New York

Confronting Climate Change in the U.S. Northeast

From thundering Niagara Falls to bustling Manhattan, the climate of New York is changing. Records show that spring is arriving earlier, summers are growing hotter, and winters are becoming warmer and less snowy. These changes are consistent with global warming, an increasingly urgent phenomenon driven by heat-trapping emissions from human activities.

New state-of-the-art research shows that if global warming emissions continue to grow unabated, New York can expect dramatic changes in climate over the course of this century, with substantial impacts on the state's economy and character. If the rate of emissions is lowered, however, projections show that many of the changes will be far less dramatic. Emissions choices we make today—in New York, the Northeast, and worldwide—will help determine the climate our children and grandchildren inherit, and shape the consequences for their economy, environment, and quality of life.

The research summarized here describes how climate change may affect New York and other Northeast states under two different emissions scenarios. The higher-emissions scenario assumes continued heavy reliance on fossil fuels, causing heat-trapping emissions to rise rapidly over the course of the century. The lower-emissions scenario assumes a shift away from fossil fuels in favor of clean energy technologies, causing emissions to decline by mid-century.

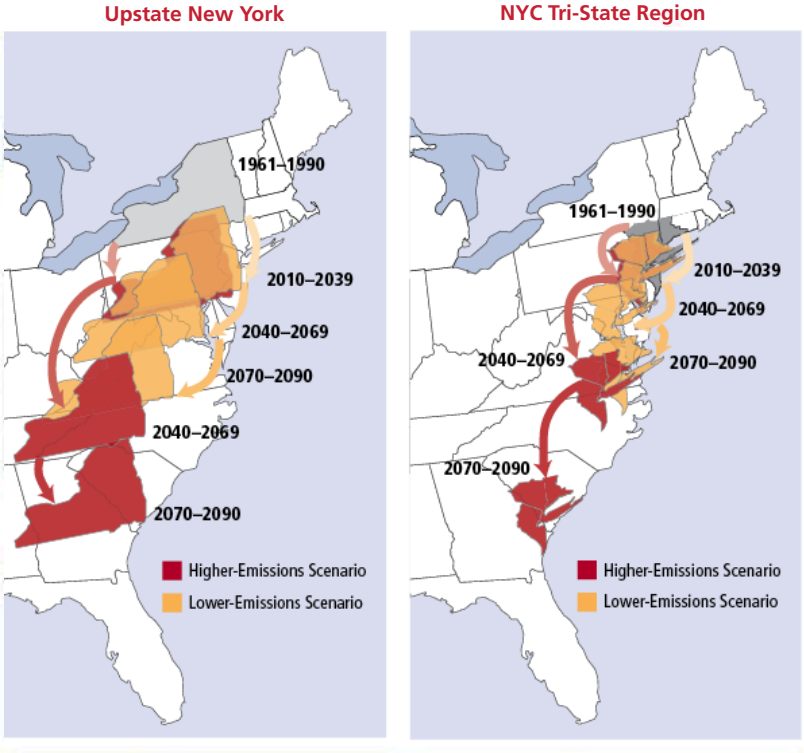
The research also explores actions that individual households, businesses, and governments in the Northeast can take today to reduce emissions to levels consistent with staying *below* the lower-emissions scenario and adapt to the unavoidable changes that past emissions have already set in motion.

NEW YORK'S CHANGING CLIMATE

Temperature. Average temperatures across the Northeast have risen more than 1.5 degrees Fahrenheit (°F) since 1970, with winters warming most rapidly—4°F between 1970 and 2000. If higher emissions prevail, seasonal average temperatures across the state are projected to rise 8°F to 12°F above historic levels in winter

Migrating State Climates

Changes in average summer heat index—a measure of how hot it actually feels, given temperature and humidity—could strongly affect quality of life in the future for residents of New York. Red arrows track what summers could feel like in the Upstate and Tri-State (the greater NYC metropolitan region, encompassing parts of New Jersey and Connecticut) regions over the course of the century under the higher-emissions scenario. Yellow arrows track what summers in these regions could feel like under the lower-emissions scenario.



