Chapter 4
Envisioning a Low-Carbon Future – 2050

This chapter describes the visioning process employed by the Climate Action Council as one of the foundational components for New York's Climate Action Plan. *Envisioning a Low-Carbon 2050 for New York State,* a white paper prepared by Brookhaven National Laboratory, details much of the Climate Action Plan visioning work and is included as Appendix F of this report.

New York State Demographic Trends

Future economic activity and population growth in New York State are important factors in estimating the greenhouse gas emission reductions necessary to meet the 80 by 50 goal. Current projections suggest that New York's population and housing stock will continue growing through 2030, although the rate of growth will slow slightly compared to current trends. Economic activity, as measured by the gross state product, and vehicle miles traveled (VMT) are expected to continue their recent growth rates over the same period.

Population: The state population is expected to increase by approximately 800,000, or 4%, from 19.6 million to 20.4 million people over the next 20 years, but this statewide projection masks two distinct regional trends. The downstate population (New York City, Nassau, Suffolk, Westchester, Putnam, and Rockland counties) is projected to increase by 1.1 million people, from 12.7 million to 13.8 million; the upstate population, however, is projected to decrease by 300,000 people, from 6.9 million to 6.6 million.[1] A substantial shift in age distribution of the population is also expected as the proportion of the population over 65 will grow faster than the rest of the population, both upstate and downstate. The total number of people over 65 is expected to increase by 1.1 million, from 2.5 million to 3.6 million as the number of people under 65 falls by 300,000 statewide, from 17.1 million to 16.8 million.

Gross State Product (GSP): New York's economy is expected to continue growing by 25 to 30 percent each decade through 2030 as it has for the past two decades with GSP reaching $6.4 trillion in 2000 dollars by 2030, from $3.9 trillion in 2010.[2] GSP is expected to continue growing significantly faster than the state's population, implying significant productivity gains and rising per capita income.

Housing Stock: The number of housing units in the state is growing faster than the population, reflecting smaller family sizes and an increasing proportion of "empty-nesters" in the population. This trend is a factor of both new home construction and decreased rates of removal of units from the total housing stock. A simple trend analysis of population, number, and age of housing units, and number of new housing units built conducted by NYSERDA suggests that New York's housing stock will increase by about 6%, from 8 million to 8.5 million, between 2010 and 2030.[3] The housing stock will also get older, on average, as fewer old homes are removed from use and the percentage of homes built in the previous 20 years continues to decline. The proportion of New York's housing units less than 20 years old fell from 21% in 1990 to 15% by 2000, and projections suggest that only 8 to 10% of housing units (approximately 700,000) will be less than 20 years old by 2030.

Vehicle Miles Traveled (VMT): On-road VMT are expected to continue growing by 15 to 20 percent each decade for the next 20 years, as they have for the past 20 years, reaching 202.6 billion per year by 2030, from 149.7 billion per year in 2010.[4] VMT per capita will continue to grow quickly with increased economic activity per capita. This trend will be offset somewhat by increases in both the proportion of residents living downstate and in the proportion of residents over 65, both groups that tend to drive fewer miles per person than the state average.

Trends in GHG Emissions: Current patterns suggest per capita emissions could fall, given the trends for an aging population and overall population growth in downstate areas. Per capita emissions are generally lower downstate than upstate, and people over 65 generally live in smaller housing units and travel less than do people under 65. However, total statewide emissions are likely to rise, driven by increased total population, growth in economic activity, aging housing stock and increased VMT.

These trends underscore the need for New York to seek optimal strategies to reduce the carbon intensity of its economy (tons of CO_2 emitted per dollar of GSP).

For example, if VMT increases as expected, New York State will have to achieve even greater improvements in vehicle efficiency or reductions in the carbon intensity of fuels to be able to reduce total GHG emissions from the transportation sector. The population trends and housing stock projections provide an opportunity for reducing VMT growth through implementation of smart growth strategies: For example, a growing and aging downstate population could benefit from new development close to public transportation and designed around mixed residential-commercial areas, which typically have lower VMT per capita than other areas.

