Meeting New Jersey's 2020 Greenhouse Gas Limit: New Jersey's Global Warming Response Act Recommendations Report

December 2009

New Jersey Department of Environmental Protection

Mark N. Mauriello, Acting Commissioner

Jon S. Corzine, Governor

This report and its appendices can be downloaded from:

State of New Jersey Global Warming Web Site
http://www.nj.gov/globalwarming

State of New Jersey
DEPARTMENT OF ENVIRONMENTAL PROTECTION

JON S. CORZINE
Governor

MARK N. MAURIELLO
Acting Commissioner

December 17, 2009

Honorable Jon S. Corzine
Governor of New Jersey
State House
P. O. Box 001
Trenton, New Jersey 08625-0001

Dear Governor Corzine:

Pursuant to a requirement of the Global Warming Response Act (N.J.S.A 26:2C-37), enclosed please find the report *Meeting New Jersey's 2020 Greenhouse Gas Limit: New Jersey's Global Warming Response Act Recommendations Report.* This final report focuses on three core recommendations and 22 supporting recommendations as measures to attain the State's 2020 limit to reduce greenhouse gas emissions to 1990 levels, as well as to put the State on track to meet its 2050 limit of reducing statewide greenhouse gas emissions 80 percent below 2006 levels.

This report was developed with considerable input from a number of agencies, including the Board of Public Utilities, the Departments of Treasury, Transportation, Agriculture, Community Affairs, Banking and Insurance, the Motor Vehicle Commission, the Economic Development Authority, New Jersey Transit, the Port Authority of New York and New Jersey, the New Jersey Turnpike Authority, the Housing Mortgage Finance Agency and the Division of Consumer Affairs. The contributions of these agencies helped shape the broad recommendations contained in the report. A draft of this report was released for stakeholder review in December of 2008, and the State hosted six stakeholder meetings throughout January of 2009 to solicit further input. As a result of this effort, the Department received valuable input on the draft report recommendations from a variety of interested and regulated entities, and many substantive revisions were incorporated into the final document.

To assess the greenhouse gas emissions reduction potential and economic impacts of the recommendations and related actions discussed in this report, the State engaged the Center for Climate Strategies and the Rutgers University Center for Energy, Economic & Environmental Policy to conduct a cost analysis associated with various recommendations. Therefore, the report provides a comprehensive technical and financial framework for decision-making related to various greenhouse gas reduction strategies.

As you are well aware, there is broad scientific consensus that human-caused greenhouse gas emissions are impacting the earth's climate, and that increasing atmospheric greenhouse gas concentrations will result in very significant adverse global, regional, and local environmental impacts. Not only does climate change threaten New Jersey's shoreline and ecology, but the socioeconomic impacts of climate change stand to be profound and costly. Therefore, aggressive action is needed to stabilize, and then reduce, atmospheric greenhouse gas concentrations in order to avoid the most catastrophic impacts of climate change.

I would be happy to provide additional information on the contents of the final report, as requested.

Sincerely,

Mark N. Mauriello
Acting Commissioner

Enclosures

c: Honorable Richard J. Codey
Senate President

Honorable Joseph J. Roberts, Jr.
Assembly Speaker

Honorable Bob Smith
Chair, Senate Environment Committee

Honorable John F. McKeon
Chair, Assembly Environment and Solid Waste Committee

David Rousseau
State Treasurer

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Executive Summary

There is broad scientific consensus that human-caused greenhouse gas (GHG) emissions are impacting the earth's climate, and that increasing atmospheric GHG concentrations will result in very significant adverse global, regional, and local environmental impacts.[1] The Northeastern United States is particularly vulnerable to the impacts of climate change, with potentially devastating ecological, economic and public health impacts to New Jersey.[2] Not only does climate change threaten New Jersey's shoreline and ecology, but the socioeconomic impacts of climate change stand to be profound and costly.

Recognizing this immediate need, New Jersey enacted the Global Warming Response Act (GWRA) (P.L. 2007, c.112) on July 6, 2007. The GWRA calls for a reduction in GHG emissions to 1990 levels by 2020, approximately a 20 percent reduction below estimated 2020 business-as-usual emissions, followed by a further reduction of emissions to 80 percent below 2006 levels by 2050. As required under the Act, this report specifically provides the Governor, Treasurer and the State Legislature with recommendations for achieving the 2020 statewide GHG limit. The report also recognizes the contributions that a set of other public policies, not developed primarily to address climate change, will have on reducing statewide GHG emissions. A draft of this report was issued for stakeholder comment in December 2008. All of the climate-specific recommendations and related actions in this final report take into consideration the numerous comments received by the State during its stakeholder period. As demonstrated throughout the report, meeting the State's ambitious GHG limits will require not only long-term measures, but also immediate actions that will both stabilize GHG emissions in the short-term and create a foundation for the carbon-neutral future required to meet the 2050 limit. Attaining the State's 2050 limit (approximately 26 MMT CO_2eq) will also provide ancillary benefits of transforming the New Jersey economy to one that drives creation of "green" jobs by making clean energy and technologies a cornerstone of the State's economy.

As highlighted by the scope and nature of the recommendations and related actions included in this report, global climate change affects all aspects of our lives, and the scope of measures needed to meet New Jersey's GHG limits is extensive. Therefore, this report includes an array of recommendations and related actions, including legislative, regulatory and market-based measures, which provide a balance that will allow New Jersey to meet its statewide GHG limits without unduly burdening any one particular sector or industry. This report provides a comprehensive technical and financial framework for decision making on a range of specific actions that can be taken to reduce GHG emissions in New Jersey.

New Jersey Statewide Greenhouse Gas Inventory

Released on October 31, 2008, the State's first GHG inventory and forecasts[3] presents a preliminary assessment of New Jersey's statewide anthropogenic GHG emissions (including CO_2, methane (CH_4), nitrous oxide (N_2O), and certain halogenated gases) and sinks (carbon

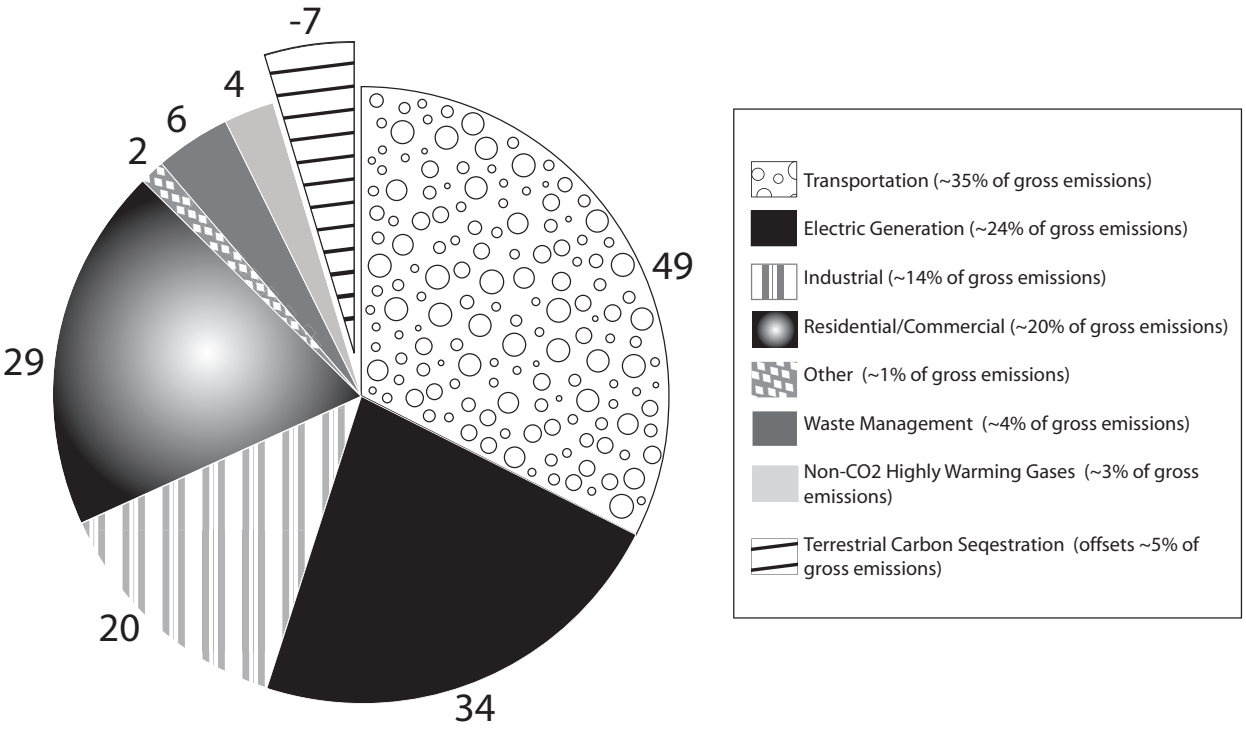
[1] Intergovernmental Panel on Climate Change, Climate Change 2007: Synthesis Report, Summary for Policymakers, Fourth Assessment Report, November 2007.

[2] Frumhoff, P.C., J.J. McCarthy, J.M. Melillo, S.C. Moser, and D.J. Wuebbles. 2007. Confronting Climate Change in the U.S. Northeast: Science, Impacts, and Solutions. Synthesis report of the Northeast Climate Impacts Assessment (NECIA). Cambridge, MA: Union of Concerned Scientists (UCS).

[3] "New Jersey Greenhouse Gas Inventory and Reference Case Projections 1990-2020", November, 2008. This document is posted on the State's Global Warming Web page at http://www.nj.gov/globalwarming/.

storage). As shown by Figure ES 1, the inventory is broken out into eight sectors, each contributing to New Jersey's overall GHG emissions profile.

Figure ES 1: GHG Emissions by Sector; New Jersey, 2004 Millions of Metric Tons CO_2eq (Source: New Jersey GHG Inventory and Reference Case Projections 1990-2020 November 2008)



New Jersey statewide GHG emissions in 1990 were approximately 123 million metric tons (MMT) of CO_2 equivalent per year. By 2004[4], those emissions had risen 11 percent to approximately 137 MMT. Under a business-as-usual scenario, emissions are projected to increase 25 percent over 1990 levels to approximately 154 MMT per year by 2020.

Ensuring Attainment of the Statewide 2020 Greenhouse Gas Limit

Three core measures form the backbone of New Jersey's plan to meet its statewide 2020 GHG limit. The core measures implement the:

- New Jersey Energy Master Plan (EMP);
- New Jersey Low Emission Vehicle (LEV) program; and,
- Regional Greenhouse Gas Initiative (RGGI) program.

The core measures are targeted at reducing GHG emissions from the two largest contributors to New Jersey GHG emissions – transportation and energy – and they lay the groundwork for all future actions in these areas.

[4]The State has completed GHG inventory estimates for 2005, 2006 and 2007. Data show that differences from the 2004 to 2007 totals are minor; the sectoral proportions are similar.

Energy Master Plan. After an intensive public participation process, the New Jersey Board of Public Utilities (NJBPU) released the State's EMP[5] on October 22, 2008. The EMP provides the State with a road map for reaching a responsible energy future with adequate, reliable energy and heating supplies that are both environmentally responsible and competitively priced. The EMP establishes the following five goals:

- Maximize energy conservation and energy efficiency to achieve reductions in statewide energy consumption of at least 20 percent by 2020;
- Reduce peak electricity demand for electricity by 5,700 MW by 2020;
- Strive to exceed the current renewable portfolio standard of 22.5 percent by 2020, and meet 30 percent of the State's electricity needs from renewable sources by 2020;
- Develop a 21st century energy infrastructure that supports the goals and action items of the Energy Master Plan, ensures reliability of the system, and makes available additional tools to consumers to manage their energy consumption; and,
- Invest in innovative clean energy technologies and businesses to stimulate the industry's growth in New Jersey.

Low Emission Vehicle Program: On November 28, 2005, New Jersey adopted a Low Emission Vehicle (LEV) program modeled after California's LEV Program.[6] The program contains three components: vehicle emission standards, fleet-wide emission requirements and a Zero Emission Vehicle (ZEV) sales requirement. New Jersey's adoption of its LEV program ensures that vehicles designed to incrementally produce fewer and fewer GHG emissions over time will be available for purchase in New Jersey.

On September 28, 2009, the U.S. Environmental Protection Agency and the U.S. Department of Transportation jointly proposed federal motor vehicle GHG emission standards and related fuel economy standards for model years 2012 through 2016.[7] Once adopted, this federal motor vehicle control program could impact the GHG emission reductions projected for the New Jersey LEV program.

Regional Greenhouse Gas Initiative: New Jersey is one of ten states participating in the Regional Greenhouse Gas Initiative (RGGI), a ten-state mandatory CO_2 cap-and-trade program to reduce CO_2 emissions from the electric power sector. The RGGI program caps regional power plant CO_2 emissions from 2009 through 2014 and then reduces those emissions 10 percent by 2018. RGGI's phased approach means that reductions in the CO_2 cap will initially be modest, providing predictable market signals and regulatory certainty. Electricity generators will be able to plan for and invest in lower-carbon alternatives and avoid dramatic electricity price impacts.

Under the RGGI program, regulated power plants must hold an emission permit, or allowance, for every ton of CO_2 they emit. Allowances are sold quarterly at auction; states will use the proceeds of allowance auctions to support low-carbon-intensity solutions, including energy efficiency and clean renewable energy, such as solar and wind power.

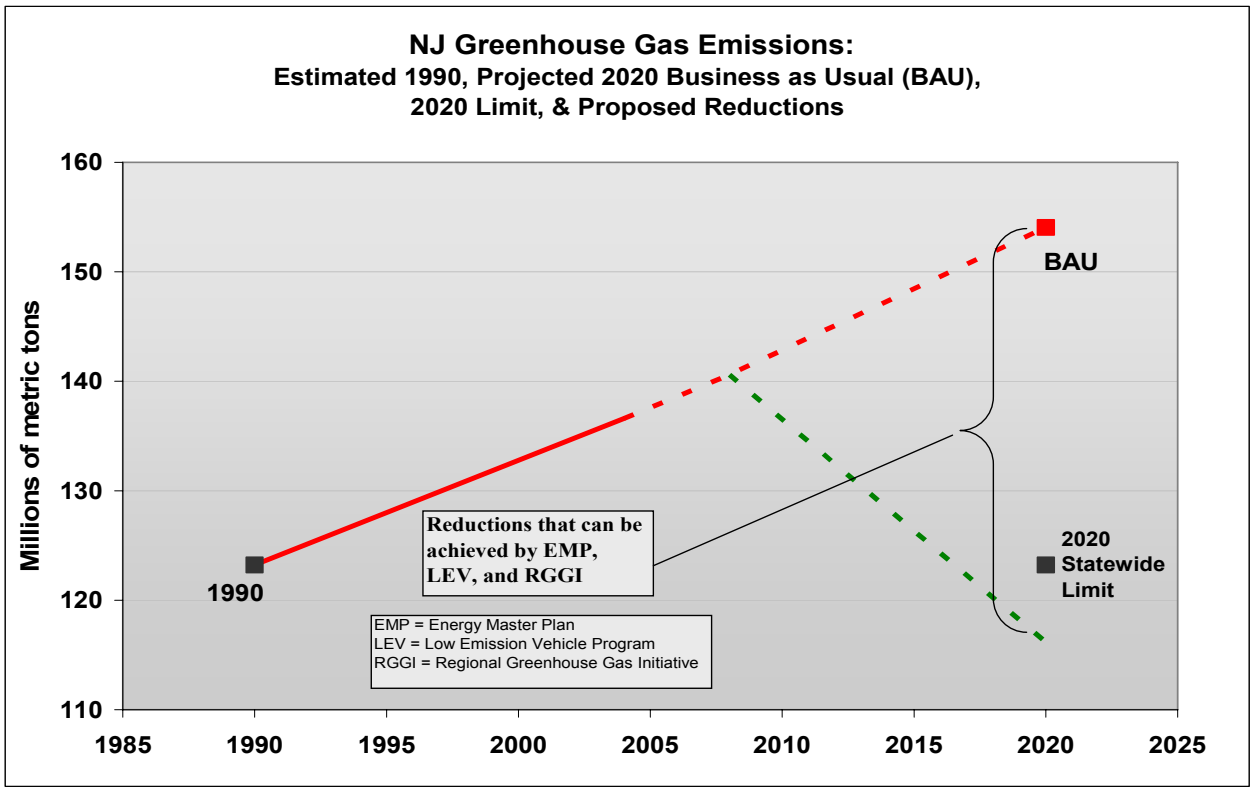
According to an analysis conducted by the New Jersey Department of Environmental Protection (NJDEP) (included as Appendix 1 of this report) the three core measures, if fully successful and

[5]The Energy Master Plan can be downloaded from http://www.nj.gov/emp
[6]38 N.J.R. 497(b), (January 17, 2006).
[7]74 Fed. Reg. 49454, September 28, 2009.

fully implemented on schedule, would result in a reduction of approximately 38 MMT CO_2eq below the estimated business-as-usual emission level of 154 MMT CO_2eq, or 116 MMT CO_2eq, by 2020. This would allow the State to meet its statewide 2020 limit of 123 MMT CO_2eq.

Figure ES 2 shows the impact of failing to implement these core recommendations, instead allowing for a business-as-usual scenario for the State. Economic impact analyses conducted by the Rutgers University Center for Energy, Economic and Environmental Policy (CEEEP), found that the implementation of the EMP (including RGGI) would have a negligible impact on the State's economy and that the implementation of the LEV program would add minimally to that impact (see Chapter 2 and Appendix 2 for further information).