Photos: (from top) iStockphoto.com/Timothy Babasade; NYS Department of Environmental Conservation, Division of Water; PPM Energy; Aaron Ogle; NYS Department of Environmental Conservation

and 6°F to 14°F in summer by late-century, while lower emissions would cause roughly half this warming. Under the higher-emissions scenario New York's cities can expect a dramatic increase in the number of days over both 90°F and 100°F (see the figure below and the section on health impacts).

Precipitation and winter snow. The Northeast region is projected to see an increase in winter precipitation on the order of 20 to 30 percent. Slightly greater increases are projected under the higher-emissions scenario, which would also feature less winter precipitation falling as snow and more as rain.

Snow is an iconic characteristic of New York winters and an integral part of many favorite winter activities and traditions. But rising temperatures over the past few decades have caused snow to become wetter (or more "slushy"), and decreased the average number of snow-covered days across the state. If higher emissions prevail, the typically snowy Adirondack region would see its snow season cut roughly in half this century. Under the lower-emissions scenario the Adirondack region would retain roughly three-quarters of its snow season (or two to three weeks of snow cover per winter month).

Heavy, damaging rainfall events have increased measurably across the Northeast in recent decades. Intense spring rains struck the region in both 2006 and 2007, for example, causing widespread flooding. The frequency and severity of heavy rainfall events is expected to rise further under either emissions scenario.

Drought. In this historically water-rich state, rising summer temperatures coupled with little change in summer rainfall are projected to increase the frequency of short-term (one- to three-month) droughts. In the Adirondack and Catskill regions these droughts are projected to occur annually by late-century under the higher-emissions scenario (compared with once every two to three years historically) with little change under the lower-emissions scenario. These changes would increase stress on both natural and managed ecosystems across the state.

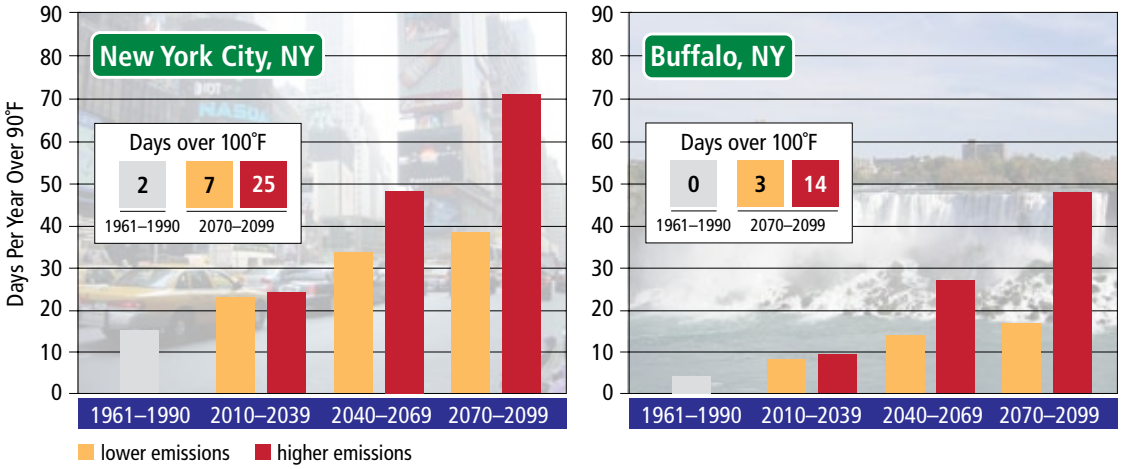
Sea-level rise. Global warming affects sea levels by causing ocean water to expand as it warms, and by melting land-based ice. With higher emissions, global sea level is projected to rise between 10 inches and two feet by the end of this century (7 to 14 inches under the lower-emissions scenario). These projections do not account for the recent observed melting of the world's major ice sheets—nor the potential for accelerated melting—and may therefore be conservative. However, even under these projections, New York's densely populated coast faces substantial increases in the extent and frequency of coastal flooding, erosion, and property damage.