[1] Cornell University Program on Applied Demographics, "New York State and County Population Projections by Age and Sex – Preliminary Population Projections by Age and Sex, New York State and 62 counties, 2005-2035," http://pad.human.cornell.edu/che/BLCC/pad/data/projections.cfm

[2] NYSERDA projections for State Energy Plan

[3] U.S. Census Bureau, Census 1990 and 2000 Form DP-4: Profile of Selected Housing Characteristics, 2000, http://www.census.gov/census2000/dp_comptables.html

U.S. Census Bureau, Census 2000 Population and Housing Unit Counts, New York, http://www.census.gov/prod/cen2000/phc-3-34.pdf

U.S. Census Bureau, Housing Unit Estimates: 2000-2009, http://www.census.gov/popest/housing/HU-EST2009.html

[4] NYSDOT Vehicle Miles Traveled projections 2007-2033

Visioning Process and Approach

The ability to visualize a sustainable New York by 2050 and to explore its implications is as vital to achieving that future as the clean energy technologies and policies, best management practices, and behavioral changes that will constitute the Climate Action Plan. The Climate Action Council and its technical and integration working groups began their planning task by building a shared vision of a low-carbon, clean energy future in an 80 by 50 New York. Through a formal visioning process, the council explored technologies and greenhouse gas management strategies.

New York's formal visioning process worked backward from an imagined mid-century New York with far lower greenhouse gas (GHG) emissions than today, using four tools:

- **Scenario development**, which was based on a coupled energy-sector model and sets of assumptions about future energy demand, patterns of energy use, and low-emission technologies that might reasonably be available to power the low-carbon economy;
- **Visioning workshop** at the New York Academy of Sciences (conducted January 5, 2010 – full session and presentations available online at http://www.nyas.org/Events/WebinarDetail.aspx?cid=e7a4211c-fd9e-4683-8491-29c46fe03651;
- **White paper** (Appendix F) incorporating workshop outcomes and information from other expert sources: Envisioning a Low-Carbon 2050 for New York State, submitted to the New York State Climate Action Council; by Gerry Stokes and Patrick Looney, Brookhaven National Laboratory, Upton, NY.
- **Sectoral visions** developed by the technical work groups for each sector of the economy. Guided by the visioning workshop and scenario information, each Technical Work Group developed an 80 by 50 vision for each mitigation sector: Power Supply and Delivery; Transportation and Land Use; Agriculture; Forestry; Waste/Materials Management; and Residential/Commercial/Institutional/Industrial Buildings. Summaries of this visioning work appear in the sector chapters of this report; the full vision documents as drafted by the work groups are available online at http://www.nyclimatechange.us.

The visioning process continues to enable examination of possible technologies with research and development needs, assessment of technical issues, design of policies to reduce GHG emissions, and identification of necessary management and societal changes. The formal visioning technique supports discussion of option if other interested parties generate their own 80 by 50 scenarios and develop analyses based on them, meaningful comparisons among options are possible.

New York's visioning process revealed that reaching the 80 by 50 goal required aggressive assumptions and transformative change, but is potentially achievable, at least from a technical point of view.

Scenarios

Scenarios are sets of assumptions describing conditions in 2050 that should yield total GHG emissions 80 percent lower than those of 1990.

Carbon dioxide and other GHGs [total GHGs are expressed as carbon dioxide equivalent (CO_2e)] are emitted by millions of homes, vehicles, farms, businesses, institutions and other sources. So in New York, achieving 80 by 50 would mean that total GHG emissions from these numerous and varied sources would fall from the current (i.e., year 2008) 254 million metric tons of CO_2e to approximately 50 million metric tons per year. Scenario analysis is commonly used as a tool for exploring options and contingencies in such complex situations.

New York's visioning process used three scenarios to explore the technical feasibility of reaching the 80 by 50 goal through energy efficiency, new energy conversion technologies, fuel switching, best practices, and other measures to shape a low-carbon future.

The three scenarios use different sets of assumptions about future energy demand, patterns of energy use, technologies available to supply energy with reduced emissions and their levels of performance. The specific assumptions making up each scenario, along with the modeling and other methodologies used to develop estimates for energy demand and technology performance, are described in detail in the Brookhaven National Laboratory white paper and its appendices.

The three scenarios are the same in several important ways:

- An end state is postulated for each major energy-consuming sector of the economy—Transportation; Electricity Production and Distribution; Residential Buildings, Commercial Buildings, Institutional Buildings, and Industrial Buildings. This end state includes low carbon-emitting central generation of electricity, as well as transportation and building sectors approaching zero carbon emissions, and accounts for emissions from non-energy producing activities. The scenarios constrain emissions and energy production to within the borders of New York State.
- Implications of the postulated technology options are examined. For example, one scenario evaluates GHG emissions assuming adoption of electricity as a transportation fuel and explores how electricity generation could be expanded to meet the increased demand while limiting emissions; another scenario considers the same for hydrogen.
- Each scenario's outcome is compared with the business-as-usual forecast in which no additional carbon mitigation measures are taken.