Figure ES 2: NJ Greenhouse Gas Emissions[8]



All emission and reduction quantities are estimates. The actual statewide emissions up to and including 2004 are unlikely to be more than 5 percent higher or lower than these estimates. The projections to 2020, and the proposed reductions, are considerably less certain. Reductions attributable to RGGI are difficult to quantify at a statewide level because the RGGI limits are regional. For purposes of the 2020 estimates that reflect the various reductions, the emissions from New Jersey facilities covered by RGGI are considered to be equal to New Jersey's estimated share of the total RGGI limit. All numbers are subject to revision by the NJDEP as better information becomes available.

Actions Now for Future Impact

While meeting the State's 2020 GHG limit is an essential first step for New Jersey, implementing additional measures in the near-term will ensure that the State stays on track to meet its 2050 limit. In addition to the three core recommendations, this report identifies a set of

[8]Based on data in "New Jersey Greenhouse Gas Inventory and Reference Case Projections 1990-2020", November, 2008. This document is posted on the State's Global Warming Web page at http://www.nj.gov/globalwarming/.

22 supporting recommendations (see Table ES-1) to ensure attainment of the 2020 statewide limit. Additionally, this report acknowledges the GHG emission reductions anticipated as a result of several other significant statewide public policies.

Successful implementation of these recommendations will require the participation, collaboration and cooperation of a broad spectrum of State agencies, businesses, organizations, public officials, and New Jersey citizens. Therefore, outreach and education will be a crucial component of the State's efforts, as discussed in greater detail in Chapter 5 of this report.

Table ES 1: 2020 Climate-Specific Supporting Recommendations

Electric Generation
Recommendation #1: Establish standards for fossil fuel EGUs
Industrial
Recommendation #2: Implement requirements for non-EGU industrial sources
Residential/Commercial
Recommendation #3: Develop and facilitate the use of State Green Building Guidelines for all New Residential and Commercial Buildings
Recommendation #4: Develop and facilitate State Green Building Remodeling, Operations and Maintenance Programs for all Existing Residential and Commercial Buildings
Waste Management
Recommendation #5: Provide incentives to reduce the carbon footprint of public water supply and wastewater treatment facilities
Recommendation #6: Implement initiatives designed to support the creation of electricity or heat from waste sources
Non-CO_2 Highly Warming Gases
Recommendation #7: Monitor the development of other states' actions to reduce non-CO_2 highly warming gases and consider if they are appropriate to be implemented in New Jersey
Recommendation #8: Broaden scope of building codes to address high Global Warming Potential (GWP) gases
Recommendation #9: Add high GWP gas requirements for HVAC contractors
Recommendation #10: Institute a Leak Detection and Repair program for high-GWP gases from commercial and industrial refrigeration equipment
Recommendation #11: Reduce HFC emissions from the do-it-yourself servicing of motor vehicle air conditioning systems
Terrestrial Sequestration
Recommendation #12: Require State-funded projects to comply with the no net loss goal of forested area and tree replacement provisions of the "No Net Loss Act"
Recommendation #13: Establish legislation, develop policies (e.g. financing via Garden State Preservation Trust (GSPT)) or implement through existing programs (e.g., re-adoption of the stormwater rules) on-site tree preservation percentage requirements for new development consistent with tree canopy target recommendations of American Forests (formerly the American Forest Association)
Recommendation #14: Develop Agricultural Best Management Practices to address energy efficiency, renewable energy and the release of GHGs in agricultural operations and structures
Transportation and Land Use
Recommendation #15: Determine needs for implementing infrastructure alternatives to conventional motor vehicle fuels (i.e., gasoline and diesel) in New Jersey
Recommendation #16: Implement transportation-related initiatives and demonstration projects
Recommendation #17: Develop and implement a LCFS through a multi-state effort
Recommendation #18: Establish a carbon footprint standard for transportation projects
Recommendation #19: Employ efforts for effectively implementing the State Development and Redevelopment Plan (SDRP)

Recommendation #20: The NJDOT and the NJDEP will work cooperatively with all three Metropolitan Organizations (MPOs) to ensure that they incorporate growth management and GHG reduction goals into their plans and programs
Recommendation #21: The State will work in partnership with local and regional entities to conduct an infrastructure capacity assessment of the 113 municipalities that will benefit from the ARC[9] tunnel as well as the municipalities that are served by, and feed, the Port Authority Transit Corporation (PATCO) rail and bus lines, and whose residents commute to Atlantic City, Camden and Philadelphia
Recommendation #22: Explore fuel-efficient vehicle incentive programs

The State engaged the Center for Climate Strategies (CCS) and Rutgers University Center for Energy, Economic & Environmental Policy (CEEEP) to assess the GHG emissions reduction potential and economic impacts of the supporting recommendations and related actions discussed in this report. These analyses focused on a subset of the supporting recommendations and related actions that were sufficiently well-developed to be quantifiable.

With respect to emission reduction potential, the supporting recommendations and related actions quantified as part of these analyses would result in an estimated 26 $MMTCO_2eq$ of reductions beyond the 38 $MMTCO_2eq$ of GHG emission reductions expected for 2020 from implementation of the three core measures, resulting in a total of 64 $MMTCO_2eq$ of GHG emission reductions in 2020. The largest additional GHG emissions reduction potential lies in the transportation sector, followed by the waste management and building sectors. With the amount of reduction needed by 2020 defined as the difference between the Business-as-Usual projection of 154 $MMTCO_2eq$ for 2020 and the 2020 limit of 123 $MMTCO_2eq$, or 31 $MMTCO_2eq$, these analyses show that the supporting recommendations and related actions provide an important start towards achievement of the 2050 limit.

With respect to economic impacts, the core and supporting recommendations and related actions taken as a whole are projected to result in a slight gain in total employment and slight decreases in personal income and Gross State Product (GSP) in 2020. The decreases in personal income and GSP result from the fact that the analysis assumes higher prices for zero-emission and low-emission vehicles and energy efficient homes; those assumptions are projected to lead to lower new vehicle registrations and residential building permits and consequently lower retail sales. It should be noted that these results do not reflect environmental co-benefits such as preservation of natural capital or reduction of SO_2 and NO_x costs.

For several reasons, the projections used in these economic analyses are probably on the conservative side. First, the costs of the measures analyzed tend to be incurred as up-front investments, while the resulting benefits accrue over a period of years. For example, planting trees to sequester carbon or putting infrastructure in place to reduce VMT are actions that have high initial costs, but will incrementally reduce the impacts of GHG emissions, preventing even more expense in the future. Therefore, delays that would increase impacts to forests such as forest loss or damage or property loss from flooding result in even greater costs to respond to these losses in the future. Second, since the analysis uses a 2020 time horizon, benefits occurring in later years are not counted. Third, while costs can usually be estimated in monetary terms, some benefits such as quality of life and species preservation are difficult or impossible to

[9]ARC stands for "Access to the Region's Core", a transit project designed to increase the capacity of the rail system under the Hudson River, which connects New York and New Jersey.

quantify and hence cannot be included in an analysis of this type, including some environmental benefits.

To reach the 2020 GHG limit, the State will need to undertake a suite of policy measures, some of which are more cost-effective than others. The State is pursuing what are expected to be the most cost-effective measures first, namely the three core recommendations. The macroeconomic impacts of the core measures are negligible. The supporting recommendations and related actions are somewhat more expensive; but even with these more expensive measures, the overall net economic impact of the full suite of policy measures would still be negligible. Considering the major stakes New Jersey has in mitigation of climate change, the projected economic effects can be seen as a cost-effective insurance policy and as an investment in maintaining New Jersey's economic vitality and quality of life.

Adaptation

Despite our best efforts to mitigate climate change in New Jersey, we must recognize that emission reductions alone are not a sufficient policy response to climate change. Once emitted, CO_2 and other GHGs reside in the atmosphere for decades or centuries.[10] Even if all GHG emissions were stopped immediately, there would still be a time lag between mitigation of emissions and cessation of warming. Because of New Jersey's uniquely diverse terrain, nearly all the impacts of climate change, from rising temperatures in our urban areas to sea level rise jeopardizing our coastal ecosystems to threats to our unique agricultural industries, will be experienced throughout the State. Each of these impacts threatens the public health of New Jersey residents, as well as the ecology and economy of State.

This report recommends that the State develop adaptation strategies to minimize climate-related risks to public health, the environment and the economy. The report recommends that experts from academia, government, non-governmental organizations, and the business community develope policy recommendations on the most pressing adaptation policies New Jersey should adopt to significantly reduce the State's risks from climate change impacts. By bringing together various constituencies to develop a statewide climate change adaptation plan, New Jersey can be proactive in fostering adaptive capacity in the built and natural environment and public health infrastructure statewide to respond to climate change.

Beyond the 2020 Recommendations: Setting the Stage for 2050 and Implementation in the Coming Months

While achieving the 2020 statewide GHG limit requires a firm commitment across the public and private sectors, there is confidence and certainty that the means to do so are clear and achievable. The essential steps are prompt action and an on-going dedication to results. However, the 2020 limit is an interim milestone intended to stabilize emissions. The 2050 limit – to reduce emissions to a level 80 percent below 2006 emission levels represents the emission level scientists advise is needed to avoid the most catastrophic potential effects from climate change.[11]

[10]IPCC.2007. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[11]It is understood that New Jersey's independent achievement of the 2050 limit will not preclude local climate change impacts; New Jersey recognizes its obligation to be part of the necessary global response if the most catastrophic impacts are to be avoided.

While this report provides a foundation for reaching the 2050 limit, additional public dialogue is needed to identify more specific actions to be implemented in the mid and long-term. This report discusses the four key policy areas that need to be considered in order to attain the 2050 GHG limit: 1) energy efficiency and conservation; 2) renewable electricity and fuels; 3) creation of natural CO_2 sinks; and 4) dramatically reduced reliance on cars. While taking aggressive action in these four key policy areas will provide the greatest GHG emission reductions over the long term, transformation in these areas will require not only bold and effective public policy, but also the creation of new technologies and markets that will drive a climate-friendly economy.

Within each of the four broad areas above, the State recommends an initial set of long-term indicators for tracking progress toward meeting the 2050 limit:

- The use of renewable energy sources in the State's energy portfolio will continue to increase aggressively until the majority of sources of electricity generation in New Jersey come from carbon neutral sources**.**
- All new buildings constructed after 2030 will have a net zero energy consumption through a combination of energy efficiency requirements and renewable energy sources.
- The current level of terrestrial carbon sequestration will increase by 1.53 million metric tons (MMT) CO_2 annually by 2020 and by 3.14 $MMTCO_2$ per year by 2050. This will raise the sequestration capacity from 7 $MMTCO_2$ to at least 8.53 $MMTCO_2$ annually by 2020 and to at least 11.67 $MMTCO_2$ annually by 2050. This will result from both an (a) expansion of the green infrastructure[12] and the implementation of the other supplemental terrestrial carbon sequestration measures[13] recommended in this report, and (b) investment[14] on at least half of the approximately 700,000 acres of state lands that are being incorporated in the forest and tidal marsh stewardship and restoration program under the Global Warming Solutions Fund (GWSF) Act. Moreover, New Jersey will further increase its terrestrial sequestration in 2050 (by an additional 2.39 $MMTCO_2$ annually) through new natural sink enhancement measures on forest lands thereby raising the total target capacity to 14.07 $MMTCO_2$ annually.
- VMT growth between now and 2020 will be limited to a rate of no more than 1 percent per year, and will stabilize thereafter.
- All vehicular VMT in New Jersey will be "green" VMT within the next 15 years.[15]
- By 2050, ninety percent of development in New Jersey will occur in areas already served by public infrastructure, and 99 percent of that development will be in the form of redevelopment.
- By 2050, at least 90 percent of all buildings in New Jersey will be fully occupied.
- Transit ridership will double by 2050, and green commuting options will be expanded such that all New Jersey residents will be guaranteed alternative transportation options to get to work beyond single occupancy vehicles.

Given the scope of public policies that will be necessary to achieve the 2050 goal, this process can greatly benefit from specific expertise and informed judgment. Recognizing such, the GWRA recommends creation of an Independent Research Panel (IRP) to evaluate the climate-

[12]Increase in area of preserved forestlands, wetlands, and associated agricultural landscapes by at least 10,000 acres annually for 10 years through Garden State Preservation (GSPT) acquisitions. This projection assumes that there is no further re-authorization of the GSPT after the 10 -year period.

[13]Forest Stewardship, No Net Loss Reforestation, Forest Cover/Tree Canopy Requirement, and Sustainable Agriculture

[14]Applying proceeds from the RGGI auctions as directed by the Global Warming Solutions Fund law (N.J.S.A. 26:2C-50 et. seq.) in the first 5 years.

[15]The NJDEP defines a "green" vehicle as a car or light-duty truck with a California 2009 GHG score of 9 or greater (equivalent to 33 miles per gallon or greater).

specific recommendations and related actions set out in this report and provide an assessment of the ecological, economic and social impacts that may result from their implementation, as well as to recommend actions that will allow the State to meet the 2050 limit. It is essential that this panel, in addition to various stakeholders who will be central to the 2050 plan's achievement, have a meaningful voice in its creation and endorsement.

Conclusion

In conclusion, this report provides:

- A cautiously optimistic analysis that shows that New Jersey can meet its 2020 statewide GHG limit with the timely and fully successful implementation of the State EMP, the LEV program and RGGI;
- A support plan that would put the State on track to meet its 2050 statewide limit;
- An overview of the potential economic and environmental impacts that could be expected from implementation of the 2020 climate-specific supporting recommendations and related actions;
- A discussion of how to develop 2050 actions that focus on the four key policy areas necessary to ensure compliance with that limit – energy efficiency and conservation; renewable electricity and fuels; creation of natural CO_2 sinks; and dramatically reduced reliance on cars;
- An adaptation planning approach that draws on the creativity and expertise of a broad range of experts and stakeholders; and,
- An outreach and education approach that will be key to the successful communication and implementation of the overall plan.

Chapter 1: Introduction

Purpose

The purpose of this report is to present, pursuant to both Executive Order 54 and the Global Warming Response Act (GWRA), recommendations for actions needed in order for the State to meet its 2020 statewide greenhouse gas (GHG) limit. The report also discusses the key policy areas that need to be considered in order to meet the 2050 statewide GHG limit.

Background

There is good evidence that as a result of ever-increasing carbon dioxide (CO_2) emissions in the atmosphere, the Earth's surface has warmed by over 1.3 degrees Fahrenheit (0.7 degrees Celsius) during the past century,[16] and the evidence for warming during the last 60 years is unequivocal.[17] These increased temperatures have contributed to:

- a reduction in the mass of the world's alpine glaciers, [18]
- an increase in permafrost thawing at high latitudes[19] and altitudes, [20]
- a reduction in the extent and thickness of Arctic sea-ice, [21]
- later freeze-up and earlier break-up of ice on rivers and lakes,[22] and
- an increase in the rate at which icebergs break off Antarctic ice shelves.[23]

There is also well-documented evidence of an increase in the storage of heat near the surface of the ocean,[24] and an overall rise in sea level, due in part to thermal expansion of the ocean and melting of continental glaciers.[25] In addition, recent measurements indicate that the rate of melting of the Greenland ice sheet has recently increased dramatically.[26, 27] If this melting continues at the recent more rapid rate or accelerates further, the rate of sea level rise will increase significantly. Continued GHG emissions at or above current rates are expected to cause further warming and induce many changes in the global climate system during the 21st century that will *very likely* be larger than those observed during the 20th century.[28]

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[16]IPCC, 2007.
[17]Bradley, R. S., 2001, Science 292, 2011.
[18]Dyrygerivm M.B., and M. F. Meier, 2000, Proc Natl Acad. Sci. U.S.A., 97, 1406; Thompson, L.G., et al., 1993, Glob. Planet. Change 7, 145; and Brecher, H. H., and L. G. Thompson, 1993, Photogramm. Eng. Remote Sens. 59, 1017.
[19]Osterkamp. T. E. and V. E. Ramanovsky, 1999, Permafrost Periglacial Proc. 10, 17.
[20]Jin, H. et al., 2000, Glob. Planet. Change 26, 387.
[21]Rothrock D. A., et al., 1999, Geophys. Res. Lett. 26, 3469; Wadhams, P., and N. R. Davis, 2001, Geophys. Res. Lett. 27, 3973; and Vinnikov, K., et al., 1999, Science 286, 1984.
[22]Magnuson, J. J., et al., 2000, Science 289, 1743.
[23]Scambos, T. A., et al., 2000, *Ann. Glaciol. 46*, 516.
[24]Levitus, S., et al., 2000*, Science 287*, 2225.
[25]Warrick, R. and J Oerlemans, 1990, in *Climate Change: The IPCC Scientific Assessment*, J. T. Houghton et al., Eds., Cambridge Univ. Press, Cambridge.
[26]Rignot, E. and Kanagaratnam, P., 2006, Science 311, 986-990.
[27]Velicogna, Isabella, and John Wahr, 2006, Acceleration of Greenland ice mass loss in spring 2004, *Nature, 443*, 329-331.
[28]IPCC, 2007.

In July 2007, the Northeast Climate Impacts Assessment (NECIA) released a report detailing the projected impacts of climate change on the Northeast Region of the United States.[29] While this research echoed the global findings of the United Nations Intergovernmental Panel on Climate Change's (IPCC) Fourth Assessment Report,[30] it also pointed out that states in the Northeastern United States are especially vulnerable to the impacts of climate change and that the potential ecological, economic and public health impacts to New Jersey may be devastating. Not only does climate change threaten New Jersey's shoreline and ecology, but the socioeconomic impacts of climate change stand to be profound and costly. The U.S. Global Change Research Program recently released the most comprehensive report to date on the possible impacts of climate change in the United States.[31] The report underscores the importance of mitigation by comparing impacts resulting from higher versus lower emission scenarios. Choices made about emissions in the next few decades will have far-reaching consequences for climate change impacts.

