicly-owned buildings can serve as examples of best practices. Risks include:

- Rising energy demand due to climate change could risk the comfort and economic security of building owners, and occupants and industrial enterprises by raising energy prices and compromising their ability to purchase adequate fuel and electric power.
- Increased loads to transmission and distribution networks (both the power grid and fuel pipelines and distributors), combined with less predictable demand, would affect both the operation of energy generators and suppliers and the energy security of customers.
- Buildings, like all other infrastructure, can be damaged by climate change impacts such as flooding, water infiltration, and extreme heat.


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4 Vulnerabilities of the Energy System

Overview of Hazards and Threats Affecting Security

The energy sector in New York State faces a number of vulnerabilities as outlined below, that make it susceptible to disruption. As defined by the Department of Homeland Security, vulnerabilities are "physical features or operational attributes that render an entity open to exploitation or susceptible to a given hazard."[1]

1. U.S. Department of Homeland Security. *National Infrastructure Protection Plan*. 2009. http://www.dhs.gov/xlibrary/assets/NIPP_Plan.pdf

Vulnerabilities identify areas of weakness that could result in consequences of concern, taking into account intrinsic structural weaknesses, protective measures, resiliency, and redundancies.

Facility locations and normal unstaffed operational status

Because energy is often used far from where it is produced, the energy sector requires an extensive infrastructure to distribute electricity, natural gas and petroleum products. These facilities present a unique security and resilience challenge because they are often spread out and cross many jurisdictional boundaries. Pipelines are a good example of this; large natural gas, and petroleum products pipelines may cross four or five states, pass through six or seven hundred towns, and cross-land owned by thousands of homeowners. Pipelines often rely on right-of-way, meaning that the operator of the line does not even completely control the land that the pipeline passes under. This makes traditional security measures such as fences and guards largely infeasible. Even though the lines mostly run underground, they do come “above ground” in a number of places to allow for service, distribution, and maintenance including gates, valves, junctions, and compressors.

The electrical grid is even more vulnerable to disruption because it generally does not have underground protection, with the exception of dense urban areas. Electrical generation is done largely far away from the places where the electricity is used. This requires an extensive transmission network that has some of the same vulnerabilities to weather as the local distribution grid.

Cyber Threat and Industrial Control System (ICS) Vulnerability

The energy sector relies on complex and interconnected industrial control systems (ICS) to manage and monitor the delivery of electricity, natural gas, and oil to New York. ICS includes Supervisory Control and Data Acquisition (SCADA) networks, Distributed Control Systems (DCS), Programmable Logic Controllers (PLC), Master and Remote Terminal Units (MTU and RTU), and Intelligent Electronic Devices (IED). These highly distributed control systems use many communication methods including wire, multiple types of radio transceivers, telephone, cable, and optical fiber.

Increasingly sophisticated and automated ICS and SCADA systems have been a part of energy management systems for over 25 years and were originally designed to operate in isolation. Beginning in the 1990s companies began connecting their operational ICS with enterprise systems that were connected to the Internet. This allowed more efficient communications, increased interoperability and remote management and troubleshooting. This connectivity however also increased the vulnerability of the system to a variety of malicious sources. These range from disgruntled employees and competitors to hackers looking for attention and sophisticated nation-states intent on damaging equipment and facilities.

Because of the significance of the energy sector to security, public health, and economic vitality, the security of ICS is of paramount importance and has been the subject of significant interest for private/investor-owned energy companies and the federal government for at least a decade. The federal Department of Energy (DOE), Department of Homeland Security (DHS), and National Institute of Standards and Technology (NIST) continue to invest considerable effort and study to increase the security of these critical systems.[2]

As an indicator of the significance of this issue, a specific unit of the DHS National Cyber Security Division, the Industrial Control Systems Cyber Emergency Response Team (ICS-CERT), works with law enforcement and intelligence agencies and the private sector to share control systems related-security incidents and mitigation measures.

Based on ICS-CERT reporting, it is clear that critical infrastructure, including water, telecommunication, critical manufacturing, and energy systems have been targeted by cybercriminals. Over 200 cyber attacks to critical infrastructure were reported between October 2012 and May 2013. Over half of these attacks targeted the energy sector.[3] An industry report indicated that in 2012 there were 85 public SCADA vulnerabilities, a decrease from the 129 vulnerabilities in 2011.[4]

- In July 2013, the U.S. Department of Homeland Security sent a memorandum to electric utility and nuclear power Chief Executive Officers warning them that malicious actors had used basic tools to

2. Presidential Executive Order. *Improving Critical Infrastructure Cybersecurity*. February 12, 2013. http://www.whitehouse.gov/the-press-office/2013/02/12/executive-order-improving-critical-infrastructure-cybersecurity. DOE. Energy Delivery Systems Cybersecurity. http://energy.gov/oe/technology-development/energy-delivery-systems-cybersecurity.

3. ICS-CERT Monitor. April/May/June 2013. https://ics-cert.us-cert.gov/monitors/ICS-MM201306. Eduard Kovacs. *ICS-CERT Warns of Brute Force Attacks Against Critical Infrastructure Control Systems*. Softpedia. June 29, 2013. http://news.softpedia.com/editors/browse/eduard-kovacs

4. Symantec. *Symantec Internet Security Threat Report 2013*. 2012 Trend, Volume 18. April 2013. http://www.symantec.com/content/en/us/enterprise/other_resources/b-istr_main_report_v18_2012_21291018.en-us.pdf gain access to power company networks and threaten their automated systems. The Department urged the CEOs to increase their security due to physical and online attacks that threatened serious damage to infrastructure and equipment. The memo indicated that "In at least one case the attackers successfully obtained all the information needed to access the industrial control systems environment."[5]

- In May 2013, the DHS ICS-CERT released an advisory warning of a heightened risk of a potentially devastating cyber-attack against U.S. infrastructure. The warning cited "increased hostility" towards "United States critical infrastructure organizations."[6]
- In February 2013, the DHS Inspector General reported that a majority of the companies in the energy sector had experienced cyber attacks and about 55 percent of these attacks targeted ICS. These attacks involved large-scale denial-of-service and network infiltrations. The report noted that "Successful attacks on ICS can give malicious users direct control of operational systems, creating the potential for large-scale power outages or man-made environmental disasters."[7]

Exacerbating the risks inherent in making ICS and SCADA networks accessible to the Internet is an increasing amount of publicly available information about these connections and associated software vulnerabilities. Two available search engines on the Internet, *Shodan and Every Routable IP Project,* specifically search for ICS systems that are accessible via the Internet.[8] An alert published by the U.S. Department of Homeland Security in October 2012 warned that these search engines are being actively used to identify and access control systems over the Internet, and that combining these tools with easily obtainable exploitation tools, attackers can identify and access control systems with significantly less effort than ever before.[9]

In September 2011, the Idaho National Laboratory (INL), on behalf of the U.S. Department of Energy's Office of Electricity Delivery and Energy

5. Houston Chronicle. *Homeland Security: Recent Cyber Attacks Hacked Into Energy Networks.* July 15, 2013. http://fuelfix.com/blog/2013/07/15/hackers-broke-into-energy-networks-in-recent-attacks.
6. ICS-CERT. Alert 13-129-01P: *Tactics and Tools of Emerging Cyber Threat Actors.* May 9, 2013. Washington Post. *U.S. Warns Industry of Heightened Risk Of Cyberattack*. May 09, 2013. http://articles.washingtonpost.com/2013-05-09/world/39139314_1_senior-u-s-oil-and-gas-companies-iran
7. Department of Homeland Security, Office of the Inspector General. OIG 13-39: *DHS Can Make Improvements to Secure Industrial Control Systems.* February 2013. http://www.oig.dhs.gov/assets/Mgmt/2013/OIG_13-39_Feb13.pdf
8. *Shodan Search Engine.* www.shodanhq.com. *Routable IP Project*. http://eripp.com.
9. ICS-CERT Alert 12-046-01A: *Increasing Threat to Industrial Control Systems.* (Update A). May 8, 2012.

Reliability issued a report entitled: *Vulnerability Analysis of Energy Delivery Systems.*[10] The report discusses the fact that many existing ICS and SCADA systems were developed before secure coding practices were well established and emphasizes the need for vendors and owners or operators to take steps to assure that existing vulnerabilities in current ICS and SCADA systems are identified and remediated, new products are developed securely, and that patching and secure configurations are supported throughout the product life-cycle. Further, the report identifies common vulnerabilities found in assessments performed by INL including unpatched known vulnerabilities, improper access control and improper authentication. In addition, researchers reported discovering that generic ICS and SCADA systems had control features that were easily exploitable, especially when vendors used "off the shelf" software without modification.

The DHS National Cyber Security Division's Control Systems Security Program (CSSP) also performs cybersecurity assessments and evaluations of industrial control systems. Federal assessment teams have noted an overall lack of defense-in-depth at ICS installations. Common vulnerabilities observed include improper user permissions and access controls, weak passwords and password policies, and poor patch management.[11]

In September of 2011, the Energy Sector Controls System Group[12] issued a report regarding key challenges in addressing cyber security issues within the energy delivery systems.[13] The report cites a number of significant obstacles currently facing the energy sector that hinder the ability to achieve cyber security resiliency including:

- Cyber threats are unpredictable and evolve faster that the sector's ability to develop and deploy countermeasures;
- Difficulty in creating consistent metrics and advanced tools for measuring risk;

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10. U.S. Department of Energy, *Vulnerability Analysis of Energy Delivery Control Systems*. September 2011. http://energy.gov/sites/prod/files/Vulnerability Analysis of Energy Delivery Control Systems 2011.pdf

11. Department of Homeland Security, *Common Cybersecurity Vulnerabilities in Industrial Control Systems*. May 2011. http://ics-cert.us-cert.gov/sites/default/files/DHS_Common_Cybersecurity_Vulnerabilities_ICS_2010.pdf

12. The Energy Sector Controls Systems Working Group (ES-CSWG) includes 14 energy delivery system experts from the public and private sectors. The Group is led by the Department of Energy under the Critical Infrastructure Partnership Advisory Council (CIPAC) in the Department of Homeland Security.

13. Energy Sector Control Systems Working Group (ES-CSWG). *Roadmap to Achieve Energy Delivery Systems Cybersecurity*. September 2011.

- Security upgrades to legacy systems are limited by inherent limitations of the equipment and architectures;
- Performance/acceptance testing of new control and communication solutions is difficult without disturbing operations;
- Threat, vulnerability, incident, and mitigation information sharing is insufficient among government and industry;
- Weak business case for cyber security investment by industry;
- The regulatory landscape is in flux at the State and federal level creating a culture of focusing on compliance with cyber security requirements instead of achieving a secure environment.[14]

All of the vulnerabilities present with cyber technology are potentially amplified as the energy sector implements the "smart grid," which leverages information technology to support a nationwide network with the goal of delivering electricity efficiently, reliably, and securely.[15] The implementation of the smart grid will significantly increase the number of digital access points to energy communications networks and the interconnection of those points with the Internet. For example, if the automated metering and control equipment necessary for the operation of the smart grid is not designed, manufactured, installed, configured, and maintained in a secure fashion, it will only increase the vulnerability of the energy distribution system to cyber attacks.

Growing Vulnerability to Theft of Materials, Particularly Copper

Copper theft from substations and other electric utility facilities has become a national problem that occurs with alarming frequency. The cost of copper thefts goes well beyond the dollar value of losing and replacing the material taken. It is also necessary to quantify the consequence of a power outage or the loss of reliability, redundancy, security, or safety. In addition to repair costs for utilities, thefts can result in power outages and revenue losses if the stolen copper wire is system critical and the in-place workarounds cannot compensate quickly. An unexpected power outage can damage other equipment within the utility and at customer facilities, especially high-tech industries with sensitive loads.

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14. Energy Sector Control Systems Working Group (ES-CSWG). *Roadmap to Achieve Energy Delivery Systems Cybersecurity.* September 2011.

15. National Institute of Standards and Technology, *Smart Grid a Beginner's Guide,* at http://www.nist.gov/smartgrid/beginnersguide.cfm

Preventing these intrusions with physical security measures before or during break-ins can reduce the frequency of these events and the possible resulting consequences. New York utilities have made considerable progress in equipping their most critical substations with modern electronic security systems and are continually expanding the deployment of electronic intrusion detection systems that have proven effective in detecting and deterring attempted copper thefts.

Hydroelectric Dam Vulnerabilities

Hydroelectric dams are a significant source of power in New York State. Included in the list of dams in the State are more than 120 hydroelectric dams that are rated as high hazard (Class C) or moderate hazard (Class B) dams. The hazard classification is determined by several factors, including the potential for loss of life, damage to property, or the environment. These dams are classified and regulated by the FERC. In accordance with FERC regulations (18 CFR 12.20), owner/operators of Class C and Class B dams are required to develop an Emergency Action Plan (EAP). An EAP is required for the operator to maintain a license. The EAP is the emergency plan for how the owner/operator will respond to an emergency situation that potentially may impact the integrity of the dam. The plan is limited in scope to control measures, and includes off-site notifications to local and State government to prepare for and implement protective actions, such as evacuation.

High Impact, Low-Frequency Events

In June 2010, the North American Electric Reliability Corporation (NERC) issued a report titled "High-Impact, Low-Frequency Event Risk to the North American Bulk Power System."[16] This report was a joint effort of NERC and the U.S. Department of Energy (DOE), which assisted NERC in hosting a workshop on High-Impact, Low-Frequency (HILF) events in Washington in November 2009. NERC is focusing on three types of HILF events: cyber or physical coordinated attack; pandemic; and geomagnetic disturbance/electro-magnetic pulse risk.

Cyber or Physical Coordinated Attack

The specific risk identified by NERC is "the targeting of multiple key nodes on the system that, if damaged, destroyed, or interrupted in a

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16. North American Electric Reliability Corporation. *High-Impact, Low-Frequency Event Risk to the North American Bulk Power System*. June 2010. http://www.nerc.com/files/HILF.pdf coordinated fashion, could bring the system outside the protection provided by traditional planning and operating criteria."[17] Although no such attack has occurred, NERC and the utility industry are working to improve both physical and cyber security protections to safeguard the grid. Nevertheless, NERC stated in the report that "more comprehensive work is need, however, to realize the vision of a secure grid." In a 2012 update to the report, NERC's Cyber Attack Task Force called for more planning for cyber incidents as well as for better information sharing on cyber threats.[18]

Pandemic

According to NERC, "...the principal vulnerability with respect to a pandemic is the loss of staff critical to operating the electric power system. Without these personnel, operational issues on the system would increase as less-trained or less-experienced individuals work to operate generation plants, address mechanical failures, restore power following outages caused by weather and other natural events, and operate the system."[19] NERC states that the relatively mild 2009 A/H1N1 pandemic was not the type of event that meets its HILF threshold. During a more severe pandemic, NERC states that public health officials would need to communicate better with the industry and provide "clear triggers...for the sector to make appropriate response decisions in the event of a severe outbreak."[20]

Geomagnetic Disturbance/Electro-Magnetic Pulse Risk

NERC has concerns about three types of events in this category. The first is a geomagnetic disturbance, or "solar storm," similar but more severe than the March 1989 storm that caused a blackout in the Hydro-Quebec electric system. Although not a new threat, new studies show that, according to NERC, "the potential extremes of the geomagnetic threat environment may be much greater than previously anticipated." Such storms have the potential to "result in widespread tripping of

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17. North American Electric Reliability Corporation. *High-Impact, Low-Frequency Event Risk to the North American Bulk Power System*. June 2010.

18. North American Electric Reliability Corporation. *Cyber Attack Task Force Final Report*. May 9, 2012.

19. North American Electric Reliability Corporation. *High-Impact, Low-Frequency Event Risk to the North American Bulk Power System*. June 2010.