The model used to analyze GHG reductions for the technical strategies considers interactions—how switching technologies in one sector may raise or lower energy demand in another (an example would be higher demand for electricity if electric vehicles were widely adopted). However, the model does not take into account whether technologies are scalable, nor does it include economic, regulatory, and other social barriers to technology adoption. The model also does not include full lifecycle GHG analyses of nuclear power and renewable energy, possible effects of a changing climate on energy use or technology performance, or detailed analysis of the feasibility of transition rates or of rates of implementation.

All the scenarios include **four core strategies** to reduce GHG emissions:

- **Energy conservation** through energy efficiency, which is the simplest and the most cost-effective strategy.
- **Reducing combustion of fossil fuels**, another obvious strategy because combustion accounts for about 85 percent of all GHG emissions in New York State. All scenarios minimize point sources of combustion (such as vehicles and oil or natural gas heating appliances), and rely principally on low-emission electricity. The scenarios assume combustion of fossil fuels only when and where necessary, or with controls to effectively limit GHG emissions.
- **Fuel switching** to minimize the GHG footprint where combustion must still be used, as in aviation and cement production.
- **Local, point-of-use renewable energy technologies** (such as solar) employed to reduce the reliance of homes and businesses on centrally generated electricity.

Summary of Scenario Assumptions

All scenarios recognize the importance of commercial and industrial sectors to the overall economic health of the state and preferentially "invest" emissions in these sectors.

The **Yellow Scenario** assumes the most obvious emission-reduction strategies: significant energy conservation; significant changes to the light-duty vehicle fleet with a mix of high mpg conventional, hybrid-electric, and plug-in electric vehicles; very significant increases in utility-scale renewable electricity generation, with widespread adoption of carbon capture and storage on the remaining fossil-fired generating plants; replacement of most fossil fuel used in buildings with electricity, and significant reductions in non-CO_2 greenhouse gases. Although it assumes significant changes to current practices, this scenario falls far short of achieving 80 percent emissions reduction by 2050.

The **Deep Blue Scenario** begins with all the reductions in the Yellow scenario, but makes a dramatic shift of the entire light-duty vehicle fleet to hydrogen fuel produced with nuclear or other low-carbon electricity (including fossil fuel combustion with carbon capture and sequestration). Additional measures include elimination of fossil fuel combustion in the residential/commercial/industrial sector and significant use of locally-sourced biofuels for trucks and aircraft. This scenario (79 percent reduction) essentially meets the 80 percent reduction goal by 2050.

The **Ultraviolet Scenario** adds to the reductions in the Yellow scenario but makes a dramatic shift of the entire light-duty vehicle fleet to all plug-in hybrids. Ninety-five percent of all vehicle miles traveled are assumed to be all-electric miles, with the remainder in-state-sourced biofuels. It assumes elimination of residential and commercial fossil fuel combustion, with part of the resultant increase in electricity demand met through local, point-of-use solar and much of the remainder with low-carbon generation and the wide-spread use of carbon-capture and sequestration. This scenario meets the 80 by 50 goal.

Visioning Workshop

The Climate Action Council formed a 2050 Visioning Advisory Panel of experts from many fields. The panel was convened at a workshop held on January 5, 2010, entitled *Envisioning a Low-Carbon Clean Energy Economy in New York***.**

Led by subject matter experts, workshop participants explored strategies for meeting the state's energy needs, reducing energy demand, managing GHG emissions, driving technological change, and creating economic opportunities for "green technology" in New York. The workshop considered the three scenarios not to validate a particular pathway to reaching the goal, but rather to explore possibilities and implications, and to identify obstacles to achieving the goal.

The Visioning Advisory Panel consisted of 13 experts in diverse elements of New York's energy and climate future:

Geoff Anderson, President and CEO, Smart Growth America

Katharine Frase, Vice President, Industry Solutions and Emerging Business, IBM Research; Member, National Academy of Engineering

Peter Goldmark, Program Director, Climate and Air, Environmental Defense

Nathan Lewis, George L. Argyros Professor of Chemistry, California Institute of Technology

Patrick Looney, Assistant Laboratory Director, Strategic Planning, Brookhaven National Laboratory

Elizabeth Malone, Joint Global Change Research Institute

James Misewich, Associate Laboratory Director for Basic Energy Sciences, Brookhaven National Laboratory

John Novak, Executive Director, Federal and Industrial Activities, Electric Power Research Institute

William Sisson, Director of Sustainability, United Technologies Corporation; Co-Chair, World Business Council for Sustainable Development Energy Efficiency in Buildings Project

Gerald Stokes, Associate Laboratory Director for Global and Regional Solutions, Brookhaven National Laboratory

Larry Walker, Professor and Director, Biomass Conversion Laboratory, Cornell University

Johanna Wellington, Technology Leader for Sustainable Energy, General Electric Global Research

Rae Zimmerman, Professor of Planning and Public Administration, New York University

Links to a webinar of the workshop sessions, workshop presentations in PDF format and the visioning white paper, *Envisioning a Low-Carbon 2050 for New York State,* are available at http://nyclimatechange.us/2050_Visioningn.cfm.