Higher Temperatures:

Based on current research, it appears likely that additional warming in the range of 2 degrees Fahrenheit (1.1 degrees Celsius) relative to 2000 will constitute dangerous climate change due to likely effects on sea level and extermination of species.[32] Recent regional modeling efforts project that, regardless of what is done now to reduce GHG emissions, average temperatures across the Northeast, including New Jersey, will rise 2.5 to 4 degrees Fahrenheit in winter and 1.5 to 3.5 degrees Fahrenheit in summer above historic levels over the next several decades. Unless GHG emissions are significantly reduced, average temperatures across the Northeast are predicted to rise up to 14 degrees Fahrenheit (approximately 8 degrees Celsius) by the end of this century, and cities such as Trenton could experience more than 20 days per summer with temperatures above 100 degrees Fahrenheit.[33]

These rising temperatures are expected to have human health impacts, including:

- Increased heat stress, especially for vulnerable urban populations, such as the elderly and urban poor;
- Increased levels of ground-level ozone, with the number of days failing to meet federal air quality ozone standard projected to quadruple if local vehicle and industrial emissions of ozone-forming pollutants are not reduced;[34]
- Accelerated secondary fine particle formation, which also have negative health impacts, particularly to children and the elderly; and,
- Potential facilitation of the northern spread of insects carrying diseases such as West Nile virus, particularly in the winter season.

[29]Frumhoff, P.C., J.J. McCarthy, J.M. Melillo, S.C. Moser, and D.J. Wuebbles. 2007. Confronting Climate Change in the U.S. Northeast: Science, Impacts, and Solutions. Synthesis report of the Northeast Climate Impacts Assessment (NECIA). Cambridge, MA: Union of Concerned Scientists (UCS).

[30]Intergovernmental Panel on Climate Change; www.ipcc.ch

[31]Karl, Thomas, J.M. Melillo, and T.C. Peterson (eds.). 2009. Global Climate Change Impacts in the United States. Cambridge University Press.

[32]Hansen, James, Makiko Sato, Reto Ruedy, Ken Lo, David W. Lea, and Martin Medina-Elizade, 2006, Global Temperature Change, PNAS, 103, 14288–14293.

[33]Frumhoff, et al., 2007

[34] Frumoff, et al., 2007.

Natural ecosystems in New Jersey will also be impacted by warmer temperatures and associated changes in the water cycle. These changes could lead to:

- Loss of critical habitat and further stresses on some already-threatened and endangered species. Climate-related habitat loss could lead to the extinction of some species and additional stress on already-stressed fishery;[35]
- Impacts on water supply and agriculture, including the possibility that New Jersey's climate will become much less favorable to blueberry and cranberry growing. [36] The past century is no longer a reasonable guide to the future for water management;[37]
- More intense rain events, since warm air holds more water vapor. However, warmer temperatures also lead to greater evaporation and transpiration of moisture, causing drier conditions in soils. In much of the Northeast, extended periods of dryness are predicted to become much more frequent;[38] and,
- Continued increases in fires, pests, disease pathogens, and invasive weed species.[39]

Increasing Precipitation[40]*:*

Precipitation and runoff are likely to increase in the Northeast (and Midwest) in both the winter and spring. Over the last 50 years, the Northeast has experienced snow pack reductions, and observations indicate a transition to more rain and less snow in both the Northeast and the Western regions of the country.

According to the State Climatologist, New Jersey is getting wetter.[41] Mean annual precipitation in the State from 1895 to 1970 was 44.57 inches, while from 1971 and 2000 it was 49.79 inches, and from 2000 to 2008 it was 51.75 inches. The additional atmospheric moisture contributes to more overall precipitation in some areas, especially in much of the Northeast. Such areas, where total precipitation is expected to increase the most, would also experience the largest increase in heavy precipitation events. For the Northeast, projections indicate spring runoff will advance by up to 14 days. Earlier runoff produces lower late-summer streamflows, which stress human and environmental systems through less water availability and higher water temperatures.

Water-related impacts will include the following:

- Heavy downpours increase the incidence of water-borne diseases and flood, resulting in potential hazards to human life and health;
- Floods disrupt transportation. Heavy downpours affect harbor infrastructure and inland waterways;
- Intense precipitation can delay spring planting and damage crops;
- Earlier spring snow melts lead to increases in the number of forest fires; and,
- With significant modifications in the major aspects of the water cycle, including precipitation, the past is no longer a reliable guide for future water planning.

[35]Karl, Thomas, et al, 2009.
[36]Frumhoff, et al., 2007.
[37]Karl, Thomas, et al, 2009.
[38]Frumhoff, et al., 2007.
[39]Karl, Thomas, et al, 2009.
[40]Karl, Thomas, et al., 2009. This report is the basis for this entire subsection.
[41]O'Neill, James, 2009. How could climate change affect New Jersey (interview with the State Climatologist) in *The Record* (North Jersey Media Group), June 19, 2009.

Rising seas:

Sea level rise due to climate change is a major concern for New Jersey. Sea level in the Northeast region is projected to rise more than the global average.[42] The State is especially vulnerable to significant impacts due to geologic subsidence, the topography of its coastline, current coastal erosion and a high density of coastal development.[43] A sea level rise in line with median projections would threaten the majority of New Jersey's coastline. These effects will be magnified during storm events, increasing the severity of storm-related flooding in coastal and bay areas. It is predicted that by the end of the century, Atlantic City will experience floods every one to two years that are as severe as those that now occur only once per century.[44] In addition, if the recent measurements showing a dramatically increased rate of melting of the Greenland ice sheet[45] are substantiated by further data, and if the melting continues at this rate or accelerates further, the rate of sea level rise throughout the world will increase significantly, and the severity and frequency of coastal flooding in New Jersey will be even greater.

***Economic Impact of Climate Change**:*

The possible economic impacts of climate change in New Jersey are enormous.[46] A key impact, sea-level rise, puts the State's coastal-dependent, $35 billion tourism industry statewide ($23 billion for just Monmouth, Ocean, Atlantic, and Cape May in 2006[47]) in jeopardy, with potentially dire repercussions on its economy.[48] The cost of climate-proofing the State increases as sea level rises and hurricanes increase in number and intensity (which many experts expect to happen as ocean waters warm). In addition to threatening New Jersey's tourism industry, climate change also creates economic risks to New Jersey's ports and agricultural tradition. Every year's delay in reducing CO_2 emissions will increase the final bill to New Jersey, including expenditures on adaptation.

However, the economic benefits of undertaking early actions to address climate change are also noteworthy. Studies[49] show that industrialized countries could achieve major reductions in carbon emissions at zero or negative net cost -- even before considering the benefits of avoided damages from climate change. With appropriate policies, such as a permit auction

[42]Karl, Thomas, et al, 2009.

[43]U.S. Department of State, 2002, U.S. Climate Action Report, p. 103, U.S. Department of State, Washington, DC.

[44]Frumhoff, et al., 2007.

[45]Velicogna, Isabella, and John Wahr, 2006, Acceleration of Greenland ice mass loss in spring 2004, Nature, 443, 329-331.

[46]The magnitude of the costs involved at the global level have been studied and reported. The IPCC Fourth Assessment Report (2007) suggests that the macro-economic effects of mitigation towards stabilization (between 445 and 710 ppm of CO_2eq, which would be achieved if New Jersey's GHG reduction limits, established by law and discussed herein, are achieved globally) in 2030 vary from a small increase in global GDP to a 3 percent decrease. The Stern Review on the Economics of Climate Change (2006) suggests that the annual cost of emissions reduction leading to stabilization at 550 ppm CO_2e is likely to be around 1 percent of GDP by 2050.

[47]Global Insights. 2008. An Assessment of the Potential Costs and Benefits of Offshore Wind Turbines: A Report for The State of New Jersey. Submitted to the New Jersey Commerce Commission August 2008.

[48]Frumhoff, et al., 2007.

[49]McKinsey & Company, Reducing U.S. Greenhouse Gas Emissions: How Much at What Cost?, U.S. Greenhouse Gas Abatement Mapping Initiative, Executive Report, December 2007.

system and improved energy efficiency, economic gains can offset the costs to the economy from increases in energy prices due to carbon pricing. Implemented in the near-to-medium term, these policies would result in sizeable benefits during the transition to a low carbon future. The sooner the transition begins, the greater the benefits will be to the economy and the climate. Economically-driven market transformation policies could include strict building, appliance and auto efficiency standards, government rebates for efficient vehicles paid for by fees on inefficient ones (e.g., feebates), financial incentives for the manufacture of energy-efficient products and utility payments to buyers of energy-efficient equipment and buildings. While New Jersey is already ranked 4th among the top ten states attracting venture capital investments in companies in the clean energy economy[50], these additional market transformations will go a long way towards advancing New Jersey's head start in creating a "green" economy.

Recent research ranked available and nearly-available GHG control technologies in terms of net cost per ton of carbon reduced, from least expensive to most expensive.[51] Twenty-five percent of the economically-achievable emission reductions are from energy efficiency measures, which ultimately pay for themselves by reducing the demand for energy. Under an advanced energy efficiency scenario (i.e., recovering 25 percent of the total economically-achievable potential of energy efficiency), one study estimates that the State could save $6.2 billion in avoided electricity and gas energy costs and provide a net benefit of about $3.8 billion over a 15-year period.[52] Also on the horizon is the potential pay-off from research and development of clean energy power generation and of alternatives to highly warming gases. New Jersey can gain a considerable technological head start in these critical areas with its well-established university and industry research and development infrastructure. Positive results will have implications for the State's economic output, income and employment.

New Jersey's Global Warming Response Act

The effects of increasing levels of GHGs in the atmosphere are accepted by most members of the international scientific community as seriously detrimental to the ecosystems and environment of the world. Ultimately, if steps are not taken to reverse these trends, the effects on humans, other animals and plant life on Earth may be catastrophic. Convinced that the solutions to halt the increase of GHGs in the atmosphere and reduce these emissions exist today, and that, as a global issue, each country and region within a country must do its part to reduce GHG emissions, New Jersey has become a leader in the effort to reduce GHG emissions through state level actions, as well as regionally through collaboration with other states and by advocating for federal action.

Taking initiative on a statewide level, New Jersey enacted the Global Warming Response Act (GWRA) (P.L. 2007, c.112) on July 6, 2007. This law codifies the targets for the reduction of GHG emissions in New Jersey that were set forth previously on February 13, 2007 in the Governor's Executive Order 54. Specifically, the GWRA mandates reductions in GHG emissions to 1990 levels by 2020, approximately a 20 percent reduction below estimated 2020 business-as-usual (BAU) emissions, followed by a further reduction of emissions to 80 percent below 2006 levels by 2050. As required under the Act, this report specifically provides the

[50]"The Clean Energy Economy – Repowering Jobs, Businesses and Investments Across America", The PEW Charitable Trusts, June 2009, page 35, Exhibit 14 - Venture Capital Investments.
[51]The McKinsey Quarterly. 2007. A Cost Curve for Greenhouse Gas Reduction.
[52]KEMA, Inc. for Rutgers University Center for Energy, Economic and Environmental Policy and NJBPU. 2004. New Jersey Energy Efficiency and Distributed Generation Market Assessment.

Governor, Treasurer and the State Legislature with a number of climate-specific recommendations, as well as related actions to achieve the statutory 2020 statewide GHG limit, and discusses the key policy areas that need to be considered in order to meet the 2050 statewide GHG limit.

The remainder of Chapter 1 discusses the New Jersey statewide GHG inventory, which is a preliminary assessment of the State's human-caused GHG emissions and carbon sinks.

What is included in this report

Chapter 2 provides a detailed look at the core measures needed for New Jersey to meet the 2020 statewide GHG limit, including an economic assessment of these core measures. Chapter 3 outlines a number of recommendations and related actions, beyond the core 2020 recommendations, that can and should be implemented immediately, to allow the State to exceed its 2020 limit on its way to meeting its 2050 limit, and to provide a cushion for the core 2020 actions. In addition, this chapter provides an assessment of the potential environmental and economic impacts of a number of these measures. Chapter 4 discusses the fact that despite the State's best efforts to meet its ambitious GHG limits, New Jersey is already experiencing, and will continue to experience, some degree of negative impact from the GHGs already present in the atmosphere (e.g., sea level rise and ambient temperature increases), requiring the State to develop an adaptation and preparedness plan. Chapter 5 outlines the State's plans for coordinating its climate change-related outreach and education efforts in the near term. Finally, Chapter 6 discusses the State's 2050 limit and next steps for implementing the recommendations in this report.

New Jersey Statewide Greenhouse Gas Inventory

The New Jersey Department of Environmental Protection (NJDEP) released the final version of its first statewide GHG inventory[53] on October 31, 2008.[54] This inventory presents a preliminary assessment of New Jersey's statewide anthropogenic (human-caused) GHG emissions (including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and certain halogenated gases) and sinks (carbon storage) from 1990 to 2020, assuming both a business-as-usual scenario and a scenario that attempts to meet the statewide 2020 reduction limit. The purpose of these inventory and forecast estimates is to supply the State with a basis for understanding New Jersey's current and possible future GHG emissions, and thereby inform the identification and analysis of policy options for mitigating those future GHG emissions.

As presented in the State's GHG inventory report, (see http://www.nj.gov/globalwarming/), New Jersey statewide GHG emissions in 1990 were approximately 123 million metric tons (MMT) of CO_2 equivalent (CO_2eq) per year. By 2004[55], those emissions had risen 11 percent to

[53]"New Jersey Greenhouse Gas Inventory and Reference Case Projections 1990-2020", November, 2008. Available at the New Jersey Global Warming Website at http://www.nj.gov/globalwarming/.

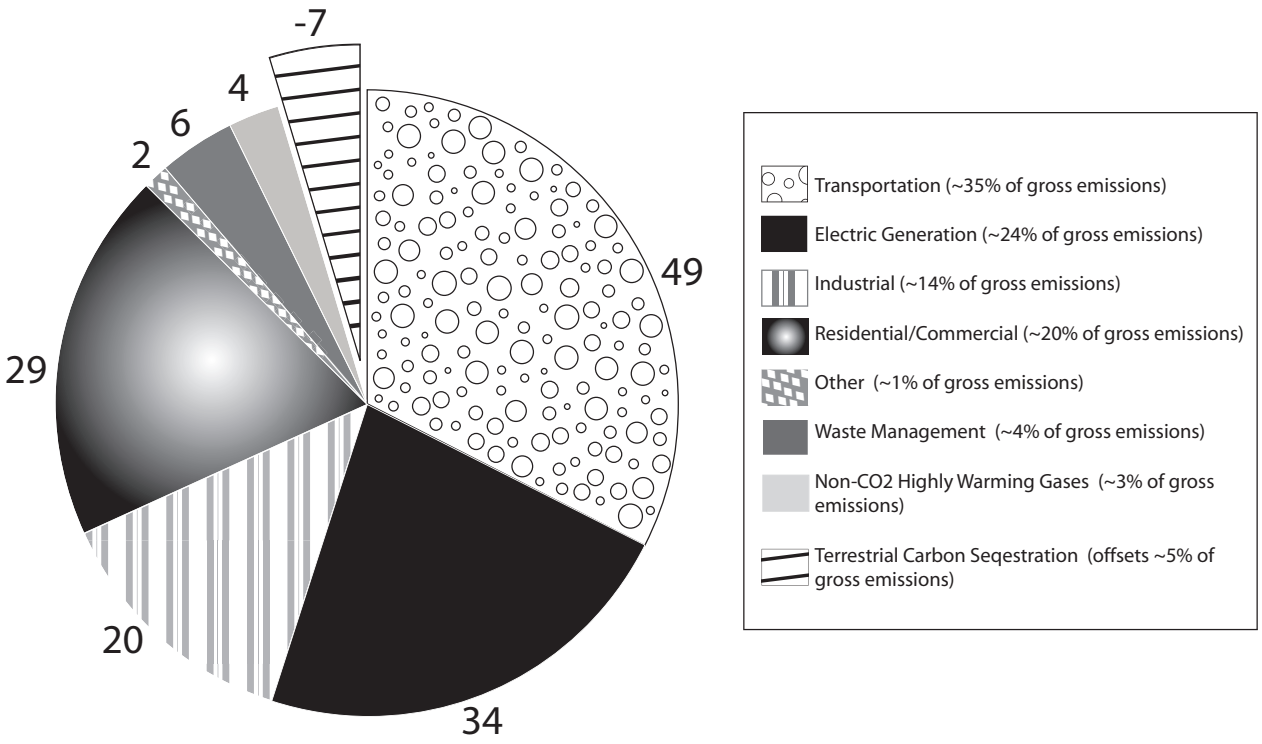
[54]The NJDEP met with stakeholders and interested parties to review and discuss a draft of this inventory on March 19, 2008 and accepted written comment.

[55]The State has completed GHG inventory estimates for 2005, 2006 and 2007. Data show that differences from the 2004 to 2007 totals are minor; the sectoral proportions are similar.

approximately 137 MMT. Under a business-as-usual scenario, emissions are projected to increase 25 percent above 1990 levels to approximately 154 MMT per year by 2020. The State recently completed GHG inventory estimates for 2005, 2006 and 2007 (see http://www.nj.gov/globalwarming/).

As shown by Figure 1.1, the State's GHG inventory is divided into eight sectors.