20. North American Electric Reliability Corporation. *High-Impact, Low-Frequency Event Risk to the North American Bulk Power System*. June 2010.

key transmission lines and irreversible physical damage to large transformers."[21]

There also is the possibility that a nuclear device could be detonated somewhere over North America that could create a widespread electromagnetic pulse incident. Such a detonation could "have devastating effects on the electric sector, interrupting system operation and potentially damaging many devices simultaneously."[22] Finally, an attack using a smaller device to create intentional electromagnetic interference "could result in more localized and targeted impacts that also may cause significant impacts to the sector." [23]

NERC recommends "further collaborative work to identify the prioritized 'top ten' mitigation steps that are both cost-effective and sufficient to protect the power system from widespread catastrophic damage that could result from any of these events."[24,]

Aging Infrastructure

Much of New York State's energy infrastructure has reached or will soon reach the end of its useful life. The New York Independent System Operator (NYISO) notes that 59 percent of all generation in the State was constructed before 1980, and the average age of steam generation facilities in the State is over 40 years old. The transmission system is equally dated, with 84 percent of high voltage transmission facilities being placed into service before 1980. Many of these facilities will require replacement in the next 20 years.[25]

Evacuation Planning for Nuclear Power Plants

A review of evacuation plans for the area surrounding Indian Point was conducted on behalf of the State of New York in 2003 by James Lee Witt Associates. This review found that evacuation plans for the facility

21. North American Electric Reliability Corporation. *High-Impact, Low-Frequency Event Risk to the North American Bulk Power System*. June 2010. http://energy.gov/oe/downloads/high-energy-low-frequency-risk-north-american-bulk-power-system-june-2010

22. North American Electric Reliability Corporation. *High-Impact, Low-Frequency Event Risk to the North American Bulk Power System*. June 2010. http://energy.gov/oe/downloads/high-energy-low-frequency-risk-north-american-bulk-power-system-june-2010

23. North American Electric Reliability Corporation. *High-Impact, Low-Frequency Event Risk to the North American Bulk Power System*. June 2010. http://energy.gov/oe/downloads/high-energy-low-frequency-risk-north-american-bulk-power-system-june-2010

24. North American Electric Reliability Corporation. *High-Impact, Low-Frequency Event Risk to the North American Bulk Power System*. June 2010. http://energy.gov/oe/downloads/high-energy-low-frequency-risk-north-american-bulk-power-system-june-2010

25. New York Independent System Operator. Power Trends 2012. March 2012. http://www.nyiso.com/public/webdocs/newsroom/power_trends/power_trends_2012_final.pdf did not incorporate base population data for the areas needing to be evacuated. This review felt that the existing plans did not accurately reflect how the population would behave in an actual incident. Their conclusions included "Emergency plans need to be based on the best available estimates of how people can be expected to behave in an emergency—not how emergency planners would like them to behave."[26] Additionally, NRC guidance calls for planning to evacuate a 10 mile area around plants, but during an actual nuclear power plant incident, NRC guidance called for a 50 mile evacuation. If that guidance were to be applied to Indian Point, the population requiring evacuation would be over 17 million people.[27]

Seismic Risk to Indian Point

Recent research has discovered that an active fault line underlies the Indian Point Energy Center. This fault line is directly under unit 3 of the plant and according to NRC calculation is actually the highest risk reactor from a seismic standpoint in the United States. The NRC estimates that there is a 1 in 10,000 chance of an earthquake strong enough to cause core damage there, as compared to the industry average of 1 in 74,176. This vulnerability is a result of the fault being unknown at the time the plant was first built.[28]

Smart Grid Vulnerabilities

In 2007, Congress gave the National Institute of Standards and Technology (NIST), an agency of the U.S. Department of Commerce, "primary responsibility to coordinate development of a framework that includes protocols and model standards for information management to achieve interoperability of smart grid devices and systems."[29] As such, NIST plays an important role in assuring smart grid systems work as desired and cannot be exploited by hackers to do damage to the grid. NIST defines Smart Grid as "a planned nationwide network that uses

26. James Lee Witt Associates. *Review of Emergency Preparedness of Areas Adjacent to Indian Point and Millstone.* 2003

27. Dedman, Bill. *Nuclear Neighbors: Population Rises near US Reactors.* Apri 14, 2011. http://www.msnbc.msn.com/id/42555888/ns/us_news-life/t/nuclear-neighbors-population-rises-near-us-reactors#.UIV_M2daeZQ

28. Dedman, Bill. *What are the Odds? US Nuke Plants Ranked by Quake Risk.* March 17, 2011. http://www.msnbc.msn.com/id/42103936/ns/world_news-asia-pacific/#.UIWB5GdaeZQ

29. 110th Congress of the United States of America. *Energy Independence and Security Act of 2007.* January 4, 2007. http://www.gpo.gov/fdsys/pkg/BILLS-110hr6enr/pdf/BILLS-110hr6enr.pdf information technology to deliver electricity efficiently, reliably, and securely."[30]

In testimony before Congress, the Director of NIST's Information Technology Laboratory outlined the risks associated with smart grid.[31] The overarching risk is that "existing vulnerabilities might allow an attacker to penetrate a network, gain access to control software, and alter load conditions to destabilize the grid in unpredictable ways." Additional specific risks identified include:

- Increasing the complexity of the grid could introduce vulnerabilities and disruptions, and increase exposure to potential malicious attackers and unintentional errors,
- Linked networks can introduce common vulnerabilities,
- Increasing vulnerabilities to communication and software disruptions could result in denial of service or compromise the integrity of software and systems,
- Increased number of entry points and paths for potential adversaries to exploit,
- Potential for compromise of data confidentiality, including breach of customer privacy, and
- Increasing vulnerabilities to potential physical attacks or disruptions, such as those due to Electromagnetic Pulse (EMP), Electromagnetic Interference (EMI), and Geomagnetically Induced Currents (GICs).[32]

In January 2011, the United States General Accountability Office (GAO) filed a report that reviewed efforts under way to assure a secure smart grid.[33] While GAO found that NIST had made progress by issuing its first version smart grid cyber security guidelines in August 2010, it highlighted an important topic not previously addressed, that the risk of attacks that use both cyber and physical means (one of NERC's HILF

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30. National Institute of Standards and Technology. *Smart Grid FAQs*. December 23, 2010. http://www.nist.gov/smartgrid/faq.cfm
31. Furlani, Cita. *Testimony before the House Committee on Homeland Security*. NIST homepage. July 21, 2009. http://www.nist.gov/director/ocla/testimony/upload/cyber-sec-smart-grid-house-hs-hearing-furlani-final.pdf
32. Furlani, Cita. *Testimony before the House Committee on Homeland Security*. NIST homepage. July 21, 2009. http://www.nist.gov/director/ocla/testimony/upload/cyber-sec-smart-grid-house-hs-hearing-furlani-final.pdf
33. GAO. *Electricity Grid Modernization: Progress Being Made on Cybersecurity Guidelines, but Key Challenges Remain to be Addressed*. January, 2011.

scenarios). Overall, GAO found six key challenges going forward to implementing smart grid technologies in a secure fashion:

- Aspects of the regulatory environment may make it difficult to ensure smart grid systems' cyber security,
- Utilities are focused on regulatory compliance instead of comprehensive security,
- The electric industry does not have an effective mechanism for sharing information on cyber security,
- Consumers are not adequately informed about the benefits, costs, and risks associated with smart grid systems,
- There is a lack of security features being built into certain smart grid systems, and
- The electricity industry does not have metrics for evaluating cyber security.

NIST, the utility industry, and government regulators will continue to address vulnerabilities and broader issues identified to date as the build out of the smart grid moves forward.

Energy System Resiliency to Climate Change

The earth's climate is changing and will continue to change for some years, despite measures taken in New York and elsewhere to reduce emissions. Energy planners must take into account New York's vulnerabilities to climate change and take advantage of New York's considerable potential to adapt as the climate changes. For a fuller summary of New York's climate change vulnerabilities, see Appendix 2.

The ClimAID report notes that because New York is a coastal state and is highly developed, the largest direct economic impacts of climate change are likely to occur in coastal areas, associated with infrastructure for transportation, energy and other uses, and with natural resources. Some of the largest costs will result from extreme events such as heat waves and large scale storms and floods. The State's recent experience with Hurricane Sandy demonstrated the devastation that rising sea levels can bring to coastal areas.

Climate change impacts and costs will be significant statewide, in all the economic sectors examined. Without adaptation measures, the ClimAID report estimated annual costs in New York for climate change at around $10 billion by mid-century.

The least expensive climate change adaptation strategy is to increase resilience before the impacts of climate change cause damage to infrastructure, communities, the human population, or critical natural resources. Adaptation measures can be taken in conjunction with routine maintenance and upgrades or in response to specific vulnerability assessments at the lowest aggregate cost with the greatest chance of avoiding disastrous and costly impacts over time. Adaptation measures should be considered in conjunction with mitigation measures to reduce GHG emissions.

Climate change adaptation is likely to take many forms in New York. Cost estimates have been calculated for individual adaptation measures, but it is difficult to develop a comprehensive cost accounting for all adaptation measures that may be required. Some adaptations (like protecting or moving low-lying infrastructure) will involve large one-time or periodic expenditures; others will represent ongoing or regular costs.

There is a wide range of adaptation options that, if skillfully chosen and scheduled, can reduce the impacts of climate change by amounts in excess of their costs. Some adaptation measures can be designed to include energy-saving features (such as upgrading water treatment plant efficiency while installing flood protections) that in the long run will offset part of their cost.

Power systems and consumers will adapt most successfully to rising temperatures and climatic changes if both energy efficiency and adaptation measures are widely adopted by power consumers. For systems operators, adaptation chiefly means accounting for climate change in long-term planning. Power conservation and demand management can reinforce system operator strategies for operation, management and infrastructure development.

Improvements to public transportation systems can enhance energy efficiency and increase ridership, thus helping to mitigate climate change by reducing GHG emissions and facilitating community adaptation.

5 Appendices

Appendix 1 | Inventory of Emissions and Discharges in New York from the Energy Sector

Table 7A | State Aggregate Emissions from Energy Use Sectors and Other Non-Energy Sources (Thousands of Tons/Year) – Commercial

FUEL/SOURCE	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
Biomass/Wood	6.9	0.3	0.2	0.2	0.0	0.0
Coal	2.1	1.7	0.7	0.4	3.8	0.0
Gas	1.6	5.1	0.3	0.3	0.1	0.3
Oil	4.6	24.3	2.0	1.6	25.9	1.2
Other	0.2	0.1	0.0	0.0	0.1	0.0
TOTAL	**15.4**	**31.4**	**3.2**	**2.5**	**29.9**	**1.5**

Table 7B | State Aggregate Emissions from Energy Use Sectors and Other Non-Energy Sources (Thousands of Tons/Year) – Electric Utilities

FUEL/SOURCE	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
Biomass/Wood	0.3	0.2	0.0	0.0	0.0	0.0
Coal	2.1	24.8	2.5	1.4	80.9	0.3
Gas	7.2	12.7	0.9	0.9	0.6	0.6
Oil	2.4	8.7	1.5	1.2	24.4	0.2
Other	1.0	0.4	0.1	0.1	0.3	0.0
TOTAL	**13.1**	**46.7**	**5.0**	**3.6**	**106.1**	**1.2**

Table 7C | State Aggregate Emissions from Energy Use Sectors and Other Non-Energy Sources (Thousands of Tons/Year) – Industrial

FUEL/SOURCE	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
Biomass/Wood	4.4	0.9	1.6	1.4	0.1	0.1
Coal	0.6	4.9	2.5	0.8	22.1	1.1
Gas	4.7	6.1	0.2	0.2	0.3	0.5
Oil	1.1	6.1	0.4	0.2	9.3	0.1
Internal Combustion	0.1	0.0	0.0	0.0	0.0	0.0
Other/Mixed Fuels	1.0	8.6	0.2	0.1	14.3	0.2
TOTAL	**11.9**	**26.7**	**4.9**	**2.6**	**46.1**	**2.0**

Table 7D | State Aggregate Emissions from Energy Use Sectors and Other Non-Energy Sources (Thousands of Tons/Year) – Residential

FUEL/SOURCE	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
Coal	0.0	0.1	0.1	0.0	0.3	0.0
Gas	8.1	20.2	1.6	1.6	0.6	1.1
Oil	3.5	16.7	1.7	1.3	32.7	0.2
Wood – Fireplaces	44.1	0.9	8.1	8.1	0.1	6.5
Wood – Stoves	23.9	0.5	4.7	4.7	0.1	3.4
Wood – Outdoor	3.9	0.0	0.7	0.7	0.0	0.6
TOTAL	**83.5**	**38.4**	**16.9**	**16.4**	**33.8**	**11.9**

Table 7E | State Aggregate Emissions from Energy Use Sectors and Other Non-Energy Sources (Thousands of Tons/Year) – Transportation

FUEL/SOURCE	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
Air, Rail & Marine	17.1	48.8	1.9	1.8	7.6	4.1
Gasoline Vehicles	4,799.6	557.0	32.8	18.2	6.6	296.3
Diesel Vehicle	861.0	441.7	28.6	25.4	1.4	119.3
Non-Road Diesel	29.3	48.9	4.4	4.3	3.7	5.4
Non-Road Gasoline	874.8	13.3	3.0	2.7	0.1	123.4
Gas	53.8	16.5	0.6	0.6	3.0	2.8
TOTAL	**6,636**	**1,126**	**71**	**53**	**22**	**551**

Table 7F | State Aggregate Emissions from Energy Use Sectors and Other Non-Energy Sources (Thousands of Tons/Year) – Totals for all sectors

SECTOR	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
Commercial	15.4	31.4	3.2	2.5	29.9	1.5
Electric Utilities	13.1	46.7	5.0	3.6	106.1	1.2
Industrial	11.9	26.7	4.9	2.6	46.1	2.0
Residential	83.5	38.4	16.9	16.4	33.8	11.9
Transportation	6636	1126	71	53	22	551
TOTAL ENERGY	**6,759**	**1,269**	**101**	**78**	**238**	**603**
TOTAL NON-ENERGY	**96**	**12**	**252**	**45**	**7**	**155**

Source: DEC. Division of Air Resources, *Emissions Inventory*. 2007.

Table 8A | New York Electricity Generation Average Emission Rates by Fuel Type (2009) – Normalized to Electricity Output[a]

FUEL	NO_x (lb/MWh)	SO_2 (lb/MWh)	CO_2 (lb/MWh)
Coal	2.1	5.9	2,067
Oil	2.8	6.1	1,535
Gas[b]	0.4	0.2	1,027

Table 8B | New York Electricity Generation Average Emission Rates by Fuel Type (2009) – Normalized to Fuel Input

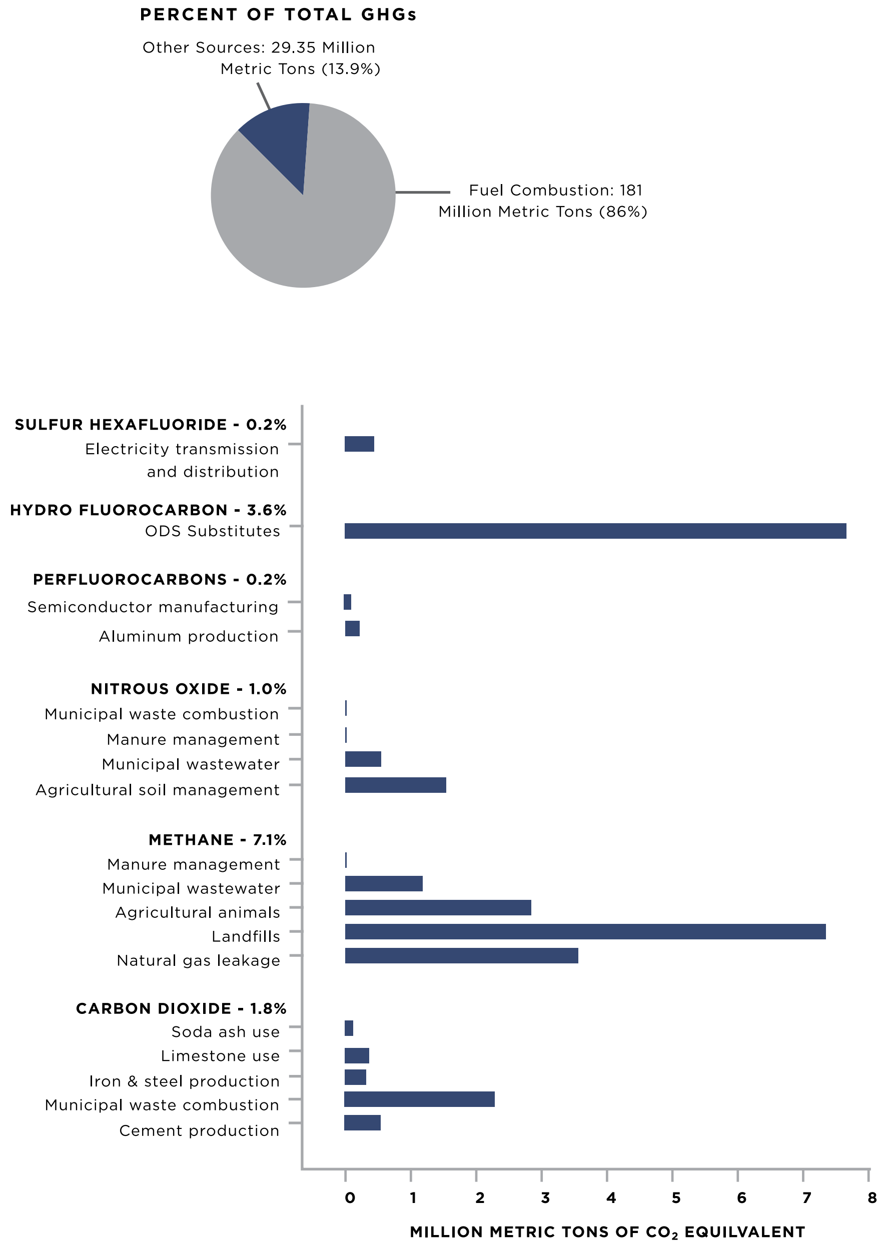
FUEL	NO_x (lb/MMBtu)	SO_2 (lb/MMBtu)	CO_2 (lb/MMBtu)
Coal	0.2	0.6	206
Oil	0.3	0.6	141
Gas[b]	0.1	<0.1	121

a Emissions per MWh or GWh average in some emissions from fuel use for steam heat in co-generation facilities.

b Gas category includes natural gas, propane and butane. MMBtu = million British thermal units; BBtu=billion Btu; MWh=megawatt hour; GWh=gigawatt hour.