IMPACTS ON COASTAL COMMUNITIES

Millions of people living along the New York coastline make this the most populated coastal area in the United States, with more than $1.9 trillion in insured coastal property. From critical infrastructure in lower Manhattan to waterfront homes on Long Island, much of this coastline is exceptionally vulnerable to sea-level rise and related impacts including severe coastal flooding, erosion, and loss of wetlands. Indeed, some major insurers have withdrawn coverage from thousands of homeowners in coastal areas of the Northeast, including New York City (NYC).

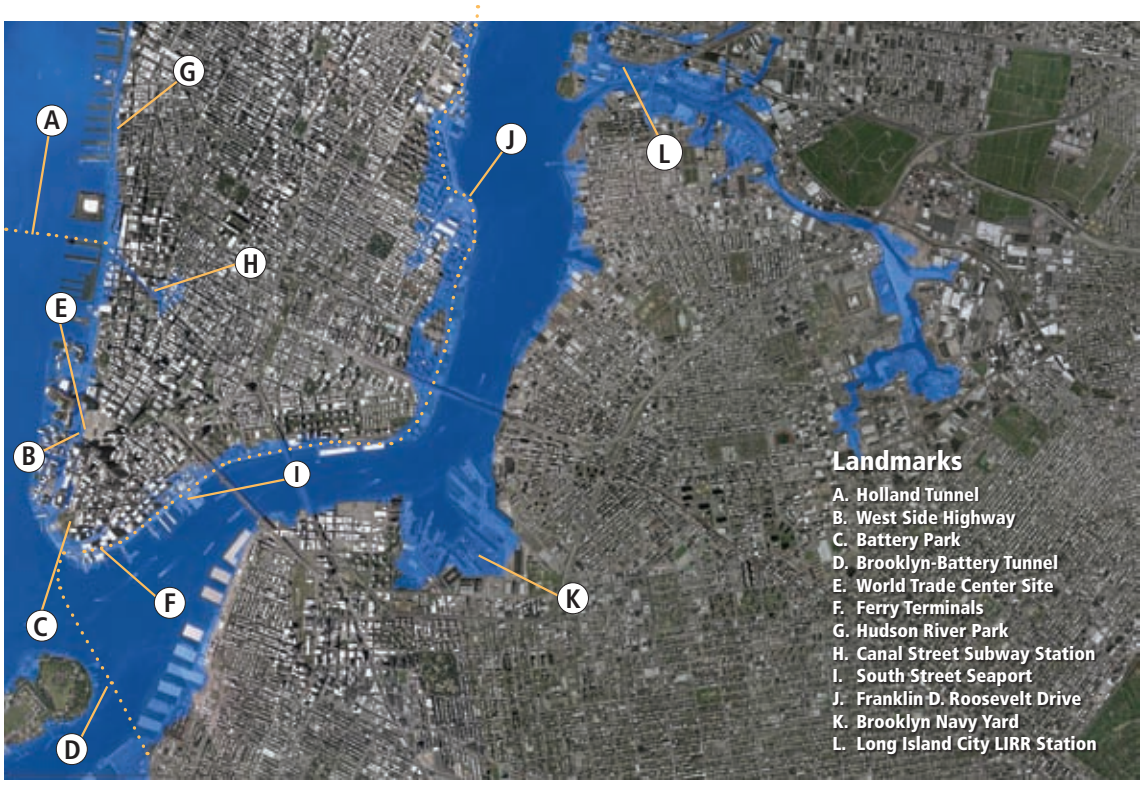
Coastal flooding. Rising sea levels caused by global warming are projected to increase the frequency and severity of damaging storm surges and flooding. Under the higher-emissions scenario what is now considered a once-in-a-century coastal flood in New York City is projected to occur at least twice as often by mid-century, and 10 times as often—once per decade on average—by late-century. With lower emissions, today's 100-year flood is projected to occur once every 22 years on average by late-century.

Shoreline change. Sea-level rise is expected to permanently inundate certain low-lying coastal areas and dramatically accelerate erosion—already a severe problem along New York's heavily



Extreme Heat in Our Cities

The number of days over 90°F in large northeastern cities is projected to increase in the coming decades until, by late-century, New York City could experience over 70 such days and Buffalo nearly 50 such days under the higher-emissions scenario. Projections under this scenario also show a dramatic increase in the currently small number of days over 100°F (as depicted in the inset boxes).