Outcomes of the Visioning Process

The visioning process makes it clear that an 80 by 50 New York requires low-carbon technologies serving an economy and society that have moved beyond dependence on fossil fuels to accept the true value and cost of energy. The recurring themes of the visioning discussion include technological elements that can be realized only with vigorous economic and social support:

- Maximum energy efficiency and conservation,
- Near-zero-carbon electricity generation,
- "Smart" electric transmission/distribution system with energy storage,
- Carbon-free energy carriers for transportation systems,
- Net energy-neutral buildings, including homes,
- Low-carbon liquid fuels,
- Carbon sink maintenance/enhancement.

Specifics and Insights

Exploration of these visioning themes led to more nuanced conclusions about the interactions of technology with the state's economy and society as we move through the next four decades. To illustrate the insights that flow from the visioning process, a selection of these conclusions is given here. The full list is found in the white paper.

- The 80 by 50 goal is very ambitious, and achieving it will require investments in new energy systems and infrastructure that have very low or no net carbon emissions. Patterns of energy use will also need to change radically.
- As policies and plans to meet the 80 by 50 goal are adopted, they need to be informed by the directions of the state's economy. The scenarios developed are consistent with the energy needs of a 21st-century economy based on clean energy technology, information technology, biotechnology, and nanotechnology.
- Incremental, short-term planning cannot achieve the goal. Near-term decisions—both those taken and not taken—can foreclose longer-term options, such as infrastructure projects with long lead times. Key climate strategies must reflect this inexorable reality.
- Major decisions are necessary to achieve the 80 by 50 goal, and many of those decisions must be made soon, as they deal with long-lead-time projects, such as infrastructure investments and research and development strategies, which can help or hinder progress.

- The goal must be pursued in part through extensive, long-term partnering among all levels of government and across the region, and between the public and private sectors. Achieving 80 by 50 will take sustained effort on the part of all.
- Energy efficiency is an essential, but not sufficient, strategy for reaching the 80 by 50 goal. It can be aggressively pursued today. A broad shift from reliance on burning fossil fuels to electricity or possibly hydrogen generated from low- or no-carbon sources, or widespread use of carbon capture and sequestration, will be needed.
- Electrification as a substitute for fossil fuel combustion is an essential strategy that will lead to a significant increase in demand and change in the patterns of electricity generation, transmission, and distribution. Therefore, ongoing planning for the smart grid and associated technologies, and storage of energy from intermittent energy resources must be part of the Climate Action Plan strategy.
- Transportation and buildings (residential and commercial) will have to move from reliance on fossil fuel combustion to use of alternate sources with significantly lower carbon or no carbon emissions. The buildings sector can reach net zero emissions through efficiency, electrification, energy storage technologies, and integration of renewable energy sources like solar and geothermal.
- Development and redevelopment based on smart growth principles, along with efficient building design practices, technologies, and construction methods, can reduce energy demand for buildings and transportation.
- Smarter means for shipping goods, including greater use of intermodal transportation and rail for freight movement, will save significant energy and reduce GHG emissions.
- All scenarios call for the phase-out of fossil fuel generation that free-vents carbon to the atmosphere. The schedule for this phase-out needs to be developed soon.
- Centrally-generated electricity must be decarbonized. This means that renewable energy generation must expand; existing nuclear power plants must be re-licensed or replaced; and carbon capture and storage added to any remaining fossil fuel-fired plants.
- Reducing vehicle miles traveled requires increased availability of mass transit, as well as travel-efficient community design, development, and redevelopment.
- Transformation to a hydrogen economy would require a new infrastructure for producing and delivering hydrogen to consumers.
- The interdependencies—and consequent vulnerabilities—of transportation, water, energy, and communication systems have direct consequences for system performance and thus for climate change adaptation and mitigation. System managers and operators must be helped to understand and manage those interdependencies.
- Greenhouse gas reduction has pervasive interconnections with the state‘s economy and social fabric: local, state and federal policies may facilitate or hinder achievement of the 80 by 50 goal. For example, interstate commerce (tourism, freight, and aviation) is shaped by federal policy, while large-scale renewable energy involves local land-use choices.