Source: EPA. *The Emissions and Generation Resource Integrated Database 2009.*

Figure 11 | 2011 Emissions from Non-Fuel Combustion Sources



Note: Total emissions include net imports of electricity.

Source: NYSERDA

Appendix 2 | Impacts of Climate Change in New York by Economic Sector

Climate change is already impacting New York's society, economy, and natural ecosystems. With changes in temperature, precipitation patterns, and sea level projected to continue, the impacts to New York are likely to increase. The ClimAid report provides the State's best guide for assessing vulnerabilities and impacts, but experience of Hurricane Sandy suggests that the report's cost estimates may be conservative.[34]

34. NYSERDA. *Responding to Climate Change in New York State: The ClimAID Integrated Assessment for Effective Climate Change Adaptation.* http://www.nyserda.ny.gov/climaid

New York's Vulnerability to Climate Change

New York is vulnerable to a changing climate but, at the same time, has a great potential to adapt to its effects. From the Great Lakes to Long Island Sound, from the Adirondacks to the Susquehanna Valley, climate change will increasingly affect the people and resources of New York. Climate hazards include higher temperatures and more frequent and intense heat waves leading to greater incidence of heat morbidity and mortality; decreased air quality, and increased health risks for those with medical conditions such as cardiovascular disease, renal disease, emphysema, and others; increased short-duration warm season droughts and extreme rainfall events affecting food production, natural ecosystems, and water resources; and sea level rise, resulting in both gradual inundation of natural and human habitats and greater risk of damage from coastal storms.

Water Resources

Rising air temperatures intensify the water cycle by driving increased evaporation and precipitation. The resulting altered patterns of precipitation include more rain falling in heavy events, often with longer dry periods in between. Such changes can have a variety of effects on water resources. Heavy downpours have increased over the past 50 years and this trend is projected to continue, causing an increase in localized flash flooding in urban areas and hilly regions. Flooding has the potential to increase pollutants in the water supply and inundate wastewater treatment plants and other vulnerable development within floodplains. Less frequent summer rainfall is expected to result in additional, and possibly longer, summer dry periods, potentially impacting the ability of water supply systems to meet demands. Reduced summer flows on large rivers and lowered groundwater tables could lead to conflicts among competing water users. Increasing water temperatures in rivers and streams will affect aquatic heath and reduce the capacity of streams to assimilate effluent from wastewater treatment plants.

Coastal Zones

High water levels, strong winds, and heavy precipitation resulting from strong coastal storms already cause billions of dollars in damages, and disrupt transportation and power distribution systems. Sea level rise will lead to more frequent and extensive coastal flooding. Warming ocean waters raise sea level through thermal expansion and have the potential to strengthen the most powerful storms. Superstorm Sandy gained additional strength from unusually warm upper ocean temperatures in the North Atlantic. Sea level rise occurring in the New York City area increased the extent and magnitude of coastal flooding during Sandy with estimated costs of damage and loss in New York exceeding $30 billion dollars.

Barrier islands are being dramatically altered by strong coastal storms as ocean waters over wash dunes, create new inlets, and erode beaches. Sea level rise will greatly amplify risks to coastal populations and will lead to permanent inundation of low-lying areas, more frequent flooding by storm surges, and increased beach erosion. Loss of coastal wetlands reduces species diversity, including fish and shellfish populations. Some marine species, such as lobsters, are moving north out of New York, while other species, such as the blue claw crab, are increasing in the warmer waters. Saltwater could reach farther up the Hudson River Estuary, contaminating water supplies. Tides and storm surges may propagate farther, increasing flood risk both near and far from the coast. Sea level rise may become the dominant stressor acting on vulnerable salt marshes.

Ecosystems

Within the next several decades, New York is likely to see widespread shifts in species composition in the State's forests and other natural landscapes, with the loss of spruce-fir forests, alpine tundra, and boreal plant communities. Climate change will favor the expansion of some invasive species into New York, such as the aggressive weed, kudzu, and the insect pest, hemlock woolly adelgid. Some habitat and food generalists (such as white-tailed deer) may also benefit. A longer growing season and the potential fertilization effect of increasing carbon dioxide could increase the productivity of some hardwood tree species, provided growth is not limited by other factors such as drought or nutrient deficiency. Carbon dioxide fertilization tends to preferentially increase the growth rate of fast growing species, which are often weeds and other invasive species. Lakes, streams, inland wetlands, and associated aquatic species will be highly vulnerable to changes in the timing, supply, and intensity of rainfall and snowmelt, groundwater recharge, and duration of ice cover. Increasing water temperatures will negatively affect brook trout and other native coldwater fish.

Agriculture

Increased summer heat stress will negatively affect cool-season crops and livestock unless farmers take adaptive measures such as shifting to more heat-tolerant crop varieties and improving cooling capacity of livestock facilities. Increased weed and pest pressure associated with longer growing seasons and warmer winters will be an increasingly important challenge. Water management will be a more serious challenge for New York farmers in the future due to increased frequency of heavy rainfall events, and more frequent and intense summer water deficits by mid to late century. Opportunities to explore new crops, new varieties, and new markets will come with higher temperatures and a longer growing season.

Public Health

Demand for health services and the need for public health surveillance and monitoring will increase as climate continues to change. Heat-related illness and death are projected to increase, while cold-related death is projected to decrease. Increases in heat-related death are projected to outweigh reductions in cold-related death. More intense precipitation and flooding along the coasts and rivers could lead to increased stress and mental health impacts, impaired ability to deliver public health and medical services, increased respiratory diseases such as asthma, and increased outbreaks of gastrointestinal diseases. Cardiovascular and respiratory-related illness and death will be affected by worsening air quality, including more smog, wildfires, pollens, and molds. Vector-borne diseases, such as those spread by mosquitoes and ticks (e.g., West Nile virus and Lyme disease), may expand or their distribution patterns may change. Water supply, recreational water quality, and food production will be at increased risk due to increased temperatures and changing precipitation patterns. Water- and food-borne diseases are likely to increase without adaptation intervention.

Transportation

Over the next few decades, heat waves and heavy precipitation events are likely to increase transportation problems such as flooded streets and delays in mass transit. Coastal flooding will be more frequent and intense due to sea level rise. Major adaptations are likely to be needed, not only in the coastal zones, but also in Troy and Albany as sea level rise and storm surge propagate up the tide-controlled Hudson River. Materials used in transportation infrastructure, such as asphalt and train rails, are vulnerable to increased temperatures and frequency of extreme heat events. Air conditioning requirements in buses, trucks, and trains, and ventilation requirements for tunnels will increase.

Low-lying transportation systems such as subways and tunnels, especially in coastal and near-coastal areas, are at particular risk of flooding as a result of sea level rise, storm surge, and heavy precipitation events. Transportation systems are vulnerable to ice and snowstorms, although requirements for salting and snow removal may decrease as precipitation tends to occur more often as rain than snow. Freeze/thaw cycles that disturb roadbeds may increase in some regions as winter temperatures rise. Runways may need to be lengthened in some locations since hotter air provides less lift and hence requires higher speeds for takeoff. Newer, more powerful aircraft can reduce this potential impact. The Great Lakes may see a shorter season of winter ice cover, leading to a longer shipping season, but lake levels may decrease due to increased evaporation. Reduced ice cover may result in an increase in "lake-effect" snow events, which cause various transportation problems.

New York State has the most days per year of freezing rain in the nation. This phenomenon affects air and ground transportation directly and also indirectly through electric and communication outages. It is unknown how climate change will influence the frequency of freezing rain in the future.

Telecommunications

Communication service delivery is vulnerable to hurricanes, lightning, ice, snow, wind storms, and other extreme weather events, some of which are projected to change in frequency and/or intensity. The delivery of telecommunication services is sensitive to power outages, such as those resulting from the increased electrical demand associated with heat waves, which are expected to increase with climate change. Communication lines and other infrastructure are vulnerable to heavy precipitation events, flooding, and freezing rain. In coastal and near-coastal areas, sea level rise in combination with coastal storm surge flooding will be a considerable threat later this century.

Energy Sector

Impacts of climate change on energy demand are likely to be more significant than impacts on supply. Climate change will adversely affect system operations, increase the difficulty of ensuring adequate supply during peak demand periods, and exacerbate problematic conditions, such as the urban heat island effect. More frequent heat waves will cause an increase in the use of air conditioning, stressing power supplies and increasing peak demand loads. Increased air and water temperatures will decrease the efficiency of power plants, as they decrease cooling capacity.

Coastal infrastructure is vulnerable to flooding as a result of sea level rise and coastal storms. Hydropower is vulnerable to projected increases in summer drought. The availability and reliability of solar power systems are vulnerable to changes in cloud cover although this may be offset by advances in technology; wind power systems are similarly vulnerable to changes in wind speed and direction. Biomass energy availability depends on weather conditions during the growing season, which will be affected by a changing climate.

Transformers and distribution lines for both electric and gas supply, as was observed recently due to Superstorm Sandy, are vulnerable to extreme weather events, such as heat waves and flooding. Higher winter temperatures are expected to decrease winter heating demand, which will primarily affect natural gas markets, while increases in cooling demand will affect electricity markets; such changes will vary regionally. The indirect financial impacts of climate change may be greater than the direct impacts of climate change. These indirect impacts include those to investors and insurance companies as infrastructure becomes more vulnerable and those borne by consumers due to changing energy prices and the need to use more energy.

Appendix 3 | Summary of Climate Risks to New York State's Power Supply System

Table 9A | Summary of Climate Risks to the New York State Power System – Energy Supply and Distribution: Energy Supply

VULNERABILITY	PRINCIPAL CLIMATE VARIABLES	SPECIFIC CLIMATE-RELATED RISKS	LOCATION	CROSS-CUTTING LINKS
Thermoelectric power plants	Temperature	The thermal efficiency of power generation is affected by air temperature.	ST	
Coastal power plants (including cogeneration at wastewater treatment facilities)	Extreme weather events & sea level rise	Flood risk at individual facilities depends on the likelihood and intensity of storm surges associated with extreme weather events and their interaction with sea level rise. Operational impacts may be different than impacts on fuel storage or fuel unloading operations.	ST	Coastal Zones
Water-cooled power plants	Temperature	Water-cooled nuclear plants are affected by changes in the temperature of intake and discharge water, which is affected by changes in temperature.	ST	Water Resources
Hydropower systems	Precipitation & temperature	Hydropower availability at individual plants is affected by the timing and quantity of precipitation, as well as snowmelt; snowmelt is also affected by seasonal temperature.	W,C,N	Water Resources, Ecosystems, Agriculture
Wind power systems	Wind speed and direction	Availability and predictably of wind power	W,C,N	
Solar power systems		Availability and predictably of solar power	ST	
Biomass-fueled energy systems	Temperature & precipitation	Biomass availability depends on weather conditions during the growing season.	W,C,N	Ecosystems

Table 9B | Summary of Climate Risks to the New York State Power System – Energy Supply and Distribution: Energy Transmission and Distribution Assets

VULNERABILITY	PRINCIPAL CLIMATE VARIABLES	SPECIFIC CLIMATE-RELATED RISKS	LOCATION	CROSS-CUTTING LINKS
Transmission lines (winter)	Extreme weather events	Frequency, duration, and spatial extent of outages are affected by winter storms, particularly ice storms, and high winds.	W,C,N	Communications
Transmission lines (summer)	Temperature	Sagging lines can result from increased load associated with higher temperatures.	ST	Communications, Public Health
Transformers	Temperature	Transformers rated for particular temperatures may fail during prolonged periods of increased temperature.	ST	Communications, Public Health
Natural gas distribution lines	Temperature, extreme weather events, & flooding	Changing temperatures may affect vulnerability to frost heave risks, which can threaten structural stability of the pipeline. Flooding risks can also jeopardize pipeline stability/operations. Extreme weather events may threaten underwater pipelines in the Gulf Coast region, a large source of natural gas supply for New York.	ST	

Table 9C | Summary of Climate Risks to the New York State Power System – Energy Demand and Consumption: Electricity Demand[35]

VULNERABILITY	PRINCIPAL CLIMATE VARIABLES	SPECIFIC CLIMATE-RELATED RISKS	LOCATION	CROSS-CUTTING LINKS
Total demand	Temperature (heating degree days & cooling degree days) & extreme weather events	Temperature affects demand for electricity in winter, summer, and shoulder-season periods. Extreme weather events may temporarily or permanently change demand patterns.	ST	Public Health
Peak demand in summer	Temperature and humidity (cooling degree days, heat index, & heat waves)	Temperature and humidity affect demand for electricity for cooling and can increase the summertime peak; increasing frequency, intensity, and duration of heat waves could be particularly problematic, leading to more brownouts and blackouts.	S	Public Health
Power sharing	Temperature (heating degree days)	Warming temperatures can increase summer demand in traditional winter-peaking areas, leading to reduced availability of power for downstate regions.	ST	Public Health

35. DPS points out that higher peak demand in summer does not invariably lead to service interruptions, although increased frequency, intensity and duration of heat waves will challenge the power system operators to use all available resources to maintain service.

Table 9D | Summary of Climate Risks to the New York State Power System – Energy Demand and Consumption: Building-sited Energy Systems*

VULNERABILITY	PRINCIPAL CLIMATE VARIABLES	SPECIFIC CLIMATE-RELATED RISKS	LOCATION	CROSS-CUTTING LINKS
Cooling systems	Temperature	Cooling capacity may not be sufficient if the period of days with high temperatures is lengthy.	ST	Public Health
Heating systems	Precipitation	Flood risk for boilers located in basements	ST	
Building envelopes	Extreme weather events	Increased severity of storm regime may reveal weaknesses in building envelopes.	ST	
Mechanical and electric systems	Extreme weather events	Failure of mechanical-electrical elements is related to extreme weather conditions.	S	Public Health

Notes: W- Western New York, C- Central New York, N- Northern New York, S- Southern New York, ST- Statewide

Source: NYSERDA. *Responding to Climate Change in New York State: The ClimAID Integrated Assessment for Effective Climate Change Adaptation*. http://www.nyserda.ny.gov/climaid