Credit: Applied Science Associates, Inc. Source: Google/Sanborn

NYC: Today's 100-Year Flood Could Occur Every 10 Years under the Higher-Emissions Scenario

The light blue area in these maps depicts today's 100-year flood zone for New York City (i.e., the area of the city that is expected to be flooded once every 100 years). With additional sea-level rise by 2100 under the higher-emissions scenario, this approximate area is projected to have a 10 percent chance of flooding in any given year; under the lower-emissions scenario, a 5 percent chance. As the close-up shows, critical transportation infrastructure located in the Battery could be flooded far more frequently unless protected. The 100-year flood at the end of the century (not mapped here) is projected to inundate a far larger area of New York City, especially under the higher-emissions scenario.

developed shore. Continued sea-level rise will further threaten coastal homes and businesses, as well as the ecologically important salt marshes and estuaries of Long Island (which serve as critical feeding grounds for migrating waterfowl and other birds, and nursery habitat for important commercial fish).

New York's policy makers will need to take steps to protect the state's vulnerable populations and infrastructure, as well as wildlife and critical coastal wetlands. This includes public education, updating and enforcing building codes and land-use regulations, and working with the insurance industry to effectively protect property and people.

James Estrin/The New York Times/Redux

Poor air quality puts large numbers of people in the region at risk from respiratory ailments such as asthma, chronic bronchitis, and emphysema. Today, one in four children in Harlem suffers from asthma. On days with poor air quality, which could increase due to global warming, both children and adults are more likely to have difficulty breathing, and people with asthma may require a visit to the emergency room, where this Harlem mother and her child find themselves.

IMPACTS ON HUMAN HEALTH

Heat was the United States' leading weather-related killer in 6 of 10 recent years (between 1993 and 2003). More intense summer heat waves and deteriorating air quality projected this century could increase the risks of many health problems.

Extreme heat. While New Yorkers are accustomed to the occasional summer heat wave, the number of very hot days is expected to increase significantly, particularly under the higher-emissions scenario. This will be especially problematic in cities, where the urban heat-island effect can amplify temperatures. By late-century, for example, New York City could experience roughly 25 days over 100°F under the higher-emissions scenario, but only seven such days under the lower-emissions scenario. With higher emissions, Buffalo, which has no 100°F days on record, is projected to face 14 such days every year by late-century (see the figure on page 2).

Very hot days are not only unpleasant but also dangerous, as NYC experienced in the summer of 2006 when 46 people, most of them elderly, died from heat stroke. As extreme heat becomes more commonplace the risk of heat stress, heart attack, and death increases. Cities across the state will need to prepare for an increase in dangerously hot conditions by taking steps (e.g., better insulation, establishing warning systems and cooling centers) that will lessen the impact of extreme heat on vulnerable populations.

Air quality. Air pollution from ground-level ozone and other components of smog is a serious concern across much of New York. In 2006 the New York-Newark-Bridgeport region was ranked the ninth most ozone-polluted metropolitan region in the country according to U.S. Environmental Protection Agency (EPA) standards; Buffalo-Niagara ranked twenty-fifth.

Global warming is expected to worsen air quality in the region, putting more stress on people with cardiovascular and respiratory diseases (e.g., asthma currently afflicts one in four children living in Central Harlem). In the absence of more stringent controls on ozone-forming pollutants, the number of days with poor air quality is projected to quadruple in Buffalo and New York City by late-century under the higher-emissions scenario. Under the lower-emissions scenario such days could increase by half.

Higher temperatures and increasing levels of carbon dioxide (CO_2) in the air are also expected to accelerate seasonal pollen production in plants within the next several decades under the higher-emissions scenario. This could extend the allergy season, increase asthma risks, and exacerbate symptoms for both urban and rural New Yorkers.