Figure ES 1: GHG Emissions by Sector; New Jersey, 2004 Millions of Metric Tons CO_2eq (Source: New Jersey GHG Inventory and Reference Case Projections 1990-2020 November 2008)



Measurement Issues

GHG emissions are reported in millions of metric tons of CO_2 equivalent, in keeping with international scientific convention. A metric ton is 1,000 kilograms. It is approximately equivalent to 1.1 short tons. The short ton, 2,000 pounds, is still used in some contexts. "Carbon dioxide equivalent" is a consistent and comparable measure for reporting quantities of multiple types of greenhouse gases. Some gases have a higher global warming effect than others, which is expressed by their Global Warming Potential (GWP). Carbon dioxide has a GWP of 1, while other gases have much higher GWPs (for example sulfur hexafluoride has a GWP of 22,800). Global Warming Potential is a measure of the radiative efficiency (heat absorbing ability) of a particular gas relative to that of carbon dioxide. That is, it is the ability of a gas to warm the atmosphere, as compared to an equivalent release of carbon dioxide over a specified timescale (generally 100 years). The carbon dioxide equivalency for a gas is obtained by multiplying the mass of a gas by its GWP. Key sectors in which the GWP of a gas has a major impact include: waste management, which is a source of methane (GWP 25) and nitrous oxide (GWP 298); and refrigeration and air conditioning, which are sources of hydrofluorocarbons (GWPs range between 124 and 14,800).

Transportation and Land Use

Estimated emissions from on-road gasoline vehicles, on-road diesel vehicles, aviation, marine vessels, and railroad and other transportation sources totaled approximately 49 MMT of CO_2eq in 2004. Combined, these five subcategories of transportation contributed approximately 35 percent of New Jersey's gross GHG emissions in 2004. Therefore, transportation represents the largest sector of New Jersey's GHG emissions, with on-road gasoline consumption representing the vast majority of those emissions. Transportation is also the fastest growing sector. This is due to both: 1) the annual increase in the number of miles driven each year by New Jersey motorists (otherwise known as vehicle miles traveled or VMT) since 1990[56], and 2) the fact that the fuel efficiency gains from cars over time have been negated by the increased use of light trucks (e.g., sport utility vehicles).[57] Even though total VMT in New Jersey from 2007 to 2008 declined by approximately 3 percent, it appears that this decrease occurred in part because of a 26 percent increase in gasoline prices during the same period. If historic trends hold true, VMT declines associated with spikes in gasoline prices tend to reverse themselves once gasoline prices drop.

The total contribution of the transportation sector to GHG emissions is a product of several factors, including the vehicles themselves, the overall level of travel activity, the technologies used to power that activity, and the infrastructure used to support that activity. Since there is a cause and effect link between land development and VMT (e.g., people living in the suburbs and commuting greater distances to work and other activities), land use is directly and synergistically linked to the transportation sector of New Jersey's GHG inventory. As such, recommendations to address transportation-related emissions must focus on each of these factors by ensuring the proliferation of increasingly cleaner vehicles and fuels; encouraging eco-friendly driving and vehicle maintenance habits; providing for clean, safe and reliable alternatives to single-occupancy vehicles and reducing reliance on motor vehicles; and, improving the State's overall land use planning and design in order to reduce sprawl and encourage compact living that is conducive to non-motor vehicle commuting.

Electric Generation

Estimated emissions from in-state electricity generation, in-state municipal solid waste (MSW) resource recovery with electric generation, and imported electricity totaled approximately 34 MMT of CO_2eq in 2004. Combined, these three subcategories of electricity generation contributed approximately 24 percent of New Jersey's gross GHG emissions in 2004. Therefore, based on New Jersey's GHG inventory, electric generation is the second largest contributor to GHG emissions in the State, with in-state generation and imported electricity representing the vast majority of those emissions. While the link between electricity generation and its environmental impacts, particularly the air quality impacts, has long been understood in New Jersey, there has also been an understanding that the environmental concerns must be balanced with the need for a reliable and affordable supply of electricity, ensuring that new environmental regulations do not negatively impact the reliability of power supplied in New Jersey.

[56]New Jersey's Annual Certified Public Road Mileage and VMT Estimates (1975-2006), NJDOT - Bureau of Transportation Data Development, Roadway Systems Section.

[57]Information obtained from a 2007 Energy Information Administration/Department of Energy (EIA/DOE) presentation ("Trends and Transitions in the Diesel Market" by Joann Shore and John Hackworth for the 2007 National Petrochemical and Refiners Association (NPRA) Annual Meeting). For more information, go to www.eia.doe.gov.

Fortunately, solutions are available today to both reduce New Jersey's energy demand and "green" its energy supply, consequently reducing this sector's "carbon footprint."

"Local Impacts" From Distributed Generation

The Energy Master Plan includes strategies to expand the use of strategically-located distributed generation resources throughout the State. Distributed generation resources refer to the generation of electricity using small, modular units. They are "distributed" because they are located near the point of use, unlike centralized large-scale power plants which are located farther away from the point of use and utilize power lines to transmit to the consumer. Locating the generation of the electricity close to its end user is advantageous because it reduces the loss of electricity through transmission lines and reduces ratepayer impacts.

Distributed generation resources include renewable and clean technologies, such as wind turbines, solar power, fuel cells, load reduction technologies, and battery storage systems, but also include more traditional fossil-fuel based technologies, including microturbines, reciprocating engines, and combined heat and power. Fossil fuel-based distributed generation resources have the potential to emit more pollutants per unit of electricity than their centralized counterparts, and these pollutants have the potential to impact areas near their location. Clearly, some forms of distributed generation resources have little or no impact on local air quality (i.e. solar), while other forms (i.e. reciprocating engines) do impact local air quality. Therefore, as the State moves forward with implementing the EMP strategy for promoting distributed generation resources, it is critical to consider localized air quality impacts as well electricity needs. Strategies to encourage the expansion of distributed generation resources must emphasize the use of renewable and clean distributed resources and demand response programs. For fossil fuel-based distributed generation resources, the NJDEP has regulations that set emission limits to define clean distributed generation. Recent initiatives to help reduce local impacts from electric generating resources include a rule to limit emissions from generating units that operate primarily on high electric demand days (HEDD). This rule includes both short and long term emission control strategies. The short term strategy achieves NO_x emission reductions, starting in 2009, based on a regional Memorandum of Understanding. The long term strategy implements performance standards for HEDD units starting in 2015. Rules are also being implemented to address particle emissions, specifically SO_2 and NO_x emissions, from coal-fired boilers, including those serving electric generating units, by 2013. Taken together, these requirements will help ensure that local impacts to public health and the environment will be reduced as the State pursues strategies to achieve our GHG emission reduction goals and meet the future demand for electricity.

Residential/Commercial

Estimated emissions from residential and commercial fuel use (excluding electricity use, which is captured in the "Electric Generation" sector) totaled approximately 29 MMT of CO_2eq in 2004. This category contributed approximately 20 percent of New Jersey's gross GHG emissions in 2004, and represents the third largest sector of New Jersey's GHG emissions. The primary source of GHGs from this category is CO_2 that is released when fuels are burned to generate space heat. However, the non-heat related sources of GHGs generated by New Jersey's residential and commercial sector for electricity use, while captured by the Electric Generation sector of the State's GHG inventory, are also impacted from a consumer perspective by energy efficiency related control measures and options. For example, energy use in this sector is a function of initial design and construction, as well as a building's total operation over its lifetime. Therefore, it is critical to focus not only on "green" design for new construction, but also on ways to retrofit existing construction to be more environmentally-friendly and less energy intensive. This can be done not only through structural changes (e.g., energy efficient windows), but also through conversions to more energy efficient equipment and appliances.

Industrial

Estimated emissions from industrial fuel use (excluding electricity use, which is captured in the Electric Generation sector) and processes, as well as natural gas transmission and distribution, totaled approximately 20 MMT of CO_2eq in 2004. As such, this category contributed approximately 14 percent to New Jersey's gross GHG emissions in 2004, representing the fourth largest sector of New Jersey's GHG emissions, including industries that are important to New Jersey's manufacturing economy. This sector can be further divided into several subcategories. The largest of these subcategories include refineries, which emitted approximately 7.3 MMT of CO_2eq in 2004. Emissions of GHGs from other industrial sectors include pharmaceutical manufacturing (0.65 MMT CO_2eq in 2004), iron and steel (0.60 MMT CO_2eq in 2004), food processing (0.39 MMT CO_2eq in 2004) and glass manufacturing (0.38 MMT CO_2eq in 2004). Several other smaller industrial subcategories have combined emissions in the range of 0.2 MMT of CO_2eq, much of which is likely from industrial boilers, which in itself represents an emissions source that might need be addressed in a coordinated manner.

The GHGs from this category are primarily those released when fuels are burned to generate process heat. The heat produced is used in a variety of different production processes to make a wide range of products. Therefore, to address this category of emissions, it is important to focus on how efficiently the heat is produced, as well as how efficiently it is used. There are non-heat related sources of GHGs generated by New Jersey's industry, including indirect releases from generation from electricity used to power motors, pumps and other applications; releases of hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) used in cooling and refrigeration equipment; and releases from vehicles used for employee commuting. While these emissions are captured in other sectors of the State's GHG inventory (i.e., Electric Generation, Non-CO_2 Highly Warming Gases, and Transportation), the industries in this sector will need to consider these sources and opportunities available to reduce their emissions in order to meet their overall reduction goals.

Waste Management

Estimated emissions from waste management sources (landfills and Publicly Operated Treatment Works (POTWs), also known as sewage treatment plants) totaled approximately 6 MMT of CO_2eq in 2004. As such, this sector contributed approximately 4 percent to New Jersey's GHG emissions in 2004, and represents the fifth largest sector of New Jersey's gross GHG emissions. Reductions from this category include capitalizing on the GHG benefits from increased recycling of the State's waste stream and controlling emissions from treatment and disposal facilities, as well as utilizing energy efficiency opportunities to reduce their overall energy demand. As the most densely populated State in United States, New Jersey produces a significant amount of waste. Beneficial use of this waste, rather than direct disposal, is viewed by the NJDEP as an opportunity to further reduce energy demands from conventional sources. As a co-benefit, reducing GHG emissions from waste management operations goes hand-in-hand with sound waste management strategies, such as reduce, reuse and recycle initiatives.

Climate Change and Waste Management

Waste management activities and infrastructure, including landfills and wastewater treatment plants, present unique opportunities or GHG reductions.

Waste reduction - New Jersey's primary policy is – and must continue to be – reduction in the use of materials that become waste at the end of their useful life and reduction in the generation of waste at its source. Waste that is never generated does not require energy for transportation, processing and disposal, and does not degrade in a landfill to form methane.

Landfill methane - Many of the State's largest landfills, including the currently operating regional landfills, have installed methane collection systems to either flare or use the captured gas for energy generation. Flaring the gas has the benefit of converting the methane to carbon dioxide, which has a lower global warming potential than methane. Using the methane to generate electricity has the added benefit of offsetting the use of fossil fuels to provide electric output. Many of the older, non-operating landfills in the State do not have collection systems to capture and burn methane. Although landfill methane emissions are declining nationally and in New Jersey, the State has identified a number of non-operating landfills that may offer the greatest opportunity for methane control, and is currently investigating ways to implement methane recovery and electricity generation at these landfills.

Waste-to-energy - Opportunities exist for diversion of organic waste (or "biomass") that is currently destined for disposal in landfills, and its conversion to energy. In general, the logic of diverting biomass material from landfills, where it would otherwise slowly degrade and release GHGs, to offset fossil fuel use through the production of electricity and heat is readily apparent. In fact, the EMP sets a goal of 900 megawatts of biomass-derived electric power by 2020.

Pursuit of this goal must be premised on a well-designed strategy that looks holistically at the lifecycle impacts of such activity. Some of the significant considerations include finding enough material to provide a steady, reliable feedstock; establishment of strict parameters around the types of biomass approved for energy recovery; ensuring that biomass diversion and processing facilities and equipment can meet State and local permitting requirements designed to protect local air quality, noise and other impacts; and disposal of any resulting residues.

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Wastewater treatment - Waste-to-energy and energy efficiency are two methods for reducing the carbon footprint of wastewater treatment plants. Wastewater treatment systems use a variety of methods to remove organic matter from wastewater. Systems using anaerobic methods (without oxygen) can generate significant quantities of methane. Like landfill methane, this methane can be captured, burned and used to generate electricity. Systems using aerobic methods (with oxygen) require aeration, which represents the largest use of energy at many of the State's treatment systems. While selection of the most appropriate treatment method for a wastewater treatment facility depends upon a number of factors, the foremost being the achievement of clean water standards, energy usage and its associated costs are also important considerations. Therefore, for existing wastewater treatment facilities, undertaking a thorough energy audit is highly desirable. Also, all systems, regardless of treatment method used, require pumping to move wastewater, which is also energy intensive. Higher efficiency motors and pumps and other process changes can help reduce electricity use in these operations. Some wastewater treatment systems may also have the capability to utilize methane generated on-site to offset energy purchases for facility operation. One way to use the methane is in combined heat and power units. The rules for the Environmental Infrastructure Trust Financing Program state that all wastewater, water and stormwater projects need to consider opportunities to reduce energy use or to recover energy as part of their facility plans and project reports. See NJAC 7:22-3.11(d)5iii(7).

Non-CO_2 Highly Warming Gases

In addition to CO_2, several other gases have the potential to warm the Earth's atmosphere. Emissions of these gases represent 4 MMT CO_2eq in 2004, contributing approximately 3 percent of New Jersey's GHG gross emissions for that year. The most common use of these gases is as heat transfer agents in refrigeration and air conditioning equipment. Without further action, GHG emissions from this category are expect to increase significantly. At the current rate of increase in emissions of these gases, their relative contribution to global warming will increase as other GHG emissions are reduced. A recent report estimates that HFC releases could account for between 28 to 45 percent of total global radiative forcing by 2050, if CO_2 is reduced in other sectors and nothing is done to reduce HFC releases.[58] This projected increase is largely due to the consistent growth in the use of many of these substances, which are replacements for stratospheric ozone-depleting substances that are being phased out globally pursuant to the Montreal Protocol. In the United States, these phase-outs are implemented through Title VI of the Clean Air Act. Although these replacement chemicals do not deplete stratospheric ozone, many have high global warming potentials (GWP).

While many of these increases are projected to occur in developing nations, releases in New Jersey are also expected to increase significantly. Releases of these gases in New Jersey are expected to increase to 8.4 MMT CO_2eq by 2020, representing 5.5 percent of the statewide GHG inventory based on BAU projections and 7.2 percent of the inventory if expected reductions of CO_2 in other sectors are considered.

Other

New Jersey's 2004 inventory contains another category which includes emissions from agriculture and land clearing. Estimated emissions from this category totaled approximately 2 MMT of CO_2eq in 2004, contributing about 1 percent of New Jersey's GHG gross emissions for that year.

Terrestrial Sequestration

The growth of vegetation and the accumulation of soil organic matter, especially in forested land, act as a carbon sink, removing approximately 7 MMT of CO_2eq from New Jersey's atmosphere in 2004. This "absorption" of CO_2 offset approximately 5 percent of New Jersey's gross GHG emissions in 2004. While most of the recommendations outlined in this report focus on reducing the amount of CO_2 and other GHG emissions emitted into the atmosphere, it is just as important to maintain, and increase, the natural sinks that absorb and sequester CO_2. There is a growing body of research that indicates a significant potential for creating GHG mitigation through agriculture, forestry and vegetative measures.

Forests play a critical role in climate change by sequestering or storing large quantities of carbon by absorbing CO_2. Photosynthesis and respiration are the essential machinery by which forests store and release carbon. As a tree grows and increases in biomass, it absorbs CO_2 from the air and, through the process of photosynthesis, uses solar energy to store carbon in its roots, stems, branches, and foliage. Some carbon is released back into the atmosphere as CO_2 during

[58] Guus J. M. Veldersa,1, David W. Faheyb, John S. Danielb, Mack McFarlandc, and Stephen O. Andersen, "The large contribution of projected HFC emissions to future climate forcing" Proceedings of the National Academy of Sciences, June 19, 2009, Early Edition.

respiration, but a living tree acts as a carbon "sink", storing more carbon than it releases. Trees continue to accumulate carbon until they reach maturity, at which point about half of the average tree's dry weight will be carbon. Nationwide, the U.S. Department of Agriculture projects that forest, crop and grassland conservation efforts can play a unique role in reducing the GHG intensity of the U.S. economy. Increasing carbon sequestration in soils has become a viable way of augmenting the reduction of atmospheric GHG emissions. A 2007 study[59] found that forest management practices would provide the lowest cost offset options in most regions of the United States.

[59]McKinsey and Company. 2007. "Reducing U.S. Greenhouse Gas Emissions: How Much at What Cost?" U.S. Greenhouse Gas Abatement Mapping Initiative Executive Report.