Appendix 4 | Historical Trends for Air Pollutants in New York

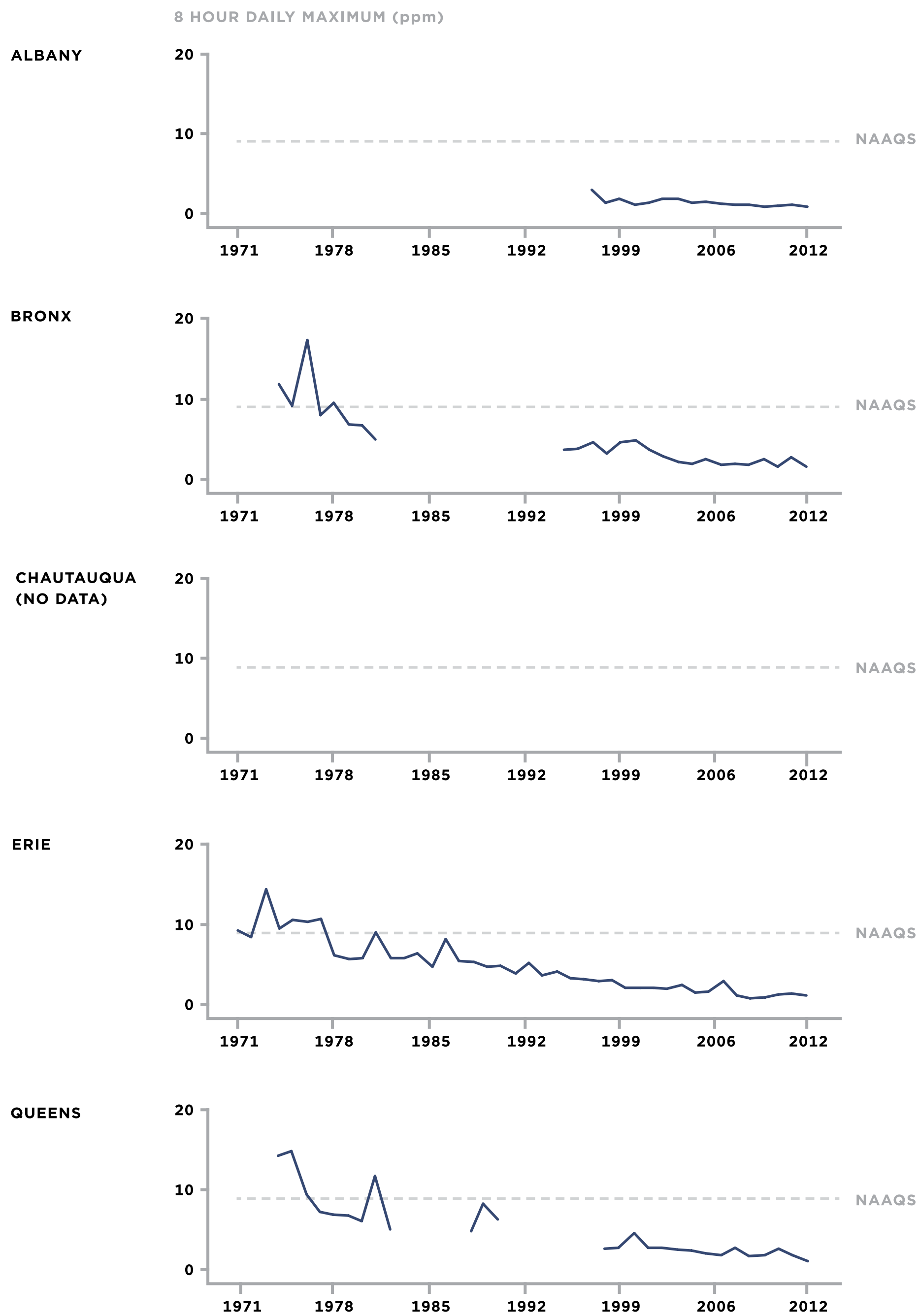
Criteria Air Pollutants

The U.S. Environmental Protection Agency (EPA) established six "criteria pollutants" for which it established National Ambient Air Quality Standards (NAAQS): ozone, particulate matter, nitrogen dioxide (NO_2), sulfur dioxide (SO_2), lead, and carbon monoxide (CO). Particulate matter is further broken into fine particulate matter or $PM_{2.5}$, composed of particles 2.5 microns or smaller, and coarse particulate matter or PM_{10}, composed of particles 10 microns or smaller. These criteria pollutants were selected for their potential to affect human health (e.g., respiratory and cardiovascular effects) and the environment (e.g., vegetative damage, acid deposition, and visibility impairment) at high ambient concentrations. Based on this potential for such harmful effects, federal and State programs have been developed to control the emissions of these criteria pollutants from electricity generation, industry, transportation, and other contributing sectors.

Since the Plan is a forward-looking document, this section focuses on the criteria pollutants that typically result from the energy sector and those for which ambient concentrations are close to the NAAQS. Figures 12 through 16 therefore illustrate historical trends for ambient air monitoring of CO, ozone, NO_2, $PM_{2.5}$, and SO_2, respectively, for Albany, Bronx, Chautauqua, Erie, and Queens Counties. The NO_2 and SO_2 NAAQS have been met for many years; recently, however, EPA established new 1-hour standard for NO_2 and SO_2 that New York is assessing. Therefore, graphs of NO_2 and SO_2 are provided and future Plans will report on the State's progress at attaining the new one-hour NAAQS.

These graphs show decreases in ambient concentration for all criteria pollutants over the years (1971 to 2012) due largely to policies and regulations that impose emissions reductions. More recently, many policies promoting efficient end use products and efficient power generation have lead to additional decreases in ambient air concentrations.

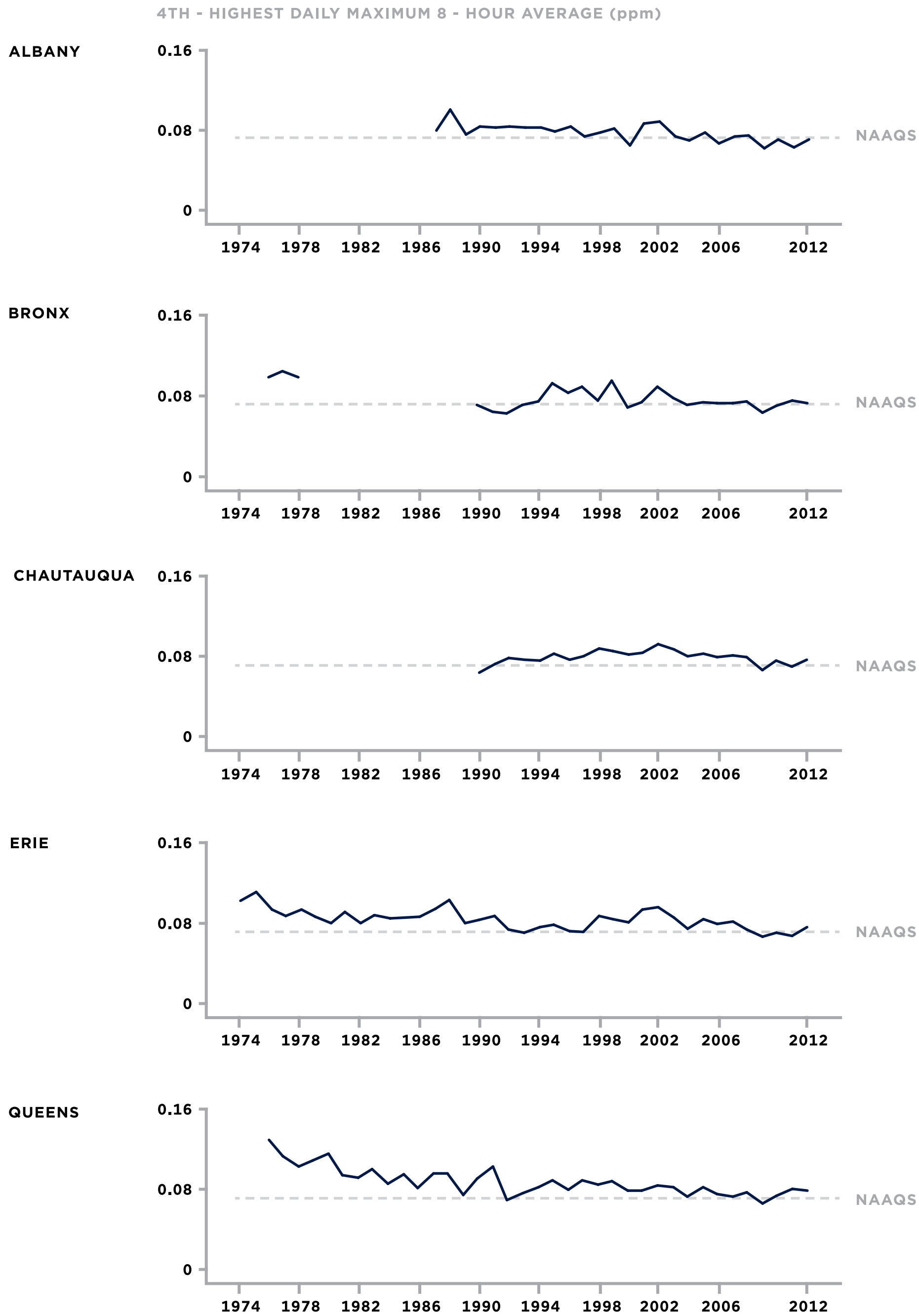
Figure 12 | Carbon Monoxide Monitoring (1971 to 2012)



Note: The 8-hr NAAQS of 9 ppm is applicable for all years illustrated.

Source: DEC. *Bureau of Air Quality Surveillance Monitoring Network*. 2013.

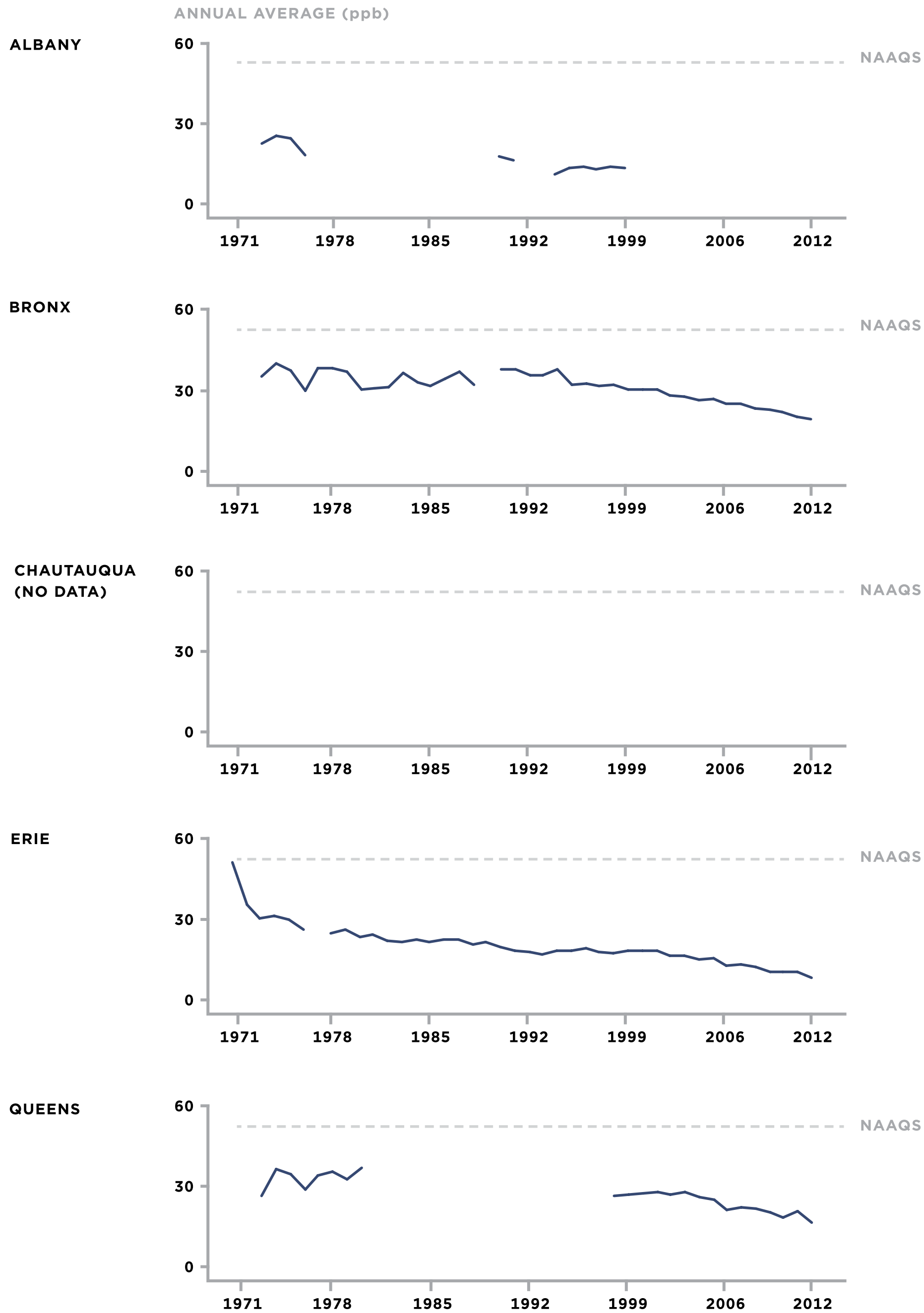
Figure 13 | Ozone Historical Monitoring (1974 to 2012)



Note: The NAAQS for 8-hour ozone was reduced from 0.08 ppm to 0.075 ppm in 2008. The revised NAAQS is displayed for all years.

Source: DEC. *Bureau of Air Quality Surveillance Monitoring Network*. 2013.

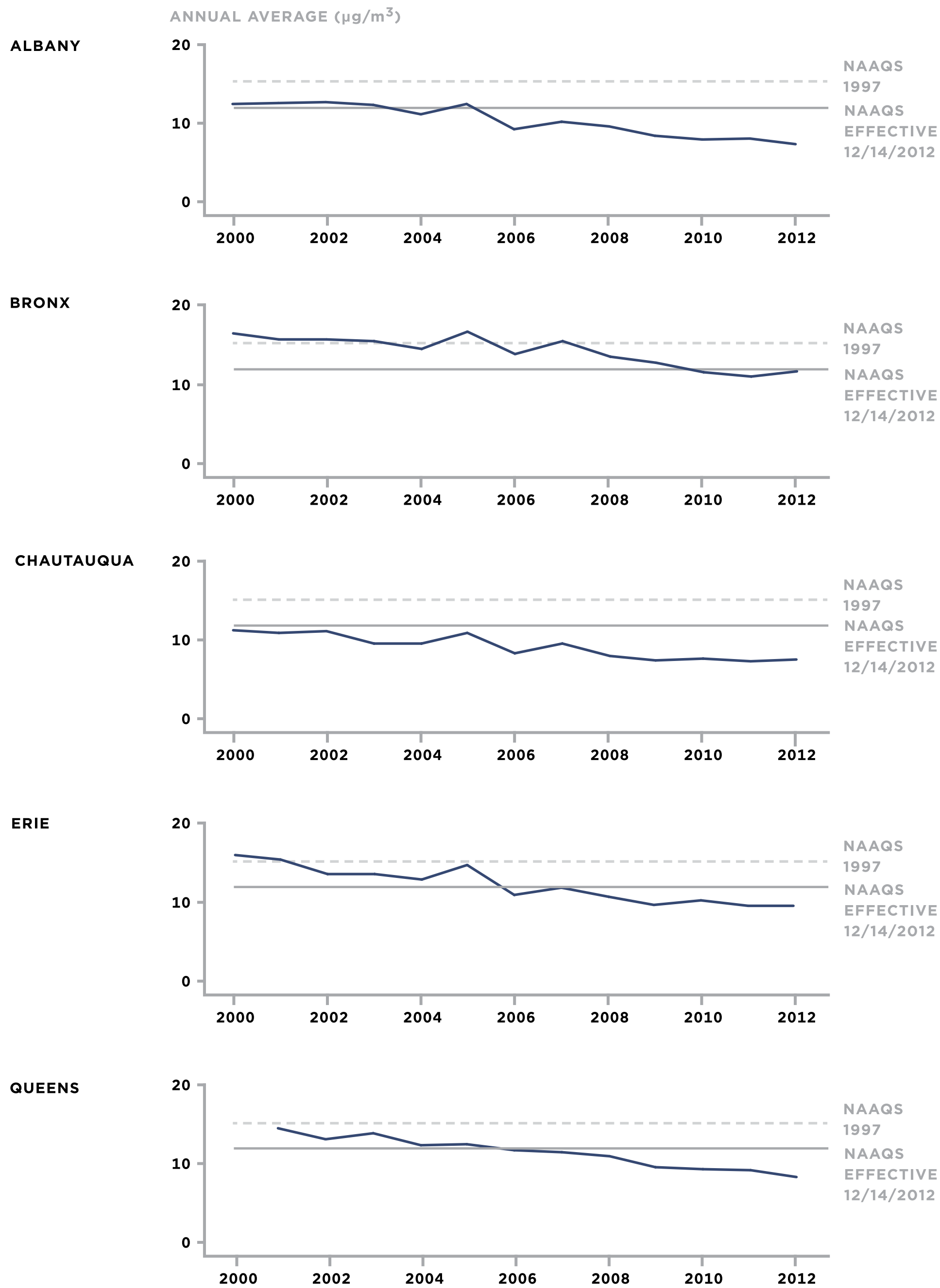
Figure 14 | Nitrogen Dioxide Historical Monitoring (1971 to 2012)



Note: The annual NAAQS of 53 ppb is applicable for all years illustrated.

Source: DEC. *Bureau of Air Quality Surveillance Monitoring Network*. 2013.