Vector-borne disease. Mosquitoes and ticks carry West Nile virus (WNV) and Lyme disease-causing bacteria, respectively, and spread them to animals or people. Factors affecting the spread of such vector-borne diseases are complex; however, projections for the Northeast of warmer winters, hotter summers, and more frequent summer dry periods punctuated by heavy rainstorms are the same conditions that can set the stage for more frequent WNV outbreaks.

IMPACTS ON FISHERIES

Rising ocean temperatures will affect New York's commercial and sport fisheries. For example, lobsters, which cannot tolerate warm water, already live at the southern edge of their preferred temperature range in Long Island Sound. As temperatures rise, the Long Island Sound lobster fishery (which has yet to recover from the massive temperature-driven die-off of 1999) is likely to be lost by mid-century under either emissions scenario.

IMPACTS ON AGRICULTURE

Beyond the lights of Times Square, New York's vast rural areas retain their pastoral appeal. Nearly 36,000 farms cover about 25 percent of the state's land area, and generated more than $3.6 billion in 2005. Global warming will present new opportunities and challenges to New York's growers and producers; for example, increases in the frequency of short-term drought (see page 2) could necessitate increased irrigation and operational costs.

Dairy. A familiar sight along New York byways is that of Holsteins grazing in rolling green meadows. The state's dairy herds produce about 1.4 billion gallons of milk and more than $1.9 billion in revenue annually, making New York the nation's third-largest dairy producer.

Hot conditions produce heat stress in dairy cows, which depresses milk production. In 2005 the state's dairy industry lost more than $24 million due to heat stress. Under the higher-emissions scenario parts of New York are

Adirondack Mountain Club

The Adirondacks under Threat

Around 9 million tourists flock to New York's Adirondack State Park each year to admire the scenery, hike, kayak, fish, ski, and snowshoe. It is also home to a wealth of wildlife, making it one of the nation's top destinations for bird-watching. Many area residents are thus employed by the tourism and retail sectors, and another 10,000 are employed by wood- and paper-product companies. Global warming will exacerbate both environmental and economic pressures on the park, threatening the very survival of some of its unique ecosystems—particularly the spruce/fir forests and alpine tundra found in its most heavily used recreational areas.

Under the higher-emissions scenario climate conditions suitable for spruce/fir forests are projected to all but disappear from the Northeast by the end of the century. Even under the lower-emissions scenario suitable conditions for spruce and fir could decrease dramatically. Wildlife species that depend on this habitat (e.g., Canada lynx, snowshoe hare, Bicknell's thrush) would decline in abundance. The climate of the Adirondacks is projected to remain suitable for maple/beech/birch forests under either emissions scenario.

Even more threatened than the Adirondacks' spruce/fir forests is its treeless alpine tundra, found in the High Peaks wilderness. Global warming is projected to further diminish—and perhaps eliminate—this highly prized and already stressed ecosystem.

Anglers will also notice changes, as warmer winters with reduced ice and snow cover not only offer less protection for native fish from harsh weather but also generate earlier peak stream flows in spring, which can harm young native brook trout. Rising summer temperatures could deprive these trout of important coldwater refuges in Adirondack lakes and streams.

Change in the Adirondacks is likely to be particularly pronounced under the higher-emissions scenario. For the region's local economies, where between 4 and 14 percent of the population is employed in the climate-sensitive forestry, fishing, and agriculture sectors, and where winter recreation is a lucrative attraction, this change could represent a serious challenge.

iStockphoto.com/Chet Mitchell

An extended growing season will tend to benefit those farmers attempting to grow high-value crops that require long, warm summers, such as watermelons, tomatoes, peaches, and certain wine grapes. However, as the region warms, all crops will face increasing summer heat stress, drought, and pressure from weeds and pests.

projected to reach temperatures by late-century that would reduce milk production up to 15 percent during key summer months—a substantial loss for an industry with an already small profit margin. Adaptive measures such as air conditioning may curb some of these potential losses (provided the costs are within farmers' reach).