Chapter 2: Ensuring Attainment of the Statewide 2020 Greenhouse Gas Limit

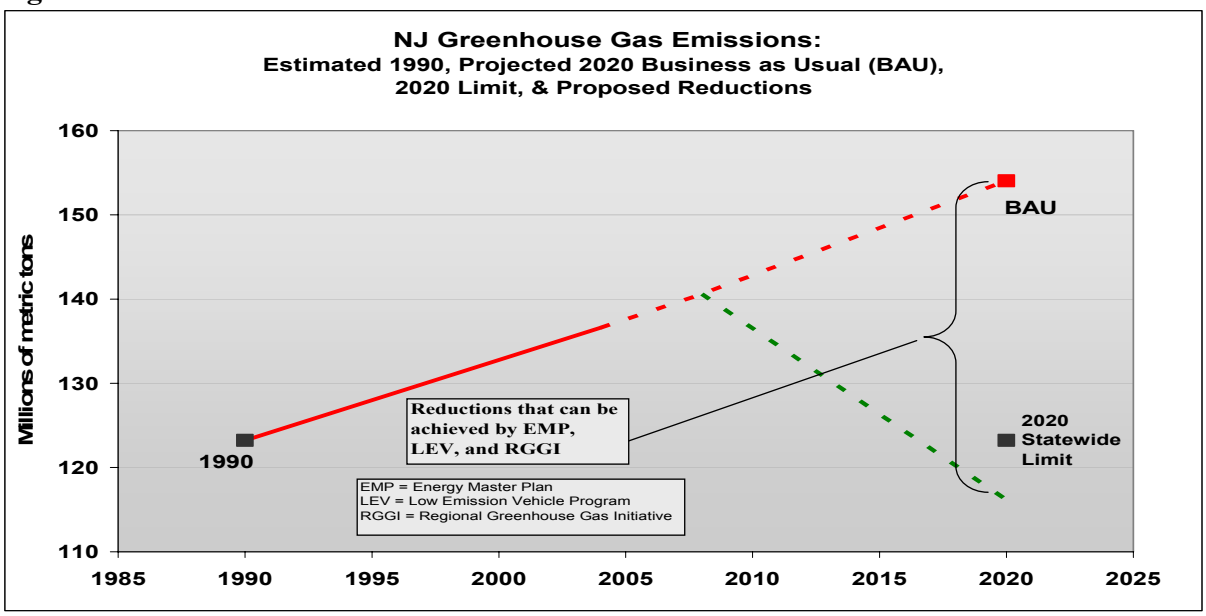
Three core measures form the backbone of New Jersey's plan to meet its statewide 2020 GHG limit. The core measures implement the:

- New Jersey Energy Master Plan (EMP);
- New Jersey Low Emission Vehicle (LEV) program; and,
- Regional Greenhouse Gas Initiative (RGGI) program.

The core measures are targeted at reducing GHG emissions from the two largest contributors to New Jersey GHG emissions – transportation and energy – and they lay the groundwork for all future actions in these areas.

According to an analysis conducted by the New Jersey Department of Environmental Protection (NJDEP) (included as Appendix 1 of this report) the three core measures, if fully successful and fully implemented on schedule, would result in a reduction of approximately 38 MMT CO_2eq below the estimated business-as-usual emission level of 154 MMT CO_2eq, or 116 MMT CO_2eq, by 2020. This would allow the State to meet its statewide 2020 limit of 123 MMT CO_2eq. Figure 2.1 shows the impact of not implementing these core recommendations, but instead allowing for a business-as-usual (BAU) scenario. Table 2.1 provides the supporting data for Figure 2.1.

Figure 2.1: NJ Greenhouse Gas Emissions[60]



All emission and reduction quantities are estimates. The actual statewide emissions up to and including 2004 are unlikely to be more than 5 percent higher or lower than these estimates. The projections to 2020, and the proposed reductions, are considerably less certain. Reductions attributable to RGGI are difficult to quantify at a statewide level because the RGGI limits are regional. For purposes of the 2020 estimates that reflect the various reductions, the emissions from New Jersey facilities covered by RGGI are considered to be equal to New Jersey's estimated share of the total RGGI limit. All numbers are subject to revision by the NJDEP as better information becomes available.

[60]Based on data in "New Jersey Greenhouse Gas Inventory and Reference Case Projections 1990-2020", November, 2008. This document is posted on the State's Global Warming Web page at http://www.nj.gov/globalwarming/.

Table 2.1: Estimated New Jersey GHG Emissions and Projections ($MMtCO_2eq$)

Sector	Sub-sector	2004	2020 BAU	2020 with potential reductions from 3 core measures	Comments
Transportation	On-road gasoline	38.3	44.3	34.6	Reductions assume LEV in place prior to implement of the National Program currently under consideration; are sensitive to VMT
	On-road diesel	7.5	11.0	10.8	
	Aviation	1.0	1.0	1.0	Primarily jet fuel, estimated in-state use only
	Marine	1.5	1.8	1.8	Near-shore and port activity only; does not include port expansion
	Railroad & Other	0.5	0.6	0.6	
Electricity Generation	In-state	19	28.1	19.6	Reductions represent RGGI cap, adjusted for non-RGGI facilities
	In-state; on-site, inc. CHP		0.9	7.2	Assumes most are < 25 MW & not subject to RGGI
	In-state, refuse & biomass	1.3	2.7	4.0	Assumes biomass CO_2eq emissions similar to biodiesel
	Imported	13.4	10.9	-10.1	Negative value represents exports
Residential	Space heat	13.6	8.2	5.8	Residential, Comm., & Industrial
	Other combustion	3.9	3.5	3.3	Reductions based on NJBPU data
Commercial	Space heat	6.6	8.0	5.6	
	Other combustion	4.8	5.1	5.0	
Industrial	Space heat	0.9	0.6	0.6	
	Other combustion	17.1	16.0	15.1	
Halogenated gases (excluding SF_6)		3.4	8.4	8.4	
SF_6		0.4	0.1	0.1	
Industrial non-fuel related		0.1	0.1	0.1	
Agriculture		0.5	0.4	0.4	
Natural gas T&D		2.4	2.5	2.5	
Landfills, POTWs		6.1	4.6	4.6	Includes out-of-state emissions from NJ MSW
Released through land clearing		1.1	1.1	1.1	
Total Gross Emissions		143.4	159.9	122.1	
Sequestered by forests		-6.8	-5.9	-5.9	
Total Net Emissions		**136.6**	**154.0**	**116.2**	
Change in net emissions relative to 1990		***11%***	***25%***	***-6%***	

All values are estimates; 2004 values are believed to be accurate to within 5 percent, 2020 projections are much less certain.

"BAU" is Business-as-Usual, "CA LEV" is the California Low Emission Vehicle program, "CHP" is combined heat and power, "MSW" is municipal solid waste, "POTW" is Publicly Owned Treatment Works, "refuse" includes municipal solid waste, "RGGI" is Regional Greenhouse Gas Initiative, "SF_6" is sulfur hexafluoride, "T&D" is transmission and distribution, "VMT" is vehicle miles traveled.

GHG Co-Benefits from Controls to Meet the National Ambient Air Quality Standards

The entire State of New Jersey is currently designated by the USEPA as nonattainment for the 1997 8-hour ozone National Ambient Air Quality Standard (NAAQS). In addition, 13 of New Jersey's 21 counties are designated as nonattainment for the 1997 $PM_{2.5}$ NAAQS. $PM_{2.5}$, also known as fine particulate matter, in the atmosphere is composed of a complex mixture of particles in the atmosphere: sulfate, nitrate, and ammonium particles; particle-bound water; black carbon (also known as soot or elemental carbon); and many organic compounds, including volatile organic compounds (VOCs). In response to the USEPA nonattainment designations, the NJDEP has submitted attainment demonstration plans designed to show how New Jersey will attain these standards by 2010. Also, the State has submitted a Regional Haze Plan to the USEPA, which establishes progress goals and control strategies for improving visibility (which is primarily impeded by fine particles in the atmosphere) in federally protected areas. All of these plans commit the State to implement a number of new control measures.

The control measures being implemented to meet the Federal ozone, $PM_{2.5}$ and Regional Haze requirements are also beneficial in the State's efforts to address climate change. Since black carbon (soot) and ozone have an atmospheric warming effect, the numerous control measures already under consideration or being implemented by the State to address these pollutants, such as diesel idling infrastructure alternatives (e.g., truck stop electricification), cleaner heating fuel, NO_x reductions on high electric demand days, and requiring VOC recovery at refineries, will also address their impact on climate change. In fact, since the atmospheric lifetime of black carbon and ozone are so much shorter than those of the long-lived GHGs, days as opposed to years for CO_2, methane and hydrofluorocarbons, reductions in these short-lived species may prove to be of some importance in slowing climate change in the short term.

Energy Master Plan

In October 2006, the State began a comprehensive planning process to generate a new statewide Energy Master Plan (EMP). The EMP plans for the State's energy needs, and is fundamentally designed to guide New Jersey toward a responsible energy future with adequate, reliable energy supplies that are both environmentally responsible and competitively priced.

The EMP focuses on the energy usage issues associated with electricity and heating, and refers the energy-related transportation issues to this GWRA recommendation report. The EMP sets forth several major goals for achieving its fundamental charge of ensuring a reliable, cost-effective electricity and heating supply that is environmentally sound and allows for economic progress in the State. Meeting these goals also ensures that the State will achieve the necessary GHG emission reductions from the electricity generation and heating sector to meet the GWRA's GHG limits, and provides the State with a roadmap to stay on track to ensure the necessary emission reductions in this sector. Specifically, the EMP establishes the following goals for New Jersey:

- Maximize energy conservation and energy efficiency to achieve reductions in statewide energy consumption of at least 20 percent by 2020;
- Reduce peak electricity demand for electricity by 5,700 MW by 2020;
- Strive to exceed the current renewable portfolio standard and meet 30 percent of the State's electricity needs from renewable sources by 2020;
- Develop a 21st century energy infrastructure that supports the goals and action items of the Energy Master Plan, ensures reliability of the system, and makes available additional tools to consumers to manage their energy consumption; and,

- Invest in innovative clean energy technologies and businesses to stimulate the industry's growth in New Jersey.

The EMP recommends 20 specific actions to achieve these five goals, which are summarized in Table 2.2. The EMP can be downloaded at www.nj.gov/emp.

Table 2.2: Draft EMP Recommendations

Conservation and Energy Efficiency	
Action	**Description**
Redesign and Transition the State's Current Energy Efficiency Program	Expand electricity and gas utility participation to support cost effective achievement of the State's desired energy efficiency goal
Enhanced Building Codes for New Construction	Coordinate with the Legislature to authorize new codes resulting in new construction which is 30% more energy efficient by 2009, and a longer term goal of achieving net zero carbon emitting buildings
New Appliance Standards	Work with the Legislature to set minimum energy efficiency standards for new appliances and other equipment not currently covered by existing standards by 2009
Education and Public Outreach	The NJBPU will continue to focus on education and outreach to inform the public about the Clean Energy Program
Reduce Peak Demand	
Action	**Description**
Expand Incentives for Participation in Regional Demand Response Programs	Governor's office and NJBPU will work with PJM[61] to maximize incentives from PJM, and state incentives, to reduce peak demand
Involve Electric Utilities in Developing and Implementing Demand Response Programs	Design and evaluate programs such as real-time pricing, electric utility procurement of demand-side resources, and utility programs for direct load control so that they ensure cost effectiveness
Target all Commercial and Industrial Customers with a Peak Demand of 500 kW or Greater for Reduction in Peak Demand, and Continue to Develop Incentives that Achieve Significant Peak Demand Savings	Aiding large commercial and industrial customers in managing their energy usage and costs through education and outreach regarding best practices and current technologies
Pilot Different Technologies and Rate Structures to Determine the Best Way to Achieve Peak Demand Reduction for Residential Customers and All Customers with a Peak Demand Below 500 kW	Researching the ability of differential rate structures, expanded communication, and expanding user technologies such as advanced metering infrastructure to effectively reduce peak demand in this sector
Monitor and Evaluate Effectiveness of Strategies, and Implement the Most Effective Mix of Action Steps	Using what is learned through piloting use of evolving new technologies and practices, the State will track its progress to the goal of a 5,700 MW reduction in peak demand by 2020
Renewable Energy	
Action	**Description**
Change the Solar Energy Goals from a Percentage of 2.12% to a Goal of 2,120 GWh by 2020	This provides a clear market signal of the depth of New Jersey's long term commitment to solar to the industry and its investors, supporting solar renewable energy certificate

[61]PJM Interconnection (PJM) is the independent electric grid operator serving the Mid-Atlantic and parts of the Southeast and Midwest regions of the country, including New Jersey.

	markets and promoting community-scale solar development
Development of New Jersey's Offshore and Onshore Wind Resources	Develop at least 1,000 MW of offshore wind by 2012, and at least 3000 MW of offshore wind and up to 200 MW of onshore wind by 2020, to provide New Jersey with 13% of its total energy needs under 2020 projections
Develop 900 MW of Biofuels and Biomass as Part of the State's 2020 RPS	Expanding the use of sustainably cultivated and harvested sources of biofuels, and capitalizing upon New Jersey's existing biomass resources
Increase the Support of Other Renewable Energy Technologies	Establish policies and funding sources to promote other renewable technologies such as low head hydro, and other technologies which may emerge, such as tidal power
Increase the Renewable Portfolio Standards for the Years 2021-2025	Examine possibilities to expand the percentage of renewable sources of electricity beyond the year 2020, to provide long-term market assurance of New Jersey's commitment to renewable energy
Develop a 21st Century Energy Infrastructure That Supports the Energy Master Plan Goals, Ensures System Reliability, and Provides Consumers Tools to Manage Their Energy Consumption	
Action	**Description**
State Cooperation with Electric and Gas Utilities in Development of Utility Territory Master Plans Which Correspond to the Energy Master Plan	Each utility territory will develop a master plan which identifies necessary infrastructure upgrades, and proposes strategies for transition the State's energy efficiency programs, to meet the 2020 goals of the Energy Master Plan
Foster the Development of 1,500 MW of New Cogeneration Capacity in New Jersey by 2020	The NJBPU, NJDEP, and NJEDA will work together to identify and alleviate regulatory conflicts, utilize the Retail Margin Fund to provide rebates to new facilities, and exempt all fuels used by new and existing cogeneration facilities that meet a minimum efficiency standard from sales and use tax
Ensure a Balance Between Supply and Demand of Energy that will Ensure Reliability of Electricity and Fuel Supplies; Serve the State's GHG Limits, and Provide Electricity at a Reasonable Price	Within our deregulated market, State efforts are required to ensure that the cleanest, most efficient, and reliable sources of generation are utilized to replace existing units as they retire, supported by distribution systems which can adequately support our infrastructure
Invest in Clean Energy Technologies and Businesses	
Action	**Description**
Encourage Clean Energy Technology Development by Expanding the Edison Innovation Fund	Expand the Edison Innovation Fund to involve clean energy technology commercialization and manufacturing to provide R&D support, gap funding, equity investments, and generating market demand for these sectors
Green Jobs Initiative	An effort to develop a timely and industry recognized curriculum and job training program in energy efficiency, renewable energy, demand response, and energy supply. Targeted statewide, but with an emphasis on urban areas, train the workforce necessary to implement the strategies within the Energy Master Plan
Establish the Energy Institute of New Jersey	Supports basic and applied energy research at the colleges and universities of the State through fostered collaboration, targeted resource allocation, linkages to the energy industry, and support for applications for federal research funding

Biofuels: Ensuring Real GHG Emission Reductions

Biofuels can either contribute to reducing GHG emissions or they can actually increase GHG emissions depending on: feedstock choice, where and how the feedstock is grown, the biofuel production process, and other factors, such as transporting the fuel to its end use. A lifecycle analysis that includes all of these factors must be performed on each type of biofuel to accurately assess its net impact on GHG emissions relative to conventional petroleum fuels such as gasoline and diesel. Although practical constraints on the yields from biofuel feedstocks and expectations about new technologies limit even optimistic projections concerning biofuels to ultimately replace only 10-20 percent of the nation's projected volumetric gasoline and diesel demand (Energy Independence and Security Act of 2007, Based on the Applicable Volumes of Renewable Fuel table in Section 202 – Renewable Fuel Standard, 36 billion gallons of Renewable Fuel in 2022 is 12-16 percent of the projected U.S. demand for gasoline and diesel fuel assuming a yearly growth rate of 1-2 percent. This does not account for the 60-70 percent reduced energy content of ethanol relative to petroleum gasoline.), it is important that biofuels are evaluated and generated with the following principles and issues in mind:

- All life cycle effects must be accounted for and the best science used to calculate net GHG emissions for each type of biofuel. In general, the most favorable lifecycle GHG emissions are for biofuels produced from waste materials (such as waste greases, agricultural residues and trash) and, native, non-invasive, sustainably grown and harvested herbaceous perennial energy crops (such as switchgrass) and short rotation woody crops (such as poplar). In general, the least favorable lifecycle GHG emissions are for biofuels produced from crops that require significant use of fertilizer, water and fossil fuels in their production. In addition, biofuel production processes that use energy from renewable sources result in lower contributions to lifecycle GHG emissions than biofuel production processes that use energy from fossil fuels such as natural gas or coal.
- Biofuel production can take place on existing cropland as well as on marginal lands. Direct and indirect land use effects must be included in the assessment of lifecycle GHG emissions, especially when land-use conversion is involved. Scientists have recently identified the land use effects of biofuels as being an extremely significant factor in the assessment of the GHG impacts of biofuels relative to conventional petroleum fuels. For example, a land use effect occurs when forest is converted to agricultural land because additional land is needed to grow biofuel feedstocks. GHG emissions that result from the clearing of the forest land and the changes to the terrestrial sequestering rate of the land that has been converted from forest to agricultural must be accounted for in the overall biofuel GHG emissions analysis. These land use effects were not included in earlier lifecycle analyses. However, recent studies have concluded that they are extremely significant and must be added to the lifecycle analysis. One study has estimated that when land use effects for corn-based ethanol are taken into account, the lifecycle GHG emissions go from a decrease of about 20 percent to an increase of about 100 percent relative to petroleum fuel over a 30 year period. ("Use of U.S. Croplands for Biofuels Increases Greenhouse Gases Through Emissions from Land Use Change", Timothy Searchinger, Ralph Heimlich, R.A. Houghton, Fengxia Dong, Amani Elobeid, Jacinto Fabiosa, Simla Tokgoz, Dermot Hayes, and Tun-Hsiand Yu, Sciencexpress (www.sciencexpress.org). February 7, 2008). The recommendations below would address land use issues specifically and suggest how to avoid unintended consequences which can prevent biofuels from achieving their potential. (http://www.ucsusa.org/assets/documents/clean_energy/ucs-bioenergy-principles.pdf).
- Establish performance-based policies that reward reductions in GHG emissions over a fuel's full life cycle, based on the best available information and vetted in an open and transparent process. California's Low Carbon Fuel Standard is an excellent example of a life-cycle performance-based fuel policy. Because the science of climate change, including indirect effects, is still evolving and new studies will improve the understanding over time, the fuel policies should include a mechanism to ensure that life cycle emissions metrics used for compliance can be easily updated as the science advances.
- Set realistic expectations about the scope of biomass production instead of establishing somewhat arbitrary production mandates or pricing mechanisms. Based on current knowledge, sustainable biomass can be obtained from waste products such as agricultural residues, forestry residues, and municipal and construction waste. Any significant expansion beyond existing resources, however,

must be based on a sound scientific determination that the required volume of biomass can be produced in a sustainable manner. (Perlack, R.D., et al. Biomass as feedstock for a bioenergy and bioproducts industry: The technical feasibility of a billion-ton annual supply. TM-2005-66. U.S.DOE).