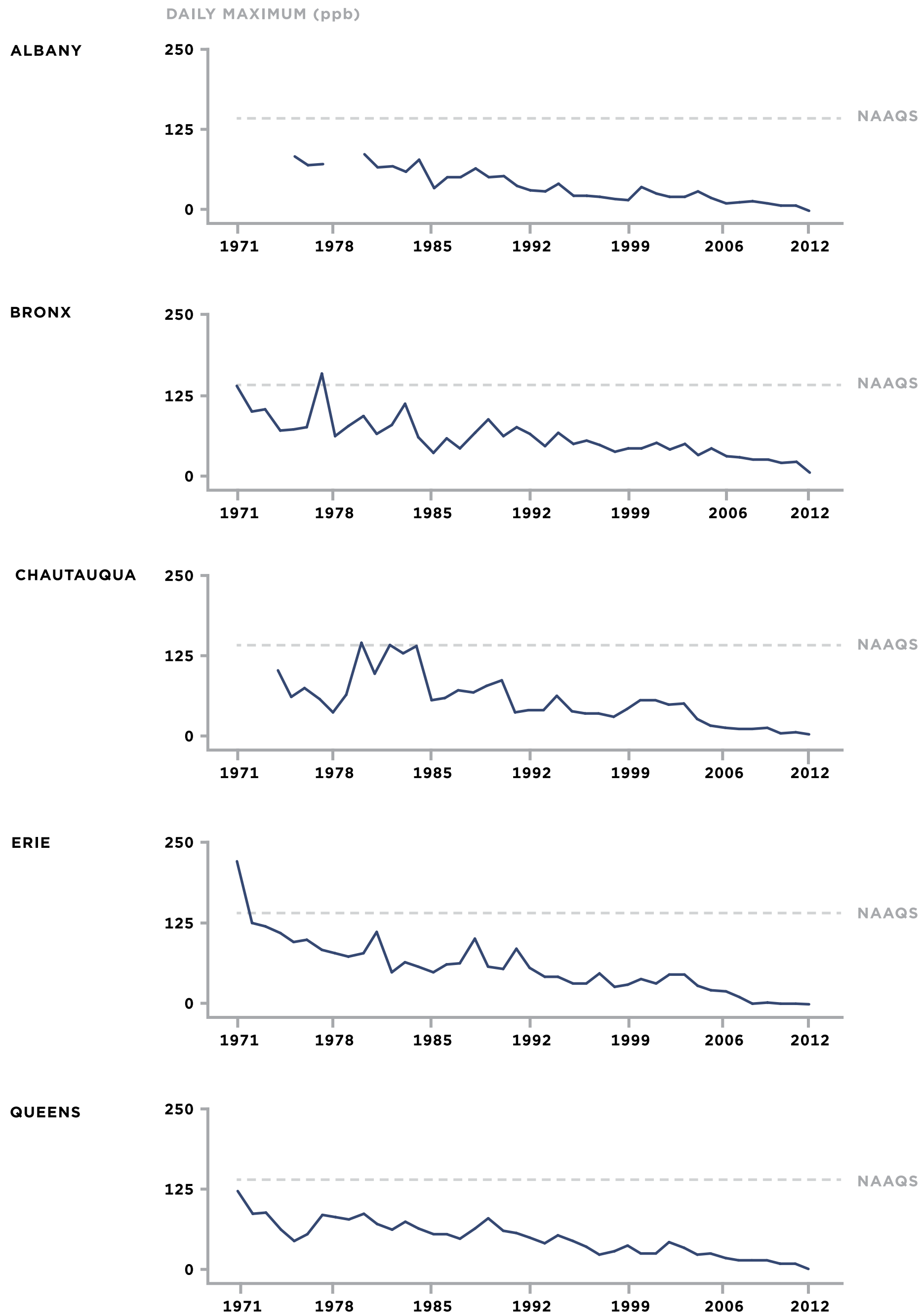
Figure 15 | Fine Particulate Matter ($PM_{2.5}$) Historical Monitoring (2000 to 2012)



Note: The annual NAAQS of 15 µg/m³ is applicable for all years illustrated. For all counties displayed, the most recent three years are below the current annual standard, of 12 µg/m³ effective 12/14/2012.

Source: DEC. *Bureau of Air Quality Surveillance Monitoring Network*. 2013.

Figure 16 | Sulfur Dioxide Historical Monitoring 24-hr Average (1971 to 2012)



Note: The 1971 24-hr standard has been displayed to illustrate the State's achievement in meeting the standard. The 24-hr standard was revoked on 6/22/2010 and a 1-hr standard was promulgated.

Source: DEC. *Bureau of Air Quality Surveillance Monitoring Network*. 2013.

Carbon Monoxide

Carbon monoxide (CO), a colorless and odorless gas, is produced as a primary pollutant during the combustion of fossil and biomass fuels. Vegetation also can emit CO directly into the atmosphere as a metabolic by-product. Sources such as motor vehicles, non-road combustion engines or vehicles, and biomass burning can cause high concentrations of CO in the outdoor environment. The primary concern about releases to the environment is human health effects that can result from high concentrations. In New York, 98 percent of the releases come from the transportation sector as shown in Appendix 1, Table 7F.

Ozone

Ground-level ozone is a criteria pollutant that is formed when volatile organic compounds (VOCs) and oxides of nitrogen (NO_X) react chemically in the presence of sunlight. VOCs are released by motor vehicle exhaust, industrial processes and from the evaporation of solvents, oil-based paints, and gasoline. Although atmospheric ozone protects the earth's surface from the sun's ultraviolet rays, ground-level ozone is an air pollutant that significantly impacts human health and vegetation. Ozone can diminish the ability of plants to produce and store food, which makes them more susceptible to disease thereby affecting crop yield and forest growth.[36] It is estimated that ground-level ozone is responsible for $500 million dollars in reduced crop production in the nation. Further aesthetic harm can be seen in leaf and tree damage in urban or other recreational areas such as the Adirondack Park.

Nitrogen Oxides (NO_X)

Nitrogen oxides include both nitric oxide (NO) and nitrogen dioxide (NO_2). NO_2, a respiratory irritant, is also a criteria pollutant that reacts with other chemicals in the atmosphere to form ozone, PM, haze, and acid rain.

The primary sources of NO and NO_2 are motor vehicle exhaust as well as the combustion of fossil fuel for the purpose of generating electricity. The environmental impacts of NO_X include visibility impairment and excessive algae growth (eutrophication) in water bodies, which leads to a depletion of oxygen. Vegetation exposed to high levels of

36. NRC. *Ozone: Good Up High, Bad Nearby*. January 2003. http://www.policyalmanac.org/environment/archive/ozone.shtml

NO_2 can be identified by damage to foliage, decreased growth, or reduced crop yields.

Particulate Matter (PM)

Particulate matter is a generic term for a broad class of chemically and physically diverse substances that exist as discrete particles (liquid droplets or solids) over a wide range of sizes. PM is classified by the size of the particle; fine PM is those particles with a size of 2.5 microns or less, and coarse PM describes all particles greater than 2.5 microns but less than 10 microns. Fine PM exposure can result in difficulty in breathing, decreased lung function, aggravating asthma, development of chronic bronchitis, non-fatal heart attacks, and premature death in people with heart or lung disease.

Atmospheric concentrations of PM have environmental impacts on the natural resources of the State. Fine particulate emissions are the major cause of reduced visibility in some locations in the nation and PM can travel long distances and settle on water and ground. PM may cause streams and lakes to become acidic (if constituents include inorganic and organic acids) and change the nutrient balance in coastal waters and large river basins. Furthermore, PM depletes nutrients in soil, damages sensitive forests and farm crops, and affects the diversity of ecosystems.[37]

Sulfur Dioxide (SO_2)

Sulfur dioxide is a criteria pollutant present in the atmosphere primarily as a result of human activity. The primary source of SO_2 is the combustion of sulfur-containing fuels such as coal and oil at electric generating facilities and industrial facilities. Along with nitrogen oxides, emissions of SO_2 can significantly contribute to acid rain, which degrades soils, lakes and streams, accelerates corrosion of buildings and monuments, and reduces visibility. SO_2 is also a major precursor of fine particulate soot.[38]

37. EPA. *Health*. June 15, 2012. http://www.epa.gov/pm/health.html
38. DEC. Acid Rain. 2012. http://www.dec.ny.gov/chemical/8418.html

Ambient Criteria Pollutant Concentrations and Health Concerns

The relative health concern related to ambient air criteria pollutant concentrations can be considered in different ways. Some of the NAAQS are based on risk estimates derived from the collective findings of epidemiological studies that have reported increased rates of morbidity and mortality associated with pollutant concentrations. Ranges of excess morbidity and mortality risk estimates for criteria pollutants are presented in Table 10. Risk estimates derived from specific time periods, populations, baseline effect incidence rates, and pollution concentration changes can be applied with some increase in uncertainty to other populations, time periods, baseline effect incidence rates, and pollution concentration ranges (increases or decreases) to estimate impacts or benefits of specific scenarios of interest.

Table 10 | Standardized Estimates of Excess Risk per 10 Microgram/M3 Increment in Air Concentration for Ozone[1], Particulate Matter[2], Sulfur Dioxide[3], and Nitrogen Dioxide[4]

POLLUTANT	AVERAGING TIME	HEALTH OUTCOME	STANDARDIZED PERCENT EXCESS RISK (RANGE)[a]
Ozone[1]	24 hr	mortality[b]	0.41 – 0.63
$PM_{2.5}$[2]	24 hr	mortality	0.29 – 1.21
$PM_{2.5}$	24 hr	CVD mortality[c]	0.3 – 1.03
$PM_{2.5}$	24 hr	respiratory mortality	1.01 – 2.2
SO_2[3]	24 hr	mortality	0.19 – 2.6
NO_2[4]	24 hr	mortality[d]	0.13 – 0.92
Ozone	annual	mortality[e]	— [f]
$PM_{2.5}$	annual	mortality[g]	6 – 13
SO_2[3]	annual	mortality	— [h]
NO_2	annual	mortality	— [h]
Ozone	max 8 hr[i]	acute asthma[j]	-0.34 – 4.6
$PM_{2.5}$	24 hr	acute respiratory	-8 – 22
$PM_{2.5}$	24 hr	acute asthma	0 – 9
SO_2	24 hr	acute asthma	-0.38 – 14
NO_2	24 hr	acute asthma	1.6 – 10

a. Percent excess risk (= (Relative Risk – 1)*100 percent) per 10 microgram/m^3 standardized increment in air pollutant concentration. Extracted values represent range of central tendency estimates from studies summarized by EPA. Estimates include adjustment for one or more co-pollutants when available.

b. All daily non-accidental mortality

c. Cardiovascular disease mortality

d. Evidence considered by EPA as suggestive, but insufficient to infer a causal relationship, although the trend is toward positive associations

e. Long-term mortality estimates extracted from reanalysis of Harvard Six Cities and American Cancer Society studies only

f. No consistent evidence of an association

g. Range based on EPA (2009) Figure 7-11 and medians for the Six Cities Study and the American Cancer Society Study. This range also includes most medians from the expert elicitation results presented in the same figure.

h. Evidence considered inadequate to infer a consistent association

i. Warm season estimates only

j. Combines studies reporting emergency department visits and hospitalizations for acute asthma exacerbations or all acute respiratory outcomes..

Sources:

1. EPA. *Air Quality Criteria for Ozone and Related Photochemical Oxidant*. 2006

2. EPA. EPA/600/R-08/139F: *Integrated Science Assessment For Particulate Matter*. 2009.

3. EPA. EPA/600/R-08/047: *Integrated Science Assessment for Sulfur Oxides- Health Criteria*. 2008.

4. EPA. EPA/600/R-08/071: *Integrated Science Assessment for Oxides of Nitrogen – Health Criteria*. 2008.

Toxic Air Pollutants

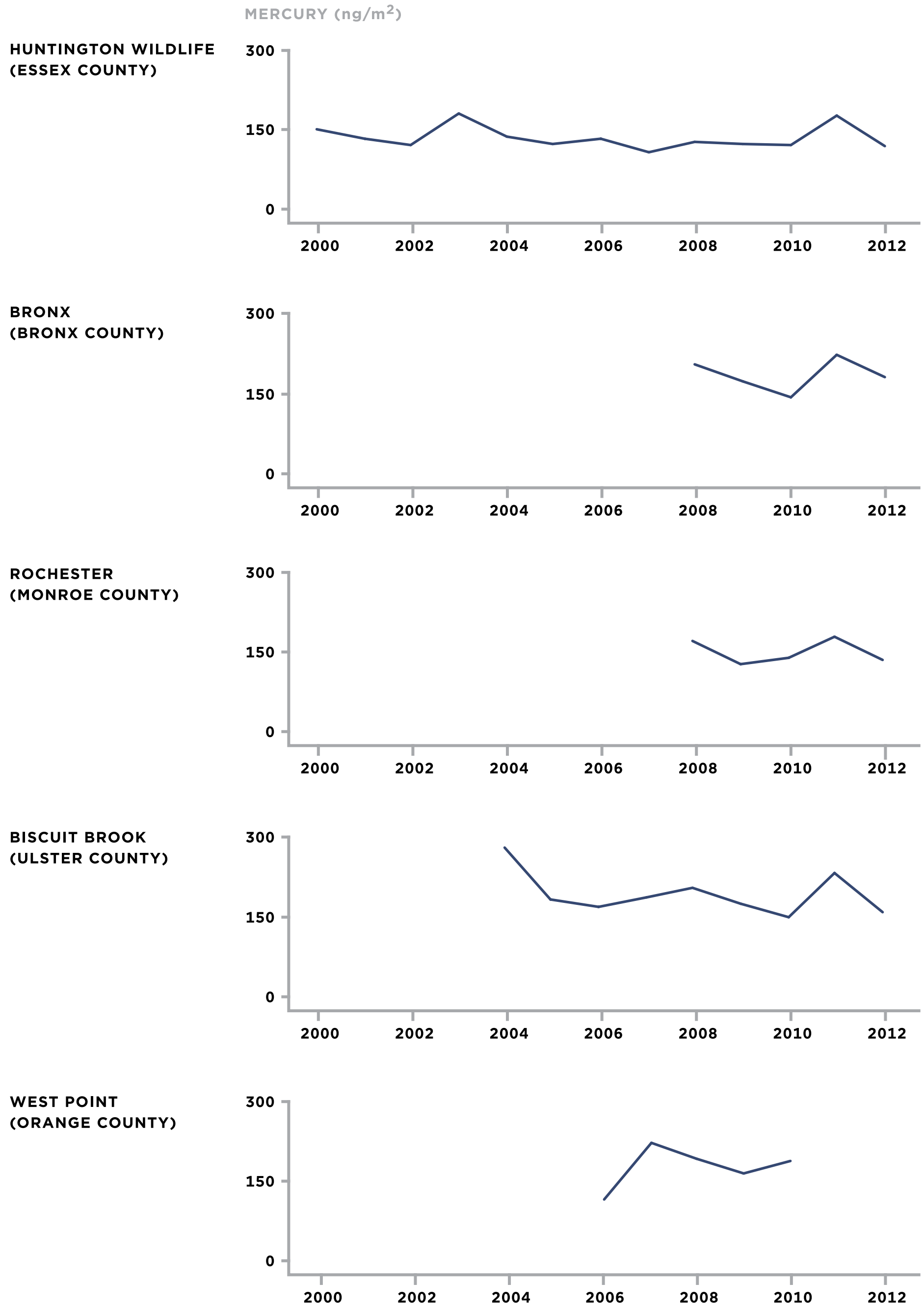
Mercury

A network of monitors operates in New York to track the progress of mercury reduction strategies for two of the largest known source categories, municipal waste combustors and coal-fired electric utilities. These monitors track ambient air concentrations of elemental mercury Hg (0), particle-bound mercury (PBM) and reactive gas mercury (RGM). As shown in Figure 17, wet deposition mercury from the longest running monitoring in the Adirondack region (Huntington Wildlife, Essex County) reports a decline of mercury deposition by 2.9 nanograms per square meter over the 13-year monitoring period.[39] Although the monitoring period for the Biscuit Brook, Bronx and Rochester monitors is shorter, the overall trend suggests a decline in wet deposition. The increase in mercury wet deposition for 2011 is a reflection in precipitation increase for that year.Because mercury is a persistent, bioaccumulative, toxic contaminant of concern for New York,[40] greater reductions in releases are still necessary to reduce overall environmental burdens.

39. The mercury deposition monitoring network consists of five monitors. All monitors have been displayed.

40. DEC. *Mercury Work Group Recommendations to Meet the Mercury Challenge*. 2006.

Figure 17 | Mercury Wet Deposition (2000 to 2012)



Source: U.S. State Agricultural Experiment Stations, National Atmospheric Deposition Program. Atmospheric Mercury Network (AMNet). 2013. http://nadp.sws.uiuc.edu/amn/

Acid Deposition

New York monitors and tests for acid deposition-through the New York State Acid Deposition Monitoring Network, which was designed in 1985 to carry out requirements of the State Acid Deposition Control Act (SADCA). In 1984, the SADCA required the reduction of SO_2 emissions from existing sources and imposed NO_X emission controls on new sources to reduce acid deposition to waters and forests. SADCA also required DEC to set an Environmental Threshold Value (ETV) for wet sulfate deposition, which was set at 20 kilograms per hectare.