Crops. The Empire State's fruit and vegetable crops bring in approximately $500 million annually, and New York generally ranks among the top three states for production of apples, grapes, sweet corn, and cabbage. If higher emissions prevail, increasing summer temperatures and heat stress are expected to depress the yields of a number of these economically important crops by mid-century, while rising winter temperatures are expected to drive the continued northward expansion of agricultural pests and weeds (such as kudzu). This would further impede crop production and potentially pressure farmers to increase their herbicide and pesticide use.

Growers of European wine grapes may benefit from warmer temperatures, but the native Concord grape requires a substantial period each winter below a certain temperature in order to produce fruit. Under the higher-emissions scenario this chilling requirement is unlikely to be met across much of New York by mid-century.

IMPACTS ON FORESTS

Forests define the Empire State as much as its urban skyline, covering more than 60 percent of its total land area. These critical ecosystems provide recreational opportunities and important plant and wildlife habitat, and can help offset the region's heat-trapping emissions by capturing and storing carbon.

As temperatures climb, the character of these forests is expected to change, particularly under the higher-emissions scenario and in the Adirondacks' spruce/fir forests. Only under the lower-emissions scenario are climate conditions suitable for these forests projected to endure into the next century.

New York's hemlock trees, which protect native brook trout and other fish by shading streams, face a double-edged threat from global warming. If higher emissions prevail, suitable habitat for hemlock is projected to shrink as much as 50 percent by the end of the century, compared with a roughly 25 percent decline under the lower-emissions scenario. Winter warming also expands the northward march of the hemlock woolly adelgid, an invasive insect that has already destroyed hemlock stands from Georgia to Connecticut and is now established in southern New York. Under either emissions scenario New York's hemlock stands are projected to be vulnerable to adelgid infestation.

IMPACTS ON WINTER RECREATION

With more than 50 ski areas, thousands of miles of snowmobile and snowshoeing trails, and hundreds of frozen lakes,

Geoff Kuchera

From skiing and snowboarding to snowmobiling, ice fishing, and sledding, many residents of New York embrace winter recreation. But the state's winters are warming. Over the course of this century more winter precipitation is projected to fall as rain, and snow and lake ice are expected to melt more quickly, reducing opportunities for popular winter activities.

New Yorkers have many winter recreation opportunities. Winter recreation and tourism in this state—twice host to the Winter Olympics—will be profoundly affected by global warming as temperatures continue to rise and snowfall declines, especially under the higher-emissions scenario.

Skiing. New York has more ski areas than any other state in the nation. Combined, they host an average of 4 million visitors each year, contributing $1 billion to the state's economy and employing 10,000 people.

Warmer winters are projected to shorten the average ski season, increase snowmaking requirements, and drive up operating costs, hurting an industry that has already contracted in recent years. Ski areas in western and southeastern New York are projected to be at risk of losing viable ski seasons over the next several decades, even under the lower-emissions scenario.

Even if New York's ski operations increase their snowmaking capacity as temperatures rise, they may no longer be viable by late-century if higher emissions prevail. New Yorkers will instead be forced to travel to western Maine or Canada. Under the lower-emissions scenario, however, ski resorts in the state's North Country would remain viable.

Snowmobiling. New York is part of a six-state network of snowmobile trails that totals 40,500 miles and contributes $3 billion a year to the regional economy. Projected losses in natural snow cover and the impracticality of snowmaking on this vast system mean a much shorter snowmobiling season throughout the region. Under the higher-emissions scenario the average season length across New York is projected to shrink to 10 days by late-century—a roughly 80 percent decline below recent levels—and to 24 days under the lower-emissions scenario (a 50 percent decline).

Yahoo/REUTERS/Ray Stubblebine

New York City Mayor Michael Bloomberg recently announced that by 2012, all of the approximately 13,000 taxis in the New York City fleet must be a hybrid-powered vehicle that gets at least 30 miles per gallon.

WHAT WE CAN DO

From the early explorers of the Hudson River Valley to the nation's most recent immigrants, New York has long been a symbol of opportunity. By reducing emissions today, we have an opportunity to help protect our children and grandchildren from the most severe consequences of global warming. At the same time, effective adaptation strategies are needed to help reduce the vulnerability of New York's residents, ecosystems, and economy to those changes that are now unavoidable.