- Account for all of the sustainability and environmental impacts associated with biofuels. There are other unintended consequences associated with many types of biofuels. These include environmental sustainability issues associated with water use and loss of biodiversity. In addition, if sustainable farming practices are not followed, environmental impacts from the use of chemical fertilizers and pesticides could be significant. Using invasive plant species as feedstock for biofuels would also have a deleterious impact on biodiversity. Finally, recently publicized concerns over the impacts of food availability and prices have been the subject of considerable debate.
- Consider the GHG benefits of all potential uses of biomass to generate alternative energy. Alternatives to using biomass to produce liquid transportation fuels may provide higher levels of energy efficiency (i.e., a greater portion of the energy derived from the biomass is used for useful purposes) and result in greater GHG reductions. For example, there may be greater GHG reductions if biomass is used for electricity generation instead of coal or if biomass is used for biogas production as a substitute for natural gas (biogas production is growing rapidly in Europe). Also, the electricity or biogas can ultimately be used for transportation as larger numbers of plug-in hybrids, pure electric vehicles and natural gas vehicles enter the fleet.
- Pursue promising biofuels of the future. New technologies and further development of existing technologies may produce biofuels in the future that overcome many of the yield constraints and sustainability problems associated with current options. One example that may hold promise involves the production of liquid fuels from algae. Theoretical yields of 5,000 gallons of biodiesel per acre per year have been estimated for an operation in which algae contained in reaction vessels is exposed to CO_2 from power plant exhaust. This should be compared with a production rate of about 300 gallons of corn ethanol a year per acre and a production rate of about 60 gallons of biodiesel from an acre of soybeans per year (Bourne, Joel, "Green Dreams", National Geographic, October, 2007, pages 57-59).

In support of the NJBPU's efforts to implement the EMP, the New Jersey Economic Development Authority (NJEDA), in conjunction with the NJBPU, the NJDEP and the Governor's Office has developed the following product portfolio of grants, loans and investments to help businesses with projects that advance the goals of the state's Energy Master Plan.

Clean Energy Manufacturing Fund

Financing is available through the Clean Energy Manufacturing Fund (CEMF) (www.njeda.com) on a competitive solicitation basis. The program encourages new jobs and the growth of Class I renewable energy manufacturers or energy-efficient manufacturers in the State while addressing the goals of the State's Energy Master Plan. The NJBPU is responsible for determining the technical eligibility of all projects; the NJEDA prepares underwriting analysis and makes a financial feasibility determination on all applications.

Grants and loans totaling up to $3.3 million per company per project are available under two separate program components. The first piece is a traditional grant that provides up to 10 percent of total CEMF funds ($300,000) for identifying and securing a leased or purchased site, completing initial project facility design, and obtaining permits and regulatory approvals to operate a facility. To receive the grant, companies must be able to provide a 50 percent cash match of total project costs from other sources/collaborators. At closing, 20 percent of the approved funds will be advanced for upfront seed money with the remainder to be paid after work has been completed and invoices have been submitted.

The second part is a zero-interest loan up to a maximum $3 million that can be used to support site improvements, equipment procurement and facility construction/completion. Eligible companies must have a minimum 50 percent match of total project costs from firmly committed, non-state-derived matching support. No more than one-half of the total project costs of the funds approved may be advanced prior to commercial production.

To take advantage of the funding, applicant companies must be for-profit entities (including corporate joint ventures) that are planning to manufacture eligible products in New Jersey and are entering or expanding within the manufacturing stage of commercial development. Preference is given to those projects that demonstrate a greater percentage of the project being designed, manufactured, processed, assembled or made ready for commercial sale at the company's project facility in New Jersey.

Energy efficiency technologies refer to those technologies, equipment or systems that use electricity or natural gas as a principal input resulting in a substantial increase in the efficient use and/or conservation of these two fuels. Qualifying under the program are energy efficiency equipment and technology that reduce electric or natural gas consumption such as furnaces, boilers and air-conditioning systems with higher efficiencies than adopted New Jersey building energy codes or federal or New Jersey appliance standards, as well as lighting systems, including LED lights and energy monitoring and control systems. Also eligible are Class I renewable energy, such as photovoltaic, solar, wind energy, renewably fueled fuel cells, wave tidal, sustainably harvested biomass and methane gas from landfills.

The NJEDA also has been working closely with the DEP to support the Regional Greenhouse Gas Initiative (RGGI). To best encourage energy efficiency measures within the commercial and industrial sectors and encourage the use of renewable energy, the NJEDA is offering the Clean Energy Solutions Capital Investment loan/grant program, capitalized through RGGI proceeds.

The Clean Energy Solutions Capital Investment Loan/Grant provides financial support in the form of no-interest loans and grants to support commercial, institutional and industrial entity end-use energy efficiency projects, combined heat and power (CHP)[62] production facilities, and new state-of-the-art efficient electric generation facilities, including renewable energy applications. New Jersey-based commercial, institutional or industrial entities that meet regulatory requirements and plan to create or maintain jobs in New Jersey are eligible. Funding may be used for real estate or equipment and there is a $1 million minimum total project cost. Funding will be provided for up to a 10-year term with amortization for up to 20 years based on need.

Maximum/Limits:

- 100% loan, a portion of which can become a grant based on NJEDA scoring criteria.
  - Maximum grant awarded, based on scoring criteria, will be lesser of 80% of amount requested or $2.5 million, with the remainder as loan.
  - Commercial buildings with energy efficiency projects will be limited to maximum grant amount of 20%.
- Total NJEDA/RGGI funding cannot exceed $5 million per applicant.
- Aggregate state funding cannot exceed 50% of project cost.

[62] Combined heat and power plants provide useful thermal energy from waste heat, unlike traditional electric generation where the heat generated as a byproduct is not utilized.

- Equity requirement.

For more detailed information about the Clean Energy Solutions Capital Investment Loan/Grant, visit www.njeda.com.

The Energy Master Plan also includes two additional topic areas considered key to the success of charting New Jersey's electric generation and space heating future: the responsibility of State entities and operations to lead by example, and the need for continued advocacy and analysis by the State of New Jersey with the federal and regional authorities which shape New Jersey's energy paradigm. Key points of each follow:

The State Leading by Example:

- Operate State facilities and equipment as efficiently as possible.
- Pursue immediate energy conservation measures, such as investing in cost-effective energy efficiency projects at State facilities.
- Work with the State Legislature to create an energy savings improvement program.
- Optimize State facility and operations energy supply portfolio to reduce GHG emissions.
- Develop a State facility demand response program.

Continued Advocacy and Analysis:

- New Jersey will work with PJM (the regional electric grid administrator) to modify or replace the Reliability Pricing Model with a mechanism that focuses incentives on new generation capacity, demand response, and energy efficiency.
- New Jersey will work to help shape PJM's planning of the electric transmission system to better protect New Jersey's economy and the environment.
- New Jersey will continue to monitor the data, forecasts and analysis provided by the federal Energy Information Administration to keep abreast of forecasts for future fuel supplies.
- The NJBPU will continue to review annually, in a transparent, public proceeding with all necessary expertise, the procurement of electric energy, capacity, and other electricity-related requirements to supply Basic Generation Service.

Low Emission Vehicle Program

On November 28, 2005, New Jersey adopted a Low Emission Vehicle (LEV) program modeled after California's LEV Program.[63] New Jersey's LEV program contains three components: vehicle emission standards, fleetwide emission requirements, and a Zero Emission Vehicle (ZEV) sales requirement. Specifically, this rule requires all new vehicles offered for sale in New Jersey to be California certified for emissions beginning January 1, 2009.

Implementation of the GHG component of the New Jersey LEV program roughly doubles the GHG reductions by 2020 relative to the GHG reductions from the current federal Corporate Average Fuel Economy (CAFE) standards, and is therefore critical to the State's efforts to meet its GWRA limits. The NJDEP proceeded with the implementation of its LEV program beginning with model year 2009.

On September 28, 2009, the U.S. Environmental Protection Agency and the U.S. Department of Transportation jointly proposed federal motor vehicle GHG emission standards and related fuel

[63] 38 N.J.R. 497(b), (January 17, 2006).

economy standards for model years 2012 through 2016.[64] Once adopted, this federal motor vehicle control program could impact the GHG emission reductions projected for the New Jersey LEV program. The State is in the process of evaluating the impact of the federal program on the State's assumptions regarding greenhouse gas reductions from new motor vehicle initiatives.

Regional Greenhouse Gas Initiative

New Jersey is one of the 10 states participating in the Regional Greenhouse Gas Initiative (RGGI), a ten-state[65] cooperative effort designed to implement a regional mandatory cap-and-trade program in the Northeast and Mid-Atlantic addressing CO_2 emissions from Electric Generating Units (EGUs) (i.e., power plants). Hosting its first allowance auction on September 25, 2008, RGGI became the first mandatory market-based CO_2 emissions reduction program in the U.S. Specifically, the program caps regional power plant CO_2 emissions from 2009 through 2014 and then reduces those emissions 10 percent by 2018. RGGI's phased approach means that reductions in the CO_2 cap will initially be modest, providing predictable market signals and regulatory certainty. Electricity generators will be able to plan for and invest in lower-carbon alternatives and avoid dramatic electricity price impacts.

The design of RGGI reduces GHG emissions while investing in energy efficiency, clean energy technologies, and renewable energy. First, the mandatory cap on CO_2 emissions from regulated power plants ensures emission reductions over time. Second, allowances to emit CO_2 are sold via a quarterly regional auction to generate proceeds that are strategically reinvested to benefit energy consumers and transform markets to promote energy efficiency and clean energy technologies.

The auctioning of allowances is a particularly innovative element of RGGI design and, in New Jersey, is expected to yield approximately $60 million annually for investment in clean energy programs and other benefits to consumers. Such investments make New Jersey businesses more competitive, create jobs immediately, stimulate new markets for energy efficiency, renewable energy, and innovative low-carbon technologies, reduce the cost of cutting GHG emissions and provide relief to ratepayers. The Global Warming Solutions Fund stipulates that 60 percent of New Jersey RGGI proceeds are to be invested by the NJEDA in end-use energy efficiency projects, combined heat and power facilities, renewable energy, and innovative technologies to reduce GHG emissions (as noted in the previous discussion regarding NJEDA's Clean Energy Solutions Capital Investment Program); 20 percent of the proceeds are to be used by the NJBPU to support programs to reduce electricity demand or costs to consumers in the low- and moderate-income residential sectors; 10 percent is allocated to the NJDEP to support programs in which local governments implement measures to reduce GHG emissions; and the remaining 10 percent is allocated to the NJDEP to support programs that enhance opportunities for sequestration of CO_2 through stewardship and restoration of the State's forests and tidal marshes.

RGGI is composed of individual CO_2 Budget Trading Programs in each of the ten participating states. These programs are implemented through state regulations, based on a RGGI Model Rule, and are linked through CO_2 allowance reciprocity. Regulated power plants are able to use a CO_2 allowance issued by any of the ten participating states to demonstrate compliance with the state program governing their facility. RGGI also allows these facilities to employ offsets (GHG

[64] 74 Fed. Reg. 49454, September 28, 2009.

[65] In December 2005, the governors of seven of the states signed a Memorandum of Understanding agreeing to adopt the program. Maryland joined RGGI in mid-2007, and Massachusetts and Rhode Island joined in January 2007.

emissions reduction or sequestration projects at sources beyond the electricity sector) to meet their compliance obligations. Taken together, the ten individual state programs function as a single regional compliance market for carbon emissions. New Jersey filed the adoption of its RGGI regulations on October 10, 2008 (see the November 17, 2008 New Jersey Register). Since December 2008, New Jersey participates in quarterly regional CO_2 allowance auctions.

Estimated Economic Impacts of the Core Recommendations

The Rutgers University Center for Energy, Economic & Environmental Policy (CEEEP) evaluated the economic impacts of these three core recommendations. Specifically, the CEEEP first used the R/ECON$^{(TM)}$ model to determine the economic impacts of implementing New Jersey's EMP initiatives, using Business-as-Usual and Alternative Scenarios under different fuel price scenarios. As a part of the EMP modeling, RGGI was utilized as the CO_2 policy for 2010 and 2015, whereas CEEEP assumed that a national cap-and-trade program would be in place in 2020 for the electric generating utility sector. This R/ECON$^{(TM)}$ modeling showed that the economic effects of implementing the EMP and RGGI were negligible, even without accounting for the benefits from environmental "externalities" from these programs.

CEEEP then used the R/ECON$^{(TM)}$ model to determine the additional economic effects of implementing the New Jersey LEV program. The modeling demonstrated that the LEV program, in conjunction with the implementation of the EMP initiatives and RGGI, would have a negligible impact on the State's economy, even before accounting for the economic benefits of reduced emissions. A more detailed summary of CEEEP's analysis is included as Appendix 2 of this report.

It is critical to stress that one serious limitation of the CEEEP analysis is that the R/ECON$^{(TM)}$ model does not account for environmental "externalities", and therefore understates the positive economic impacts associated with emission reductions. For example, while the CEEEP model can assess the small additional cost of buying a low emission vehicle, it does not factor in the economic benefit that society gains from creating less pollution (i.e. improved impacts on health care costs associated with air pollution).

It should also be noted that the core measures as described earlier involve important investments in the New Jersey economy. For example, the Energy Master Plan envisions major expansions in the State's clean energy facilities such as wind power and solar photovoltaic systems and major improvements in the energy efficiency of the state's businesses, residences, and institutions. The former will help grow the State's green economy, while the latter will make New Jersey businesses more competitive with those in other states and countries and help reduce consumer energy bills. Similarly, the proceeds from the auctions of CO_2 allowances under RGGI are being used to fund measures such as combined heat and power, solar photovoltaic systems, improved forest management, and local measures to address climate change. Measures like these help will create new jobs as well as reduce GHG emissions.

It is important to recognize that while the complete and timely implementation of these three core initiatives form the backbone of New Jersey's plan to meet its statewide 2020 GHG limit, their success is built upon a foundation formed by numerous other actions to address climate change that the State has already taken or are currently underway. In short, New Jersey is currently in a position to be able to meet its 2020 statewide GHG limit through full implementation of the Energy Master Plan, RGGI and its LEV program specifically because the State has been aggressive in development of programs and policies designed to address GHG

emissions. For a comprehensive list of the New Jersey accomplishments and on-going initiatives that formed this foundation, as well as a summary of the other GWRA requirements, please see Appendix 3. In addition, it is important to note that New Jersey is not acting alone in its efforts to combat climate change. Many other states are taking actions similar to New Jersey to do their part. For more information on what other states are doing, see Appendix 4.

Moving Forward in Light of Action at the Federal Level

The United States has taken recent steps forward at the federal level for development of national climate change policy. In general, these developments complement policies and programs already underway and planned in New Jersey. The United States Environmental Protection Agency (USEPA) granted California's waiver request regarding greenhouse gas emissions standards for new motor vehicles. This decision is complemented by President Obama's announcement on May 19, 2009 of his proposal to set new fuel economy standards for motor vehicles, covering model years 2012-2016, and ultimately requiring an average fuel economy standard of 35.5 mpg in 2016. The new proposed standards are projected to save 1.8 billion barrels of oil over the life of the program with a fuel economy gain averaging more than 5 percent per year and a reduction of approximately 900 MMT of GHG emissions. This would surpass the CAFE law passed by Congress in 2007 that required an average fuel economy of 35 mpg in 2020. As part of the federal action, from 2012 to 2016, California and states that have adopted the California LEV program (including New Jersey) will allow automobile manufacturers to comply with the LEV GHG standards by complying with the federal GHG standards for the same model years. Beyond 2016, California may propose the more stringent Pavley III GHG standards for 2016 and beyond at which point USEPA may consider proposal of the Pavley III standards as the federal GHG standards for the same time period. While the new federal fuel economy standard will lead to significant reductions in greenhouse gas emissions nationally, the short-term reduction (2012-16) in New Jersey will be less than what was anticipated under New Jersey's adherence to the California standard. Nevertheless, in the long-term and nationally, significant emission reductions are anticipated both in New Jersey and nationally as a result of the federal action.

Additionally, on December 9, 2009, USEPA adopted its proposed endangerment finding in response to a finding by the Supreme Court in *Massachusetts v. EPA*, 549 U.S. 497 (2007), that greenhouse gases are air pollutants covered by the Clean Air Act. In its action, USEPA found that current and projected concentrations of the mix of six key greenhouse gases—carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6)—in the atmosphere threaten the public health and welfare of current and future generations. This is referred to as the "endangerment finding." USEPA also found that the combined emissions of CO_2, CH_4, N_2O, and HFCs from new motor vehicles and motor vehicle engines contribute to the atmospheric concentrations of these key greenhouse gases, and hence to the threat of climate change. This is referred to as the "cause or contribute finding." The endangerment finding pursuant to the Clean Air Act does not by itself automatically trigger regulation under the entire Act. However, it lays the foundation for future regulatory action by USEPA subject to the provisions of the Clean Air Act.

In a separate action, USEPA adopted a rule on October 30, 2009 that requires mandatory reporting of GHG emissions from large sources in the United States. The rule requires collection of GHG emissions data to inform future policy decisions. Suppliers of fossil fuels or industrial greenhouse gases, manufacturers of vehicles and engines, and facilities that emit 25,000 metric tons or more per year of GHG emissions will be required to submit annual reports to EPA. The

gases covered by the rule are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFC), perfluorocarbons (PFC), sulfur hexafluoride (SF_6), and other fluorinated gases including nitrogen trifluoride (NF_3) and hydrofluorinated ethers (HFE). The most significant differences between the USEPA and the requirements for a mandatory reporting program in the New Jersey Global Warming Response Act are: 1) the USEPA rule does not provide states information for upstream fossil fuel suppliers; 2) the USEPA threshold of 25,000 tons/yr does not capture many facilities that have been reporting CO_2 or methane to New Jersey since 2003; and 3) the USEPA rule does not provide states information on industrial gases (i.e. hydrofluorocarbons), from upstream manufacturers/distributors or downstream users.

Finally, on September 30, 2009, the USEPA announced a proposal designed to tailor the major source applicability thresholds for greenhouse gas emissions under the Prevention of Significant Deterioration (PSD) and Title V programs of the Clean Air Act. The proposal also sets a PSD significance level for greenhouse gas emissions. The proposal would cover nearly 70 percent of the nation's largest stationary source greenhouse gas emitters, including power plants, refineries, and cement production facilities, while shielding small businesses and farms from permitting requirements. New or modified facilities with GHG emissions that trigger PSD permitting requirements would need to apply for a revision to their operating permits to incorporate the best available control technologies and energy efficiency measures to minimize GHG emissions. These controls are determined on a case-by-case basis during the PSD process. The USEPA estimates that 400 new sources and modifications would be subject to PSD review each year for GHG emissions. Less than 100 of these would be newly subject to PSD. In total, approximately 14,000 large sources would need to obtain operating permits for GHG emissions under the operating permits program. About 3,000 of these sources would be newly subject to CAA operating permit requirements as a result of this action. The majority of these sources are expected to be municipal solid waste landfills.

Clearly, these administrative actions at the federal level support the policies inherent in New Jersey's initiatives over the past decade. With an engaged federal partner, New Jersey needs to assess the effective mix of state and federal action that will be most effective in addressing climate change. Nowhere is this need more evident than in consideration of legislative proposals currently pending in Congress.

The American Clean Energy and Security (ACES) Act of 2009 passed the U.S. House of Representatives on June 26, 2009. Among other things, the ACES Act establishes a combined efficiency and renewable electricity standard, develops a strategy for promoting carbon capture and sequestration, places performance standards on new coal-fired power plants, supports state and local adoption of advanced building codes, supports state building retrofit programs, instructs states to submit goals for transportation-related GHG emission reductions, establishes a cap-and-trade program covering multiple greenhouse gases and sectors, and establishes a national climate change adaptation strategy. This expansive scope clearly calls for ongoing and national discussions about the most effective means to meet the intent and provisions of the Act as well as any upcoming federal climate change policies.

On November 5, 2009, the Clean Energy Jobs and American Security Act passed the Senate Committee on Environment and Public Works. The bill, which is similar to ACES on many counts, is currently under consideration by several other Senate committees.

In general, effective, scientifically sound, comprehensive and cost-effective Federal climate and energy legislation needs to include the following principles:

- **Establishment of aggressive science-based greenhouse gas emissions reduction requirements.** Current science indicates that strong near-term limits are crucial to stabilize and reduce emissions in the next decade. Long-term emission reductions of at least 80 percent relative to current levels are required by 2025 to avoid dangerous interference with the climate system.

- **Ensuring the economic and environmental integrity of a Federal greenhouse gas cap-and-trade program.** There will be strong pressure to compromise by raising the emissions cap, allowing offset project types that cannot be credibly verified or quantified, capping allowance price, or building in a "safety valve." Such compromises will discourage investments in clean energy technologies over the next decade or more, increase long-term costs by making more aggressive and accelerated emission reductions necessary in the future, and leave the program rightly vulnerable to charges that it is increasing costs without significant benefits.

- **Ensuring that rigorous offset quality requirements are designed to ensure that emission offsets represent real, verifiable, permanent emission reductions**. Experience with Kyoto Protocol offset programs, the voluntary offset markets as well as New Jersey's open market emission trading program for ozone precursors and CO_2 has shown the potential for offset projects to fail to produce credible emission reductions. Any offset provision in federal legislation must include only the most robust, transparent and rigorous standards to evaluate project eligibility and outcomes.

- **Creation of systems to distribute allowances, and use revenues from the sale of allowances, in ways that benefit energy consumers and transforms markets**. Energy consumers bear much of the cost of allowances in a cap-and-trade program, and should benefit from the sale or distribution of those allowances. Providing direct relief from energy costs offers some benefit; strategically investing allowance proceeds to improve customers' energy efficiency offers greater and longer-lived benefits. Such investments make American businesses more competitive, create jobs immediately, stimulate new markets for renewable energy and innovative low-carbon technologies, and reduce the cost of cutting greenhouse gas emissions.

- I**nvestment in an economy-wide portfolio of approaches for reducing emissions from uncapped sectors and for enhancing natural carbon sinks.** A portfolio of complementary policies and measures can reduce emissions from transportation, land use, waste management, the building sector, agriculture, and smaller energy generators and industrial emitters. The country's green infrastructure of forests, grasslands, wetlands, and agricultural lands play a vital role in absorbing and sequestering carbon. Protecting and enhancing these natural sinks is an effective way to reduce emissions.

- **Facilitation of the role of the states as policy innovators by preventing federal preemption of state programs that go beyond federal minimum requirements, as well as preventing preemption of state programs outside the scope of federal initiatives.** Given the states' experience in designing and implementing greenhouse gas emission reduction programs, and their long history of environmental leadership and innovation, states must continue to have the latitude to pursue a menu of varied and innovative approaches within their jurisdictions.

- **Guidance of transmission investments toward preserving reliability of energy supplies while reducing greenhouse gas emissions**. Federal actions in recent years have supported and expedited the construction of electric transmission lines that link coal-producing regions with population centers in the Northeast and Mid-Atlantic. Those projects are likely to spur expanded use of existing coal-fired power plants and the development of new ones, increasing greenhouse gas emissions and perpetuating that increase for decades to come. Development of transmission lines to link concentrated wind resources with centers of demand hundreds of miles away poses additional risks. When winds die down, high-emitting, inefficient fossil-fueled electric generation would come online to avoid disruption of electricity supply. Renewable resources can be integrated into the grid much more effectively and with much less risk to reliability if they are geographically dispersed. Unless this federal direction is decisively reversed by requiring transmission planning and siting efforts to include analysis of how transmission projects will affect CO_2 emissions, the cost of reducing greenhouse gas emissions will grow substantially.

  With its experience as a leadership state in addressing climate change, New Jersey is certain to be highly engaged in efforts at the federal level for years to come, in developing and implementing policies that reflect the right mix of state and federal action. New Jersey's leadership and early action can benefit the State economically by being poised to implement clean energy investments that will become available under federal programs.

Chapter 3: Actions Now for Future Impact

Introduction

Exceeding the 2020 limit is critical for New Jersey to stay on track to meet its 2050 limit. For this reason, this chapter outlines additional climate specific recommendations that support attainment of the statewide 2020 GHG limit and put New Jersey on the right track towards meeting the 2050 limit. Table 3.1 lists the 24 climate-specific supporting recommendations by sector. In addition, the chapter outlines additional related actions that, while primarily designed to address other issues (e.g., water quality, waste reduction, transportation issues, etc.), will provide greenhouse gas reductions.

Table 3.1: 2020 Climate-Specific Supporting Recommendations

Electric Generation
Recommendation #1: Establish standards for fossil fuel EGUs
Industrial
Recommendation #2: Implement requirements for non-EGU industrial sources
Residential/Commercial
Recommendation #3: Develop and facilitate the use of State Green Building Guidelines for all New Residential and Commercial Buildings
Recommendation #4: Develop and facilitate State Green Building Remodeling, Operations and Maintenance Programs for all Existing Residential and Commercial Buildings
Waste Management
Recommendation #5: Provide incentives to reduce the carbon footprint of public water supply and wastewater treatment facilities
Recommendation #6: Implement initiatives designed to support the creation of electricity or heat from waste sources
Non-CO_2 Highly Warming Gases
Recommendation #7: Monitor the development of other states' actions to reduce non-CO_2 highly warming gases and consider if they are appropriate to be implemented in New Jersey
Recommendation #8: Broaden scope of building codes to address high GWP gases
Recommendation #9: Add high GWP gas requirements for HVAC contractors
Recommendation #10: Institute a Leak Detection and Repair program for high-GWP gases from commercial and industrial refrigeration equipment
Recommendation #11: Reduce HFC emissions from the do-it-yourself servicing of motor vehicle air conditioning systems
Terrestrial Sequestration
Recommendation #12: Require State-funded projects to comply with the no net loss goal of forested area and tree replacement provisions of the "No Net Loss Act"
Recommendation #13: Establish legislation, develop policies (e.g. financing via GSPT) or implement through existing programs (e.g., re-adoption of the stormwater rules) on-site tree preservation percentage requirements for new development consistent with tree canopy target recommendations of American Forests (formerly the American Forest Association)
Recommendation #14: Develop Agricultural Best Management Practices to address energy efficiency, renewable energy and the release of GHGs in agricultural operations and structures
Transportation and Land Use
Recommendation #15: Determine needs for implementing infrastructure alternatives to conventional motor vehicle fuels (i.e., gasoline and diesel) in New Jersey
Recommendation #16: Implement transportation-related initiatives and demonstration projects
Recommendation #17: Develop and implement a LCFS through a multi-state effort
Recommendation #18: Establish a carbon footprint standard for transportation projects

Recommendation #19: Employ efforts for effectively implementing the SDRP
Recommendation #20: The NJDOT and the NJDEP will work cooperatively with all three MPOs to ensure that they incorporate growth management and GHG reduction goals into their plans and programs
Recommendation #21: The State will work in partnership with local and regional entities to conduct an infrastructure capacity assessment of the 113 municipalities that will benefit from the ARC tunnel as well as the municipalities that are served by, and feed, the Port Authority Transit Corporation (PATCO) rail and bus lines, and whose residents commute to Atlantic City, Camden and Philadelphia
Recommendation #22: Explore fuel-efficient vehicle incentive programs

Electric Generation

Climate-Specific Recommendation(s):

Recommendation #1: Establish standards for fossil fuel EGUs

Implementation of this recommendation would involve a NJDEP rulemaking to establish a minimum CO_2 emissions performance standard for electric generating units (EGUs) expressed in pounds of CO2 emitted per megawatt-hour of electricity generated. Such a performance standard would apply to all new fossil fuel fired EGUs and reconstructed EGUs, including coal, oil and natural gas. Such a standard would be fuel-neutral, based on efficient combustion of natural gas. Lower-efficiency natural gas and oil fired peaking units would be exempt from the emissions performance standard only if such units are subject to a permit restriction on annual electricity generation. This performance standard would be technology forcing and would be set at a level to functionally require a level of performance commensurate with emissions of a facility with carbon capture and sequestration (CCS) or other CO_2 reducing technology for coal-fired power plants. Basing a fuel-neutral standard on the most efficient combined cycle natural gas fired EGU would require any new or reconstructed coal EGU to achieve minimum reductions from CCS or other CO_2 reducing technology in the range of 50 to 60 percent, or better. Thus, this technology forcing aspect of the standard would not allow new coal fired EGU's in New Jersey unless CO_2 reduction technologies are used. Such a rulemaking would also include a requirement to review best available technology at the time of permitting to ensure that any new or reconstructed fossil fuel fired EGU employs the best technology to reduce GHG emissions, in addition to meeting the baseline performance standard.

Related Action(s) with Climate Benefits:

Expand use of the Hazardous Discharge Site Remediation Fund to incentivize cleanup of contaminated sites for renewable energy projects

Currently, the NJBPU uses the Clean Energy Fund to help defray the cost of renewable energy systems throughout New Jersey. These dollars can be applied to siting renewable energy systems on properly-closed landfills. The NJDEP and the NJBPU will continue to collaborate to promote and encourage these types of projects.

An area for which existing monies are currently not available in New Jersey is for siting renewable energy systems on contaminated sites and brownfields. Frequently, the cost to clean up a contaminated property is greater than the value of the property itself. Therefore, financial incentives may be necessary to return these properties to productive use. The

Hazardous Discharge Site Remediation Fund (HDSRF) provides grants and loans to public and private entities and 501(c)(3) nonprofit organizations for the investigation and cleanup of contaminated sites. Through the HDSRF, public entities can obtain up to $5 million per year and private parties up to $1 million total for this remediation work. One incentive could be to amend N.J.S.A. 58:10B-4 through 9 and 25 to expand the use of the HDSRF to provide grants to counties, municipalities, or their redevelopment entities for up to 75 percent of the cost of remediating a contaminated site if the end use of that site will be a renewable energy project.

Expand use of the Brownfields Reimbursement Fund to incentivize renewable energy projects on brownfield sites

Using brownfields for renewable energy projects results in the beneficial reuse of otherwise underutilized contaminated sites. One incentive could be to expand the use of the New Jersey Brownfield Reimbursement Fund (BRF) to provide financial incentives to build renewable energy projects on brownfield sites. The BRF, established in 1998 in conjunction with the Brownfield and Contaminated Site Act (N.J.S.A. 58:10B-26 through 31), allows for the reimbursement of certain taxes, up to 75 percent of the remediation costs, that are generated from the redevelopment of a brownfield site. This fund was created to provide the additional incentive that is needed to make these redevelopment projects financially feasible. Many sites may not have been selected and prioritized for cleanup, if not for the financial incentives offered through this program. This initiative would expand the taxes eligible for reimbursement under the BRF to allow for reimbursement of the Sales and Use tax on the purchase of materials for the construction of renewable energy projects, up to 75 percent of the remediation costs.

Industrial

<u>Climate-Specific Recommendation(s)</u>:

Recommendation #2: Implement requirements for non-EGU industrial sources

The statewide GHG inventory indicates that industrial operations, including petroleum, glass, pharmaceutical, chemical, plastic, and other manufacturing activities, significantly contribute to statewide GHG emissions. For the industrial sector, there are several types of regulatory options (i.e. performance standards, cap-and-trade, mandatory planning) that are available and need to be explored to determine which would be most effective in delivering reductions consistent with the statewide GHG limits, while maximizing market mechanisms and operational flexibility for the business community. In addition, New Jersey must consider interest among other states in the region for development of regulatory approaches for industrial sectors as it weighs appropriate regional regulatory actions as well as emerging federal policy. As a result, additional dialogue is needed with the regulated community and other stakeholders to determine the most cost-effective regulatory strategies for reducing industrial GHG emissions.

Residential/Commercial

Climate-Specific Recommendation(s):

Recommendation #3: Develop and facilitate the use of State Green Building Guidelines for all New Residential and Commercial Buildings

The State has already begun to facilitate the use of green building design systems and these initiatives are ongoing. A continuation of current efforts would include: building capacity in the emerging green building industry in New Jersey, developing partnerships with the private sector, setting green building measures for which state agencies may direct voluntary incentives, analyzing additional public policies to foster green building practices, and identifying additional technical and educational training opportunities. In addition, the State is working to adopt the IECC 2009 code for the residential sector and ASHRAE 90.1-2007 for the commercial sector. This is a concrete and important incremental step toward implementing the State's Energy Master Plan, which recommends that new residential, commercial and industrial construction built in 2020 use 30 percent less energy.

The NJDEP, the New Jersey Department of Community Affairs (NJDCA), the NJBPU and the New Jersey Housing and Mortgage Financing Agency are working in collaboration with the Rutgers Center for Green Building to complete and release New Jersey-specific green building guidelines by the summer of 2010. These guidelines will provide new and existing green building performance criteria and "how to" information to be used by applicants seeking State agency incentives for achieving green performance. The guidelines can help State agencies to incorporate the use of these guidelines into their existing regulatory and/or incentive-based programs to facilitate new and existing green building programs. The guidelines can also provide a consistent tool for use by local governments and the private sector, and can inform green building training/education programs.

To take advantage of the expertise of individuals in New Jersey who are currently leading the way in implementing green building practices, state agencies have already begun to consult with technical experts in the private sector. Formalizing these interactions, perhaps through creation of a task force, can assist the State in expanding its ongoing efforts to foster green building practices, and respond to legislative efforts to promote green building design in New Jersey.

Recommendation #4: Develop and facilitate a State Green Building Remodeling, Operations and Maintenance Programs for all Existing Residential and Commercial Buildings

In conjunction with the development of the green buildings guidelines discussed above (which will include green guidelines for both new and existing buildings), the NJDEP, the NJDCA, the NJBPU and the New Jersey Housing and Mortgage Finance Agency are working together to develop a New Jersey Green Building Remodeling, Operations and Maintenance Program for existing residential and commercial buildings. This program could be applied statewide by the private sector, municipalities and individual homeowners.

As with the New Jersey-specific green building guidelines for new residential and commercial buildings discussed above, all State agencies are identifying specific actions to incorporate the use of these guidelines into their existing regulatory and/or incentive-based

programs. This will build upon existing efforts such as the NJ Green Home Remodeling Guidelines (completed November 17, 2009; see http://www.greenbuildingrutgers.us/), as well as the NJ Clean Energy Program's Pay for Performance Program which takes a comprehensive, whole-building approach to saving energy in existing commercial facilities. Specifically, these new actions can complement Pay for Performance by considering additional strategies for reducing energy consumption such as green design (e.g., landscaping, building materials, green roofs), water conservation, and on-going monitoring of building performance followed by corrective actions. This guideline targets homeowners and the remodeling industry to increase energy efficiency, reduce carbon footprints, improve water conservation, minimize waste and resource use, decrease stormwater runoff, improve indoor air quality, and provide greater support for local and sustainable building materials and services. Further, the New Jersey's Clean Energy program subsidizes energy audits in the public sector for municipal buildings and facilities and in the residential sector for private homes and provides financial incentives that support the adoption of energy efficiency measures.

Related Action(s) with Climate Benefits:

Support statewide outdoor water use limits on lawn and landscape irrigation to minimize consumptive water losses and water waste

Water Use and Greenhouse Gases

New Jersey already faces mounting challenges that threaten assurances of an adequate water supply in the future. These challenges are exacerbated by the prospect of a changing climate.

While water supply planning traditionally has been conducted with an eye toward historic conditions as a reliable guide of what to expect in the future, a warming planet and changing hydrologic cycle may increasingly frustrate efforts to plan for and ensure sustainable water supply yields. The reality of increasing climatic variability accents the need to develop adaptive strategies that consist of fresh and innovative approaches to managing water supplies in the new millennium.

Eliminating water waste and improving water efficiency is the most cost-effective, least disruptive, and environmentally sound means of reducing demands on our limited water resources. Maximizing the use of existing supplies also reduces pumping, treatment and distribution, thereby cutting energy consumption and resulting in further reductions in GHG emissions. Responsible use of our water resources reduces strain on the State's aging infrastructure and extends supplies to ensure water availability in times of need. Demand management is a key feature of the soon-to-be-released New Jersey Water Supply Plan.

The soon-to-be-released New Jersey Water Supply Plan highlights the increasing consumption of fresh water supplies as an emerging trend that threatens water supply availability in the Garden State. The use of high-quality water sources and treated drinking water for non-potable purposes (such as irrigation for residential and commercial landscapes and golf courses) unnecessarily depletes water supplies reserved for essential human and ecological needs, especially during droughts and high-demand periods. The prospect of global warming and the potential for warmer, drier summers accentuate the need to increase water-use efficiency, reduce water waste, and align water quality with the intended use.

The adoption of mandatory statewide watering limits focusing on excessive irrigation of lawns and landscapes would provide the ancillary benefit of reducing energy consumption associated with unnecessary water pumping, treatment and distribution, thereby reducing

GHG emissions. Such mandatory statewide lawn and landscape watering limits would need to be set at a level that is reasonably needed to sustain turf and plants through the institution of an efficient irrigation regimen that is supplemental to natural precipitation and ultimately reduces water waste.

Waste Management

Climate-Specific Recommendation(s):

Recommendation #5: Provide incentives to reduce the carbon footprint of public water supply and wastewater treatment facilities

The State is providing favorable financing from the New Jersey Environmental Infrastructure Financing Program (NJEIFP) to local government units (such as municipal utilities authorities) to install energy efficiency and/or GHG reduction measures at Publicly Owned Treatment Works (POTWs) and public water supply systems. To facilitate this process, the NJEIFP is developing protocols to provide additional priority points for projects that incorporate measures to reduce energy usage. This also involves placing increased emphasis on compliance with N.J.A.C. 7:22-11(d)5iii(7), which requires that all wastewater, water and stormwater projects consider opportunities to reduce the use of energy or recover energy as part of their facilities plan/project report.

The NJDEP can also expand the practice of using anaerobic digester gases at POTWs for energy generation. There are existing technologies for recovery of methane that is generated from the anaerobic digestion of wastewater treatment plant sludge, and for its use as a source of energy for various purposes, including heating and electricity to run POTW equipment. A USEPA report shows that 3 New Jersey POTWs have existing on-site combined heat and power (CHP) facilities that are burning anaerobic digester gas.[66] However, the full extent of this highly desirable practice throughout the State is not known. To assess the existing use of CHP and other practices as well as their unutilized potential, the NJDEP is conducting a survey of POTWs with a design flow of greater than one million gallons per day to obtain targeted information on digester gas management, the extent to which energy recovery is utilized, and the relevant operating conditions. The NJDEP will partner with selected POTWs to develop and refine case studies documenting energy savings, costs and costs savings, and GHG reductions for different operating scenarios to show that the practice can be effectively applied across a range of POTW sizes and designs.

After completion of this study, the NJDEP will develop an education and outreach program to inform POTWs across the State about the effectiveness and benefits of digester gas energy recovery and to promote this practice. The NJDEP will take steps to partner with groups representing the wastewater treatment sector, along with the NJBPU in these activities.

Recommendation #6: Implement initiatives designed to support the creation of electricity or heat from waste sources

The key to waste management is to extract the maximum practical benefits from materials while generating the minimum amount of waste. This is why the waste management hierarchy, outlined below, moves from most desirable to least desirable activities:

[66] U.S. Environmental Protection Agency Combined Heat and Power Partnership "Opportunities for and Benefits of Combined Heat and Power at Wastewater Treatment Facilities," April 2007.

- Reduce (consume less, buy less packaging)
- Reuse (thrift store, refillable bottles)
- Recycle (return for deposit, curb collection)
- Recover (such as waste-to-energy and fuels)
- Residuals (portion that goes to landfill)

Mechanisms by which the State can "recover" waste through processes that create energy in the form of electricity or heat from waste sources include:

- Working with academia to: a) further refine assessments of New Jersey's available biomass resources for potential energy generation, as specified in the State's Energy Master Plan (EMP), to ensure consistency between interdepartmental policies such as renewable energy goals and the recycling statute; and b) complete a Life Cycle Assessment (LCA) of bio-energy generation systems from cellulosic parts of the waste stream that are not otherwise designated as recyclable materials by utilizing existing conversion technologies, such as anaerobic digestion and current thermal decomposition technologies. The LCA assessments of these energy generation systems will address GHG reductions related to these technologies, as well as the feedstocks identified in a) above, and will allow the State to ascertain the GHG benefits from using these technologies and feedstocks.
- Promoting environmentally-positive waste-to-energy demonstration projects to convert the non-recycled organic fraction of the municipal solid waste stream into renewable electricity and/or sustainable low-carbon biofuels.
- Providing guidance to support in-state sustainable low-carbon biofuels production while addressing the ongoing waste-disposal needs of New Jersey and ensuring that all NJDEP regulations and EMP goals are met.
- Evaluating the potential for sustainable cultivation and harvesting of bio-energy crops, with a focus on non-invasive species such as switchgrass and other short-rotation woody crops like poplar and willow, to avoid diverting prime New Jersey farmland.

Related Action(s) with Climate Benefits:

Meet and exceed existing recycling goals to move toward a goal of zero waste production by 2050

Major changes in the way New Jersey addresses its waste must occur if we are to meet the State's long-term GHG limit. The first step toward making those changes would be to achieve New Jersey's current statutorily-required Municipal Solid Waste (MSW) recycling rate[67] of 50 percent, which translates into an annual GHG reduction of 8.8 MMT CO_2eq (1.67 tons CO_2eq reduction for every ton of MSW recycled).[68] Exceeding the 50 percent requirement to achieve a MSW recycling rate of 70 percent by 2020 would further contribute significantly to the reduction of statewide GHG emissions. At a 70 percent MSW recycling rate, the GHG reduction would be approximately 12.4 MMT CO_2eq annually. The State's ultimate goal is zero waste production by 2050, whereby all products and packaging entering

[67] P.L. 1992, c. 167.

[68] 2006 MSW data indicate that New Jersey documented approximately 4 million tons of recycled materials, which represented a reduction of approximately 6.7 MMT CO_2eq of GHGs.

the MSW stream must either be fully biodegradable, refillable or reusable a minimum number of times, and then recyclable in an economically-sustainable manner.

To support this initiative, the NJDEP is using recycling research demonstration, education and professional training money from the fund created by the Recycling Enhancement Act to focus on those activities that will maximize the GHG emission reductions that can be achieved through recycling, specifically targeting those materials in the waste stream for which increased recycling will yield the largest GHG reductions (plastics, metals, aluminum, and organics). These activities involve increasing the scope and efficiency of collection systems and increasing marketing opportunities for the materials collected. Initially, the focus will be on food waste recycling efforts.

Implement methane control mechanisms at Non-New Source Performance Standard landfills

Landfill gas is a natural by-product of the decomposition of solid waste in landfills and is comprised primarily of CO_2 and methane. Although landfill methane emissions are falling nationally and in New Jersey, there are still many historic landfills in New Jersey that remain uncontrolled. Of these, approximately 20 landfills have gas collection systems with active or passive venting and no landfill gas (LFG) control mechanism in place. The NJDEP has determined that the landfills with venting systems already installed offer the greatest opportunity for methane control through the use of relatively low-cost technologies. To take advantage of the opportunity for GHG controls at these landfills, the NJDEP is developing a State of the Art (SOTA) manual for LFG emission control which establishes the threshold criteria for installing LFG control. Additionally, the NJDEP can propose amendments to its rules pertaining to the design standards and construction requirements for sanitary landfill gas collection and venting systems. Such amendments would specify that gas collection systems may also include gas destruction mechanisms in order to reduce or eliminate methane and other GHG emissions from landfills during closure, in those cases where gas continues to be generated and such a system is feasible.

Use of 100-year timeframe for GWP:

The global warming potential (GWP) of a greenhouse gas is a measure of its radiative efficiency (heat absorbing ability) relative to that of carbon dioxide (CO_2) after taking into account the decay rate of each gas (the amount removed from the atmosphere over a given number of years). GWPs allow for a comparison of impacts of emissions and reductions of different gases.

The time horizon, or time frame, to be considered in comparing a gas with CO_2 is relevant. An analogy is an assessment of the heat given off by a smoldering fire versus the heat given off by a firecracker. If one were to look at a time period of a few seconds after the initiation of combustion of each, the heat given off by the firecracker would look much larger relative to that given off by the fire than if one looked at a period of several hours. This is because a firecracker gives off heat in one burst, whereas a smoldering fire releases heat gradually over a long period. So too, a gas that has a relatively short lifetime in the atmosphere, while it may absorb heat strongly, will do so for only a relatively short period of time. If a short time horizon is considered, the GWP of this short-lived gas looks larger relative to longer-lived gases than if a longer time horizon is used. On the other hand, a gas that may absorb heat less strongly, but does so for a much longer period, will have a relatively higher GWP if a longer time horizon is considered. GWP values for time-periods of 20 years, 100

years, and 500 years have been developed and published by the IPCC (Intergovernmental Panel on Climate Change, 2007, Fourth Assessment Report, Working Group One, Physical Science Basis, Chapter 2, Table 2.14, http://www.ipcc.ch).

The State has used GWPs based on a 100-year time horizon. This is consistent with other inventory and reduction efforts throughout the world. As noted by the USEPA, (USEPA, 2008, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2007, http://www.epa.gov/climatechange/emissions/usgginventory.html) the parties of the United Nations Framework Convention on Climate Change have agreed to use GWPs based upon a 100-year time horizon. This horizon represents a compromise between the long (500 year) and short (20 year) time horizons. Choice of this time horizon lessens the possibility of undervaluing what is arguably the most important and difficult to control greenhouse gas, CO_2, relative to the shorter-lived greenhouse gas methane, as would be the case if a 20-year horizon was used.

Non-CO_2 Highly Warming Gases

Climate-Specific Recommendation(s):

Recommendation #7: Monitor the development of other states' actions to reduce non-CO_2 highly warming gases and consider if they are appropriate to be implemented in New Jersey

Like New Jersey, many states are now developing their GHG mitigation plans. Part of that focus is to determine strategies to reduce and control releases of the non-CO_2 highly warming gases. For example, the California Air Resources Board is currently developing reduction strategies in 13 different sectors and subsectors to reduce emissions of gases with high global warming potential (GWP) from stationary and mobile sources. The NJDEP will monitor the development of other states' actions and will consider whether they are appropriate for implementation in New Jersey.

Recommendation #8: Broaden the scope of building codes to address high GWP gases

In conjunction with modifications to New Jersey's building codes to foster greater energy efficiency, the State is developing requirements through the DCA Uniform Construction Code rules that new building Heating, Ventilation and Air Conditioning (HVAC) systems be designed to minimize or eliminate use of ozone-depleting substances and replacement substances, including HFCs.

Recommendation #9: Add high GWP gas requirements for HVAC contractors

The following actions will help to strengthen existing programs pertaining to professional HVAC contractors:

- Establish a State Board of Examiners of Heating, Ventilating, Air Conditioning and Refrigeration (HVACR) Contractors and require licensure through this Board in order to work as a Master HVACR Contractor in the State. Any rules or regulations adopted by this Board will consider proper management of chlorofluorocarbons and other refrigerants, including high-GWP gases.
- Add a continuing education requirement covering high-GWP gases to the new licensing requirements for HVACR contractors.

- Seek a legislative amendment to allow only licensed HVACR contractors or licensed plumbers to purchase any high-GWP refrigerants.

Recommendation #10: Institute a Leak Detection and Repair program for high-GWP gases from commercial and industrial refrigeration equipment

To complement other high-GWP gas recommendations outlined above, the NJDEP could develop a Leak Detection and Repair (LDAR) regulatory program for high-GWP gases used in commercial and industrial refrigeration equipment that exceeds a designated threshold size. Such a regulation would extend many of the current federal requirements for Ozone Depleting Substances (ODSs) under Title VI of the Clean Air Act to cover hydrofluorocarbons (HFCs), which are used as replacements for ODSs but are currently not regulated under Title VI.

Recommendation #11: Reduce HFC emissions from the do-it-yourself servicing of motor vehicle air conditioning systems

The current automotive refrigerant HFC-134a, commonly known as R-134a, is a highly potent GHG with a global warming impact 1,300 times greater than CO_2. The GWP of the refrigerant in a single 12-ounce container is equivalent to 1,000 lbs of CO_2, or the emissions from an automobile burning 50 gallons of gasoline. Regulating small containers that hold between 2 ounces and 2 pounds of automotive refrigerant with a GWP greater than 150 would be consistent with the approach taken by the California Air Resources Board.

Terrestrial Sequestration

<u>Climate-Specific Recommendation(s)</u>:

Recommendation #12: Require State-funded projects to comply with the no net loss goal of forested area and tree replacement provisions of the "No Net Loss Act"

Currently, any State entity, such as a department, agency or office of State government or State university or college, is subject to compensatory reforestation requirements under the "No Net Loss Act" (N.J.S.A. 13:1L-14.2 et seq.) if it is going to deforest an area on property it owns or maintains that is at least one-half acre in size. Extending the same requirements to any State-funded project resulting in the same level of impact would ensure that State-funded projects account for lost carbon storage and sequestration capacity, as well as increased GHG emissions due to deforestation, while providing for the necessary lag time for tree growth to meet the 2020 statewide GHG limit. Based on estimated energy consumption, the GHG emissions of State government (excluding counties and municipalities) amount to more than 800,000 tons of CO_2 equivalent annually.[69] The carbon sequestered and stored in trees preserved through the strict implementation and expanded application of the "No Net Loss Act" would help offset some portion of these CO_2 emissions.

[69]Rhodes, J. 2007. Improving Air Quality through Energy Efficiency and Conservation in State Government: Taking Action. Presentation at NJ Air Quality Council Public Hearing at NJDEP, Trenton, NJ. [Rhodes is Director, Office of Energy Savings at NJ Treasury Department]

Recommendation #13: Establish legislation, develop policies (e.g. financing via GSPT) or implement through existing programs (e.g., re-adoption of the stormwater rules) on-site tree preservation percentage requirements for new development consistent with tree canopy target recommendations of American Forests (formerly the American Forest Association)

As the most densely populated and highly urbanized state in the nation, New Jersey faces the constant threat of development consuming its remaining open land. Nationwide, urban areas have increased in size by about 20 percent in the last decade, while over the same period, urban tree cover has declined by about 30 percent.[70] Existing trees in urban as well as other areas maintain the State's green infrastructure and associated ecosystem services, including carbon storage and sequestration. Establishment of municipal tree canopy goals or requirements would drive design of development or maintenance projects to consider tree cover. American Forests recommends an average goal of 40 percent tree cover for Northeastern cities[71]. This percentage is an average for the entire Northeast metropolitan area. It is made up of 50 percent tree cover in suburban areas, 25 percent tree cover in urban residential areas, and 15 percent tree cover in the central business district.[72] These tree cover targets could be translated into on-site tree preservation requirements for each parcel of new development through new legislation or implemented as part of existing regulations such as the stormwater management rules. The Coastal Zone Management Rules (N.J.A.C. 7:7E-5A.10 and 7:7E- B.5) already have these tree preservation/planting percentage requirements for the coastal region. These requirements are consistent with the American Forests target tree cover goals. It would be technically feasible to extend the application of similar requirements statewide such that development in all areas, including those that are not considered environmentally sensitive, are subject to tree preservation standards.

Recommendation #14: Develop Agricultural Best Management Practices to address energy efficiency, renewable energy and the release of GHGs in agricultural operations and structures

By purchasing food grown or produced locally, consumers reduce the number of "food miles" needed to bring the food from farm to fork. While reducing food miles will result in GHG reductions, the energy required to grow produce locally, especially out of season, needs to be evaluated to ensure that there is a net benefit in terms of GHG reductions overall. Therefore, to reduce the GHG emissions associated with agricultural production, the State can work to develop Agricultural