Early measurements of acid deposition and related quantities were used to assess the effectiveness of the sulfur control policy and other strategies aimed at reducing the effects of acid rain (Title IV of the Clean Air Act). In recent years, results from the monitoring network have provided information on the effectiveness of federal and State programs to control emissions contributing to acid deposition. The more recent programs include the 2004 NO_X and SO_2 Budget Trading rules and the 2009 Clean Air Interstate Rule (CAIR) Trading rules.[41, 42] Most recently, EPA adopted the Cross State Air Pollution Rule (CSAPR) which is EPA's response to the federal court mandate to replace CAIR as a result of legal defects. CSAPR was vacated by U.S. Court of Appeals for the District of Columbia Circuit on August 21, 2012.[43] As a result, the CAIR program remains in effect.

The effectiveness of these regulations can be seen in the State's acid deposition monitoring. Because the amount of rainfall affects deposition from the atmosphere, acid deposition is reported as a concentration measurement (grams acid per liter water) and a deposition measurement (mass per area). Figure 18 illustrates the changes in sulfate concentration for a 23-year period starting in 1987.[44] The average decrease in sulfate concentration for this time period is 0.13 milligrams per liter (mg/L) per year. Figure 19 illustrates the changes in nitrate concentration for a 23-year period starting in 1987 and shows that the average decrease in nitrate concentration for this time period is 0.07 mg/L per year. As shown, both the sulfate and nitrate concentrations are higher for the western region, Chautauqua and Erie counties, which are immediately downwind of the largest fossil fuel burning mid-western utilities in

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41. 6NYCRR Parts 237 and 238: Acid Deposition Reduction NO_X and SO_2 Budget Trading Programs

42. 6NYCRR Parts 243, 244 and 245: CAIR NO_X Ozone Season, NO_X Annual and SO_2 Trading Programs

43. U.S. Court of Appeals for the District of Columbia Circuit No. 11-1302, August 21, 2012.

44. The acid deposition network consists of 20 monitoring sites. Four representative county monitors have been displayed in this chapter.

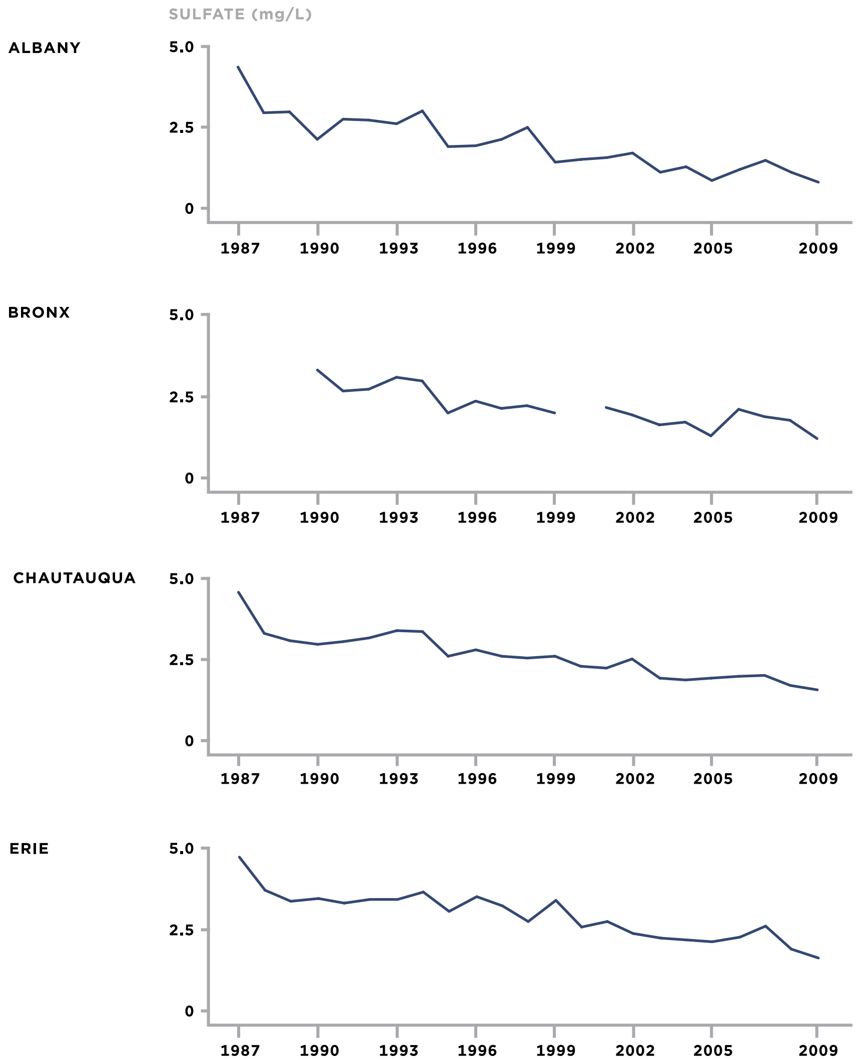
North America. The eastern counties of Albany and Bronx show greater declines in nitrate concentration suggesting that State regulations have had more of an impact on decreasing acid deposition concentration than federal programs.

In 2010, the acid deposition monitoring network consisted of 20 sites.[45] The yearly sulfate deposition value for all monitors was below the ETV of 20 kilograms per hectare. The two highest monitors in the State are in Erie and Chautauqua Counties, as shown in Figure 20. Even though acid deposition is generally decreasing across New York, there are still lakes, streams, and soils that are too acidic to support healthy fish and vegetation communities. Deposition changes (achieved under Title IV from electrical generation units) are leading to chemical recovery, but there may be a delay in biological recovery in these sensitive ecosystems and continued emission reductions are necessary in order to protect sensitive ecosystems.[46]

45. Currently the acid deposition network consists of 16 sites.

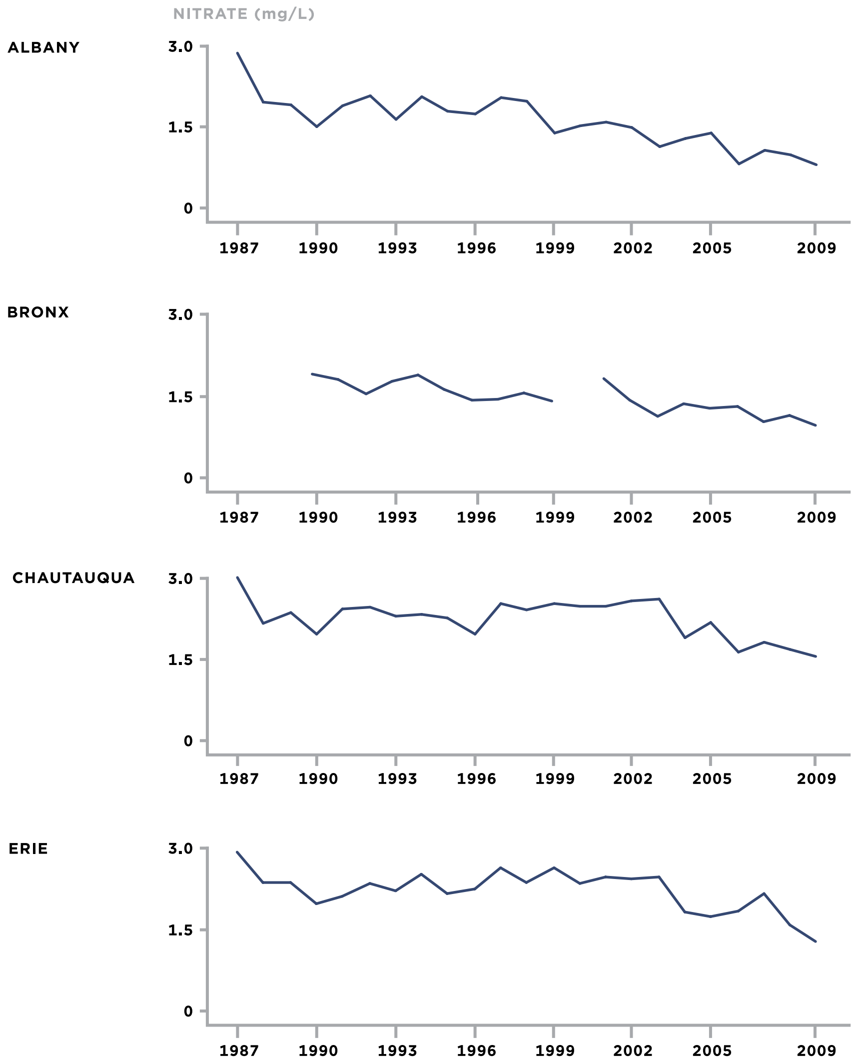
46. National Science and Technology Council (NSTC). *National Acid Precipitation Assessment Program Report to Congress: An Integrated Assessment*. Washington, DC: Executive Office of the President, 2005.

Figure 18 | Sulfate Concentration (1987 to 2009)



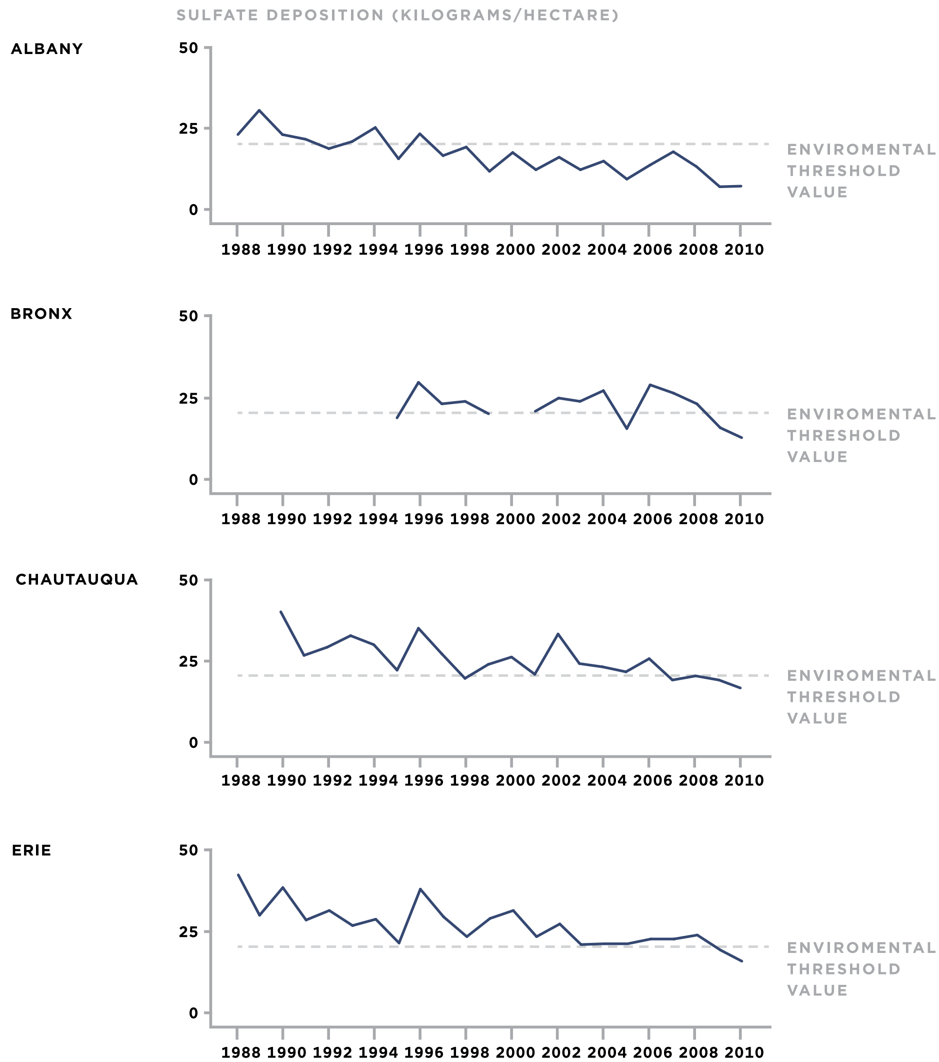
Source: DEC. *Bureau of Air Quality Surveillance Monitoring Network*. 2012.

Figure 19 | Nitrate Concentration (1987 to 2009)



Source: DEC. *Bureau of Air Quality Surveillance Monitoring Network*. 2012.

Figure 20 | Sulfate Deposition per Hectare (1988 to 2010)



Source: DEC. *Bureau of Air Quality Surveillance Monitoring Network*. 2013.

Appendix 5 | Maps of PEJAs and Facility Densities, May 2012

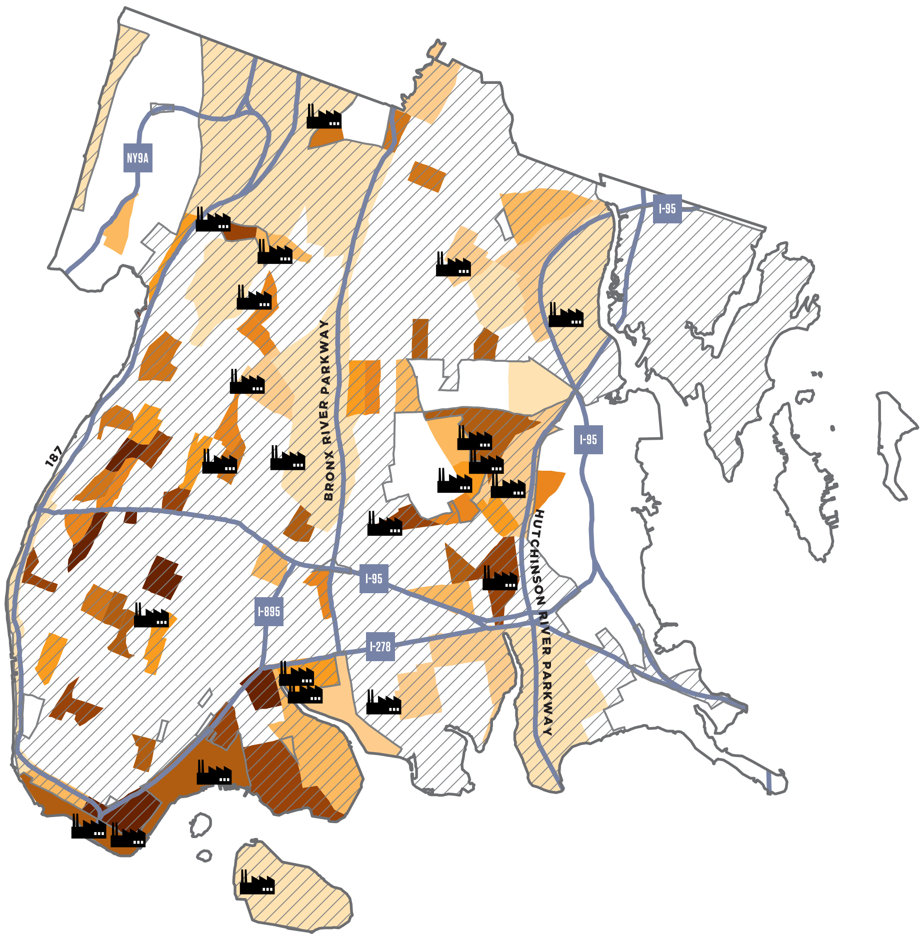
Figure 21 | Bronx County Map of PEJAs and Density of Facilities, Including Title V Emission Sources

This computer representation has been compiled from supplied data or information that has not been verified by NYSDEC. The data are offered here as a general representation only and are not to be used for commercial purposes without verification by an independent professional qualified to verify such data or information.

NYSDEC does not guarantee the accuracy, completeness, or timeliness of the information shown and shall not be liable for any loss or injury resulting from reliance.

Data Source for Potential Environmental Justice Areas:
U.S. Census Bureau, 2000 U.S. Census

For questions about this map contact:
New York State Department of Environmental Conservation
Office of Environmental Justice
625 Broadway, 14th Floor
Albany, New York 12233-1500
(518) 402-8556
ej@gw.dec.state.ny.us



Legend

- Title V Facility
- Potential EJ Areas
- Major Roads

Facilities per sq. mile (10th percentiles)

- 0.00
- 0.01 – 4.34
- 4.35 – 4.34
- 7.47 – 10.55
- 10.56 – 12.79
- 12.80 – 14.96
- 14.97 – 15.92
- 15.93 – 18.27
- 18.28 – 25.13
- 25.14 – 106.43

MILES
0 0.5 1 1.5 2
Scale: 1:80,000

Source: DEC, Office of Environmental Justice. 2012

Figure 22 | Queens County Map of PEJAs and Density of Facilities, including Title V Emission Sources

This computer representation has been compiled from supplied data or information that has not been verified by NYSDEC. The data are offered here as a general representation only and are not to be used for commercial purposes without verification by an independent professional qualified to verify such data or information.