Here, and across the world, there is growing momentum to meet the climate challenge. New York, for example, led the Northeast states in establishing the Regional Greenhouse Gas Initiative (RGGI)—the first multi-state, market-based plan to reduce emissions from power plants—and continues to work toward strong, precedent-setting climate and energy policies.

Of course our actions alone will not be sufficient to avoid dangerous climate change. But as a global leader in technology, finance, and innovation and a major source of heat-trapping emissions, New York (and the rest of the Northeast) is well positioned to drive national and international progress. Concerted, sustained efforts to reduce emissions in the region—on the order of 80 percent below 2000 levels by mid-century and just over 3 percent per year on average over the next several decades—can help pull global emissions below the lower-emissions scenario described here.

State and local governments have a rich array of strategies and policies at their disposal to meet the climate challenge in partnership with other states, businesses, civic institutions, and the public. These strategies and policies can reduce emissions in the following sectors:

Electric power. Thirty percent of New York's electric power comes from an aging class of inefficient coal- and oil-burning power plants. These plants can be steadily replaced under the pressure of new market-based policies (such as RGGI) that attach a price to carbon emissions, making cleaner technologies more financially attractive, and through power-market reforms and state policies that place energy efficiency on

an equal footing with new power supply. Progress toward the state's renewable electricity standard could be accelerated by improving the siting process for renewable energy facilities. Revenues from the sale of emissions permits under RGGI could substantially increase investment in energy efficiency and clean energy.

Buildings. New York's relatively old stock of residential, commercial, and industrial buildings offers substantial opportunities to reduce emissions associated with water and space heating. New York City, for example, under its plaNYC Sustainability Initiative, is aiming to cut energy use in city buildings 30 percent over the next decade. The state can continue to update and strengthen enforcement of its building energy codes to significantly reduce emissions and lower energy costs, and local governments can amend zoning laws to require that builders meet the U.S. Green Building Council's LEED certification and/or the EPA's Energy Star Building designation.

Transportation. Cars and trucks account for 34 percent of total carbon emissions in the Empire State. New York has adopted California's tailpipe emissions standards, which require reductions of approximately 30 percent below 2002 levels by 2016, beginning with the 2009 model year (implementation is contingent upon a ruling expected from the EPA). State and local governments can further reduce vehicle emissions through sustained investment in public transportation, incentives to purchase low-emissions vehicles, and incentives and regulations that promote "smart growth" strategies such as concentrating development in clusters.

Industries and large institutions can reduce emissions while lowering energy costs by improving the energy efficiency of their buildings and facilities, and by installing combined-heat-and-power systems and on-site renewable energy systems.

Forestry and agriculture policies in New York can be designed to promote management practices and systems that cost-effectively reduce emissions. Such practices include increased carbon capture in soils, more efficient use of nitrogen fertilizers, reduced on-farm use of fossil fuels, and expanded use of wind and bioenergy—provided the latter is produced in a sustainable manner. Capturing and using methane to power farm operations is one successful strategy already under way on many farms.

CONCLUSION

Global warming represents an enormous challenge, but we can meet this challenge if we act swiftly. The emissions choices we make today in New York, the Northeast, and globally will shape the climate our children and grandchildren inherit. The time to act is now.

PPM Energy

The 320 MW Maple Ridge wind farm (pictured), which generates enough electricity to serve up to 160,000 average homes, makes New York by far the leader among Northeast states for installed wind generation, and much more is in the development "pipeline." The Noble Clinton Windpark, under construction as of mid-2007 in Clinton County, will have 67 turbines, adding just over 100 MW.

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This summary was prepared by the Union of Concerned Scientists based on *Confronting Climate Change in the U.S. Northeast: Science, Impacts, and Solutions*, a report of the Northeast Climate Impacts Assessment (NECIA, 2007). NECIA is a collaborative effort between the Union of Concerned Scientists and a team of independent scientific experts to assess how global warming may further affect the climate of the U.S. Northeast and to explore options for meeting the climate challenge.

For more information on our changing Northeast climate and what you can do, or to download a copy of the full report and additional state summaries, visit *www.climatechoices.org*.