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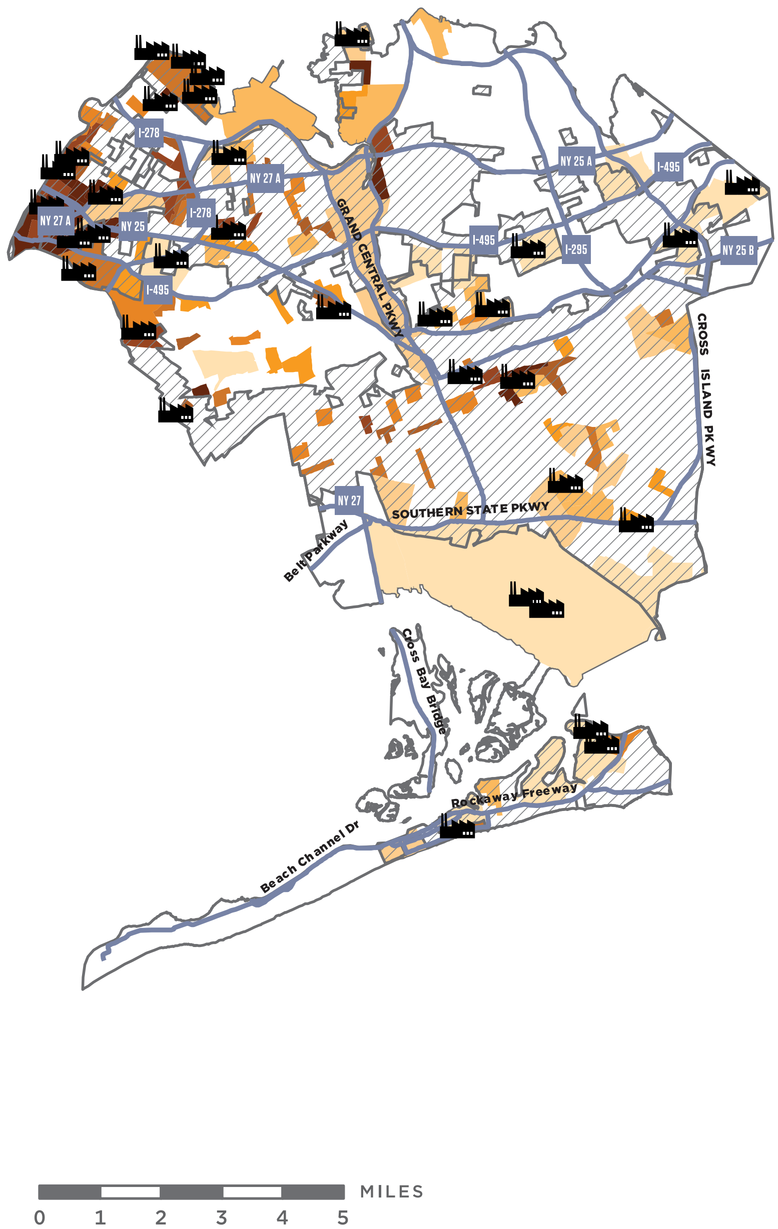

Legend

Title V Facility
Potential EJ Areas
Major Roads

Facilities per sq. mile (10th percentiles)

0.00
0.01 – 3.41
3.41 – 4.87
4.88 – 7.72
7.73 – 11.62
11.63 – 13.16
13.17 – 15.47
15.47 – 17.70
17.71 – 25.68
25.68 – 62.69

Source: DEC, Office of Environmental Justice. 2012

Figure 23 | Erie County Map of PEJAs and Density of Facilities, including Title V Emission Sources

This computer representation has been compiled from supplied data or information that has not been verified by NYSDEC. The data are offered here as a general representation only and are not to be used for commercial purposes without verification by an independent professional qualified to verify such data or information.

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Data Source for Potential Environmental Justice Areas:
U.S. Census Bureau, 2000 U.S. Census

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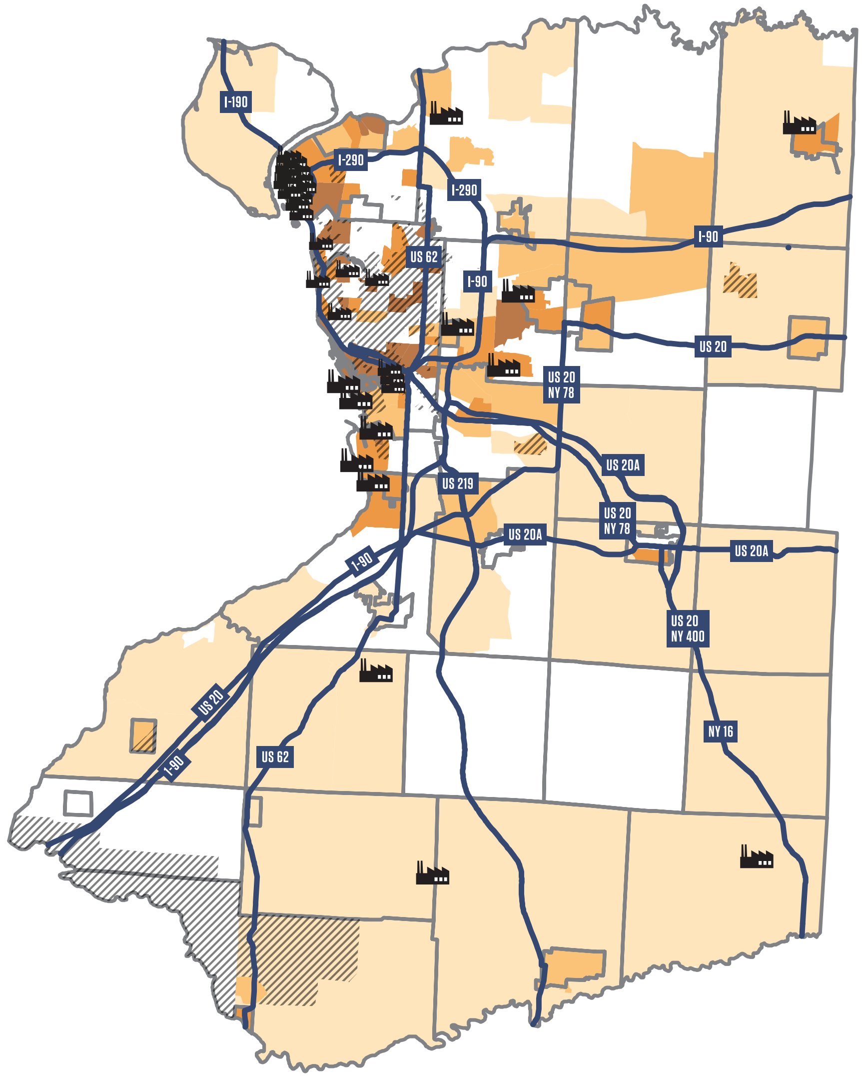


Legend

- Title V Facility
- Potential EJ Areas
- Major Roads

Facilities per sq. mile (5th percentiles)

- 0.00
- 0.01 – 0.49
- 0.50 – 1.74
- 1.75 – 3.54
- 3.55 – 13.94

MILES
0 2 4 6 8 10

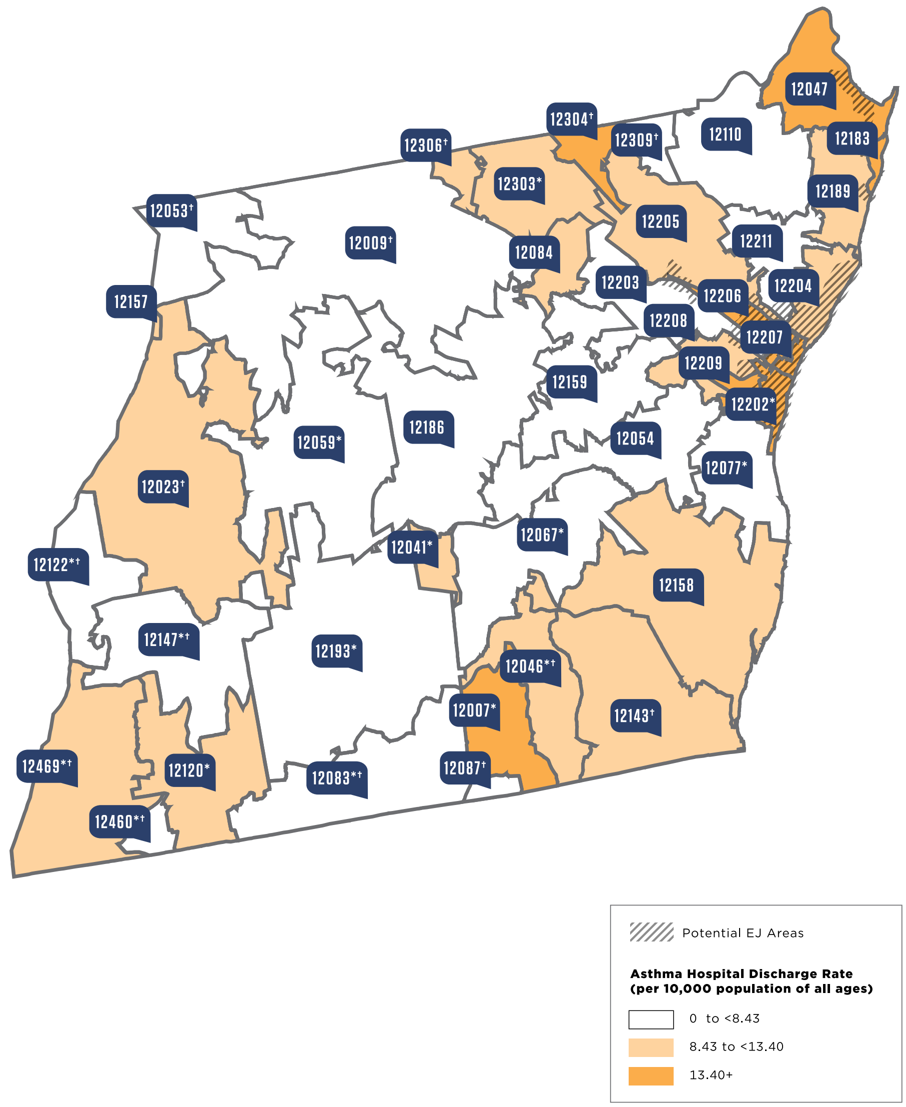
Scale: 1:400,000

Source: DEC, Office of Environmental Justice. 2012

Appendix 6 | Maps of Asthma Discharge Rates

Maps of asthma hospital discharge rates by ZIP code and PEJAs are shown for Albany, Bronx, Chautauqua, Erie, and Queens Counties as examples of depicting PEJAs in relation to other factors. The five counties selected differ in land use. The Bronx and Queens counties are very urban; Albany and Erie counties are a mixture of urban, suburban, and rural areas; and Chautauqua County incorporates one small city but is otherwise predominately rural. There does not appear to be a consistent pattern between asthma hospitalization rates by ZIP code and PEJAs in this set of maps. In some cases, there is considerable overlap between PEJAs and areas with the highest asthma hospitalization rates, and in other cases there is not. Additional GIS (geographic information system) investigations are examining PEJAs and exploring relationships among factors such as facilities density, air pollution, traffic, housing quality, disease burden, and access to medical care.

Figure 24 | Albany County Asthma Hospital Discharge Rate by ZIP Code, Three-Year Average (2007 to 2009)

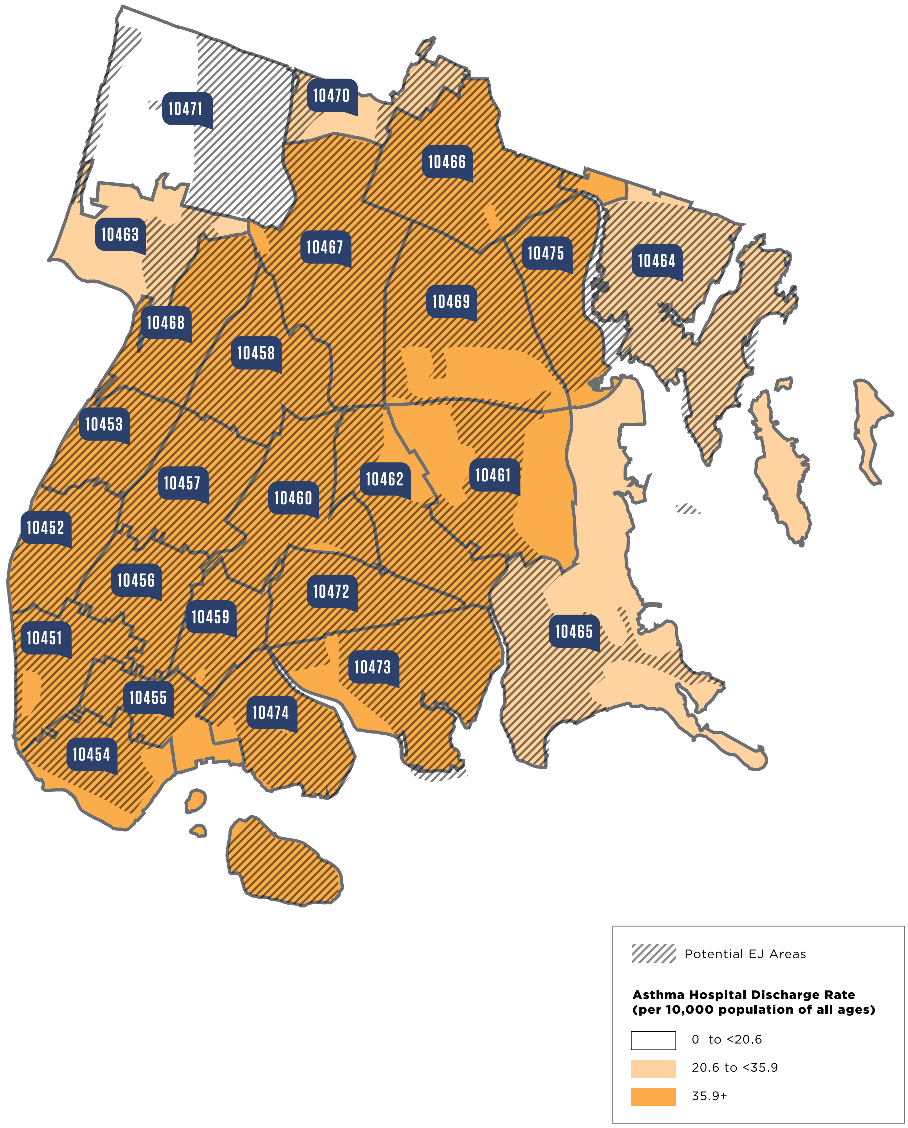


Note: *Indicates ZIP Code asthma hospital discharge rate based on less than or equal to 10 hospital discharges, therefore the rate may not be stable (Relative Standard Error or RSE > 30%). †This ZIP Code crosses county boundaries. The rate is for the entire ZIP Code, not just the portion in this county.

Sources: DOH. *Asthma Hospital Discharge ZIP Code Level Data for Counties*. 2009. http://www.health.ny.gov/statistics/ny_asthma/hosp/zipcode/map.htm.

DEC. *Potential Environmental Justice Areas*. 2005. http://www.dec.ny.gov/docs/permits_ej_operations_pdf/albanyej.pdf

Figure 25 | Bronx County Asthma Hospital Discharge Rate by ZIP Code, Three-Year Average (2007 to 2009)

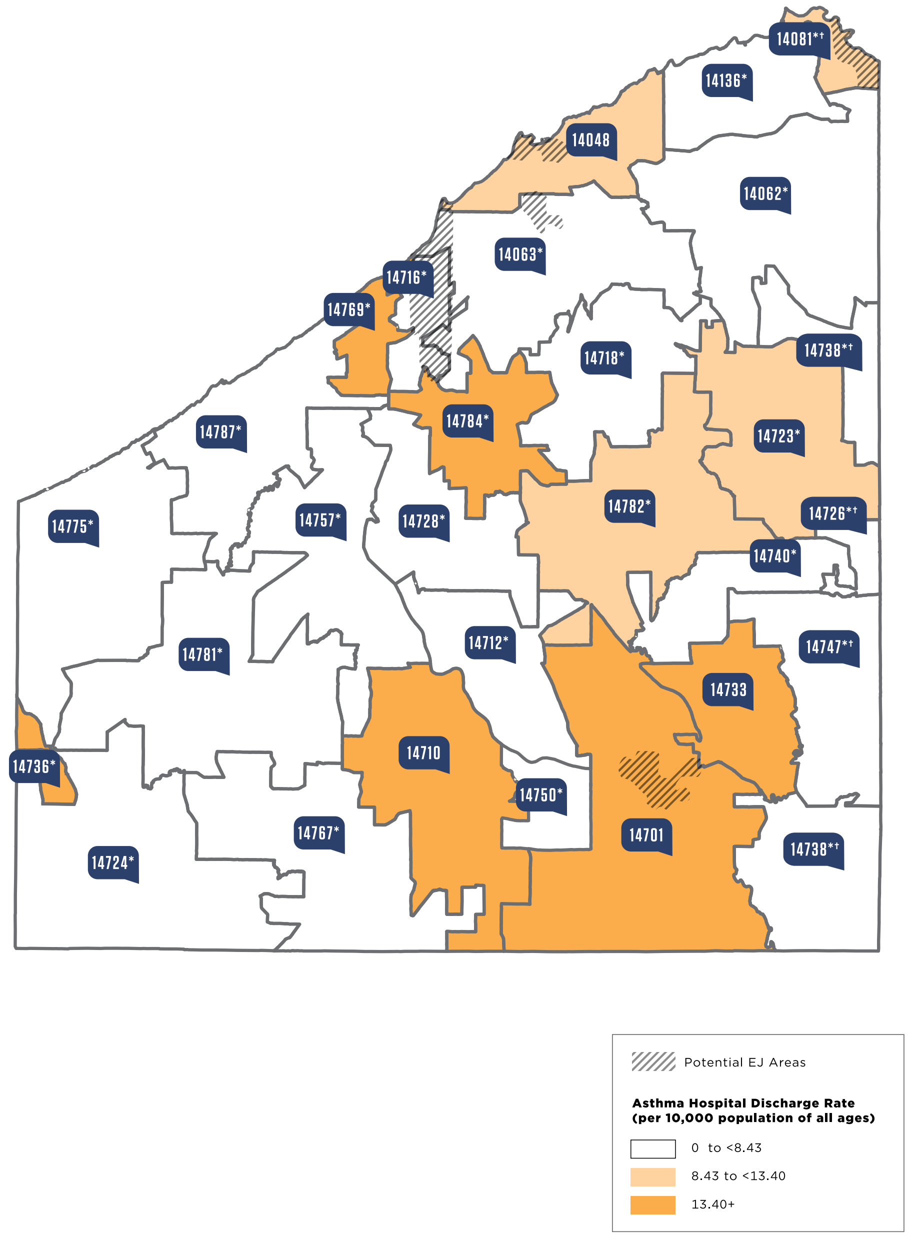


Note: *Indicates ZIP Code asthma hospital discharge rate based on less than or equal to 10 hospital discharges, therefore the rate may not be stable (Relative Standard Error or RSE > 30%). †This ZIP Code crosses county boundaries. The rate is for the entire ZIP Code, not just the portion in this county.

Sources: DOH. *Asthma Hospital Discharge ZIP Code Level Data for Counties*. 2009. http://www.health.ny.gov/statistics/ny_asthma/hosp/zipcode/map.htm.

DEC. *Potential Environmental Justice Areas*. 2005. http://www.dec.ny.gov/docs/permits_ej_operations_pdf/bronxejdetail.pdf

Figure 26 | Chautauqua County Asthma Hospital Discharge Rate by ZIP Code, Three-Year Average (2007 to 2009)

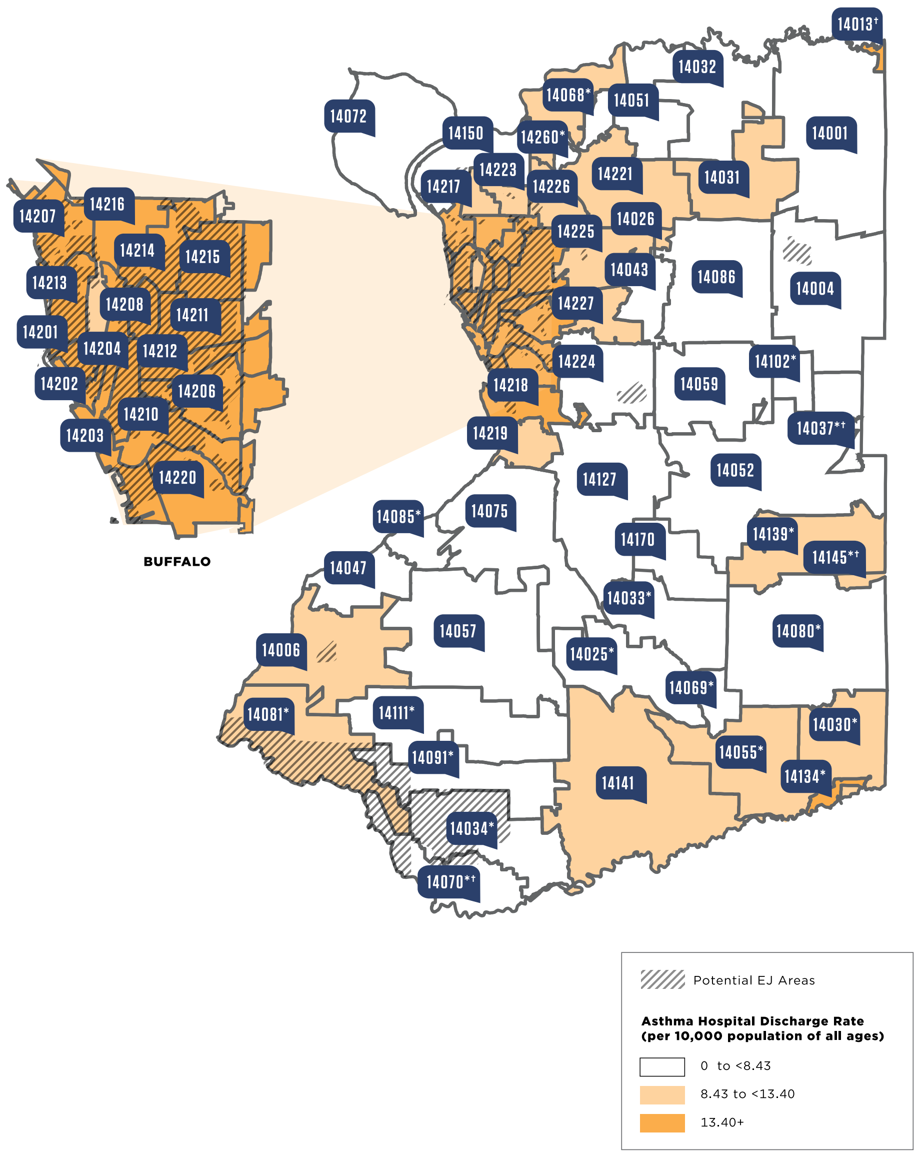


Note: *Indicates ZIP Code asthma hospital discharge rate based on less than or equal to 10 hospital discharges, therefore the rate may not be stable (Relative Standard Error or RSE > 30%). †This ZIP Code crosses county boundaries. The rate is for the entire ZIP Code, not just the portion in this county.

Sources: DOH. *Asthma Hospital Discharge ZIP Code Level Data for Counties.* 2009. http://www.health.ny.gov/statistics/ny_asthma/hosp/zipcode/map.htm

DEC. P*otential Environmental Justice Areas.* 2005. http://www.dec.ny.gov/docs/permits_ej_operations_pdf/chautauquaej.pdf

Figure 27 | Erie County Asthma Hospital Discharge Rate by ZIP Code, Three-Year Average (2007 to 2009)

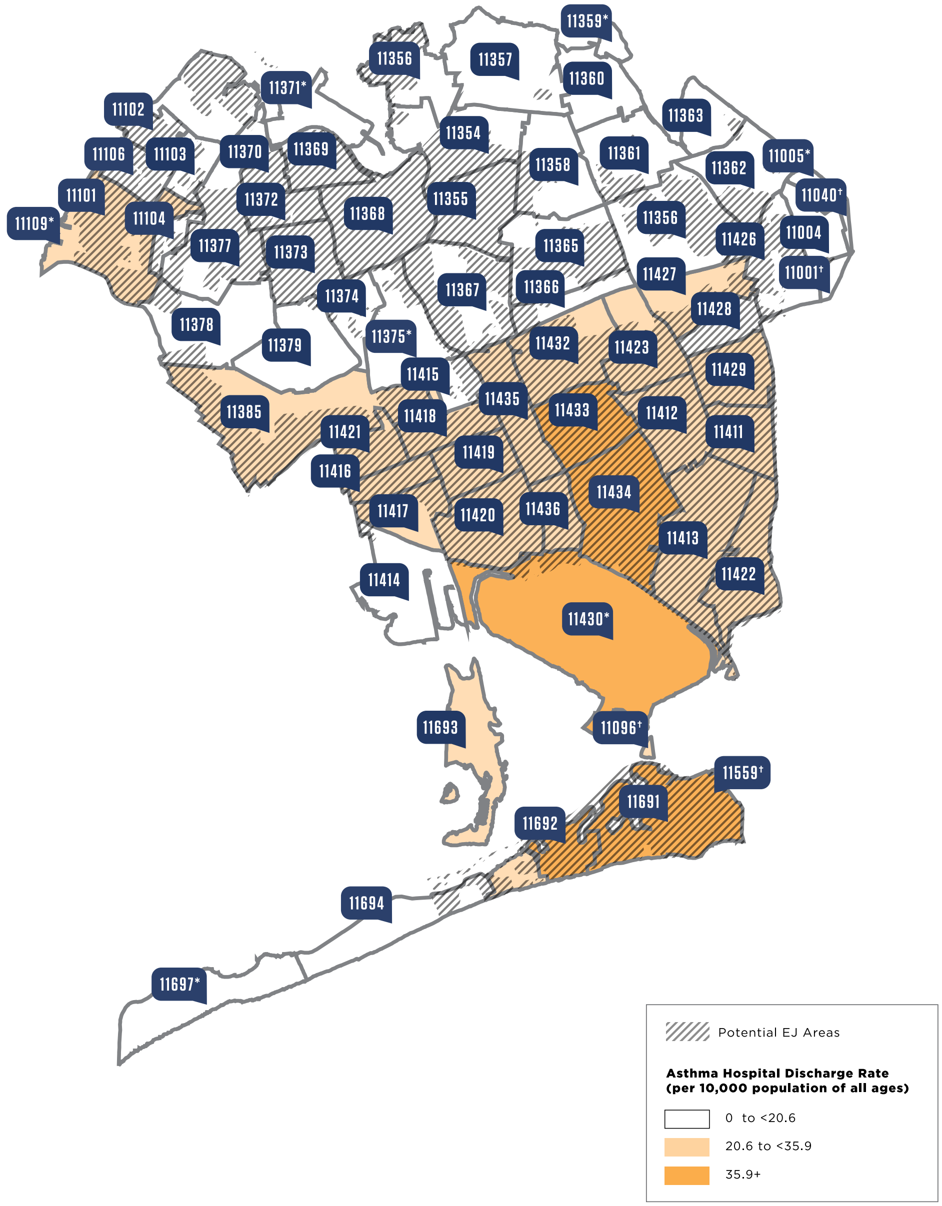


Note: *Indicates ZIP Code asthma hospital discharge rate based on less than or equal to 10 hospital discharges, therefore the rate may not be stable (Relative Standard Error or RSE > 30%). †This ZIP Code crosses county boundaries. The rate is for the entire ZIP Code, not just the portion in this county.

Sources: DOH. *Asthma Hospital Discharge ZIP Code Level Data for Counties*. 2009. http://www.health.ny.gov/statistics/ny_asthma/hosp/zipcode/map.htm

DEC. *Potential Environmental Justice Areas*. 2005. http://www.dec.ny.gov/docs/permits_ej_operations_pdf/erieejdetail.pdf

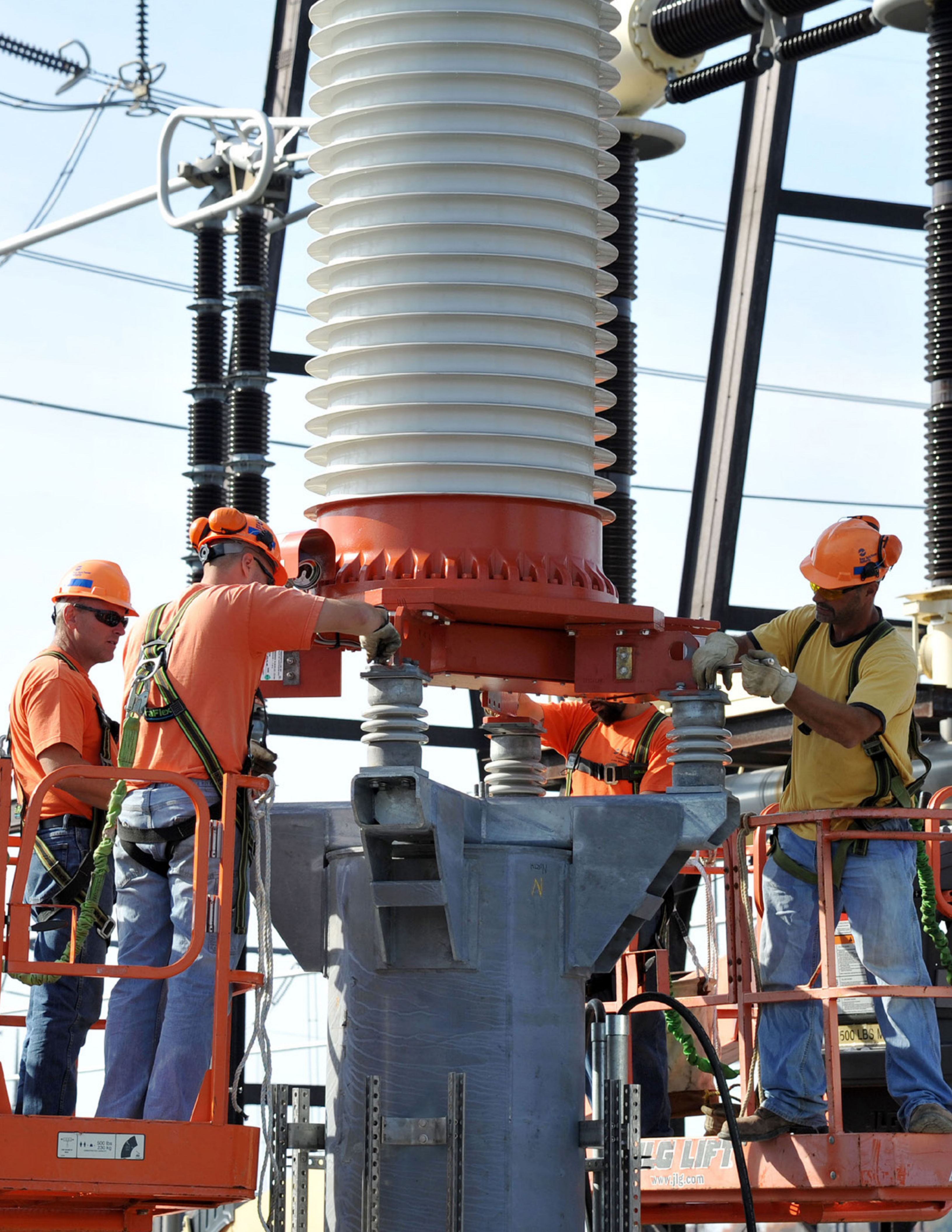
Figure 28 | Queens County Asthma Hospital Discharge Rate by ZIP Code, Three-Year Average (2007 to 2009)



Note: *Indicates ZIP Code asthma hospital discharge rate based on less than or equal to 10 hospital discharges, therefore the rate may not be stable (Relative Standard Error or RSE > 30%). †This ZIP Code crosses county boundaries. The rate is for the entire ZIP Code, not just the portion in this county.

Sources: DOH. *Asthma Hospital Discharge ZIP Code Level Data for Counties*. 2009. http://www.health.ny.gov/statistics/ny_asthma/hosp/zipcode/map.htm

DEC. *Potential Environmental Justice Areas*. 2005. http://www.dec.ny.gov/docs/permits_ej_operations_pdf/queensej.pdf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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

CO_2
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

SO_2
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 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."

I

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 petro-chemical 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 is 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 NYSERDA.

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

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New York's Brooklyn Bridge at dusk.
Photographer: Tetra Images (Getty Images)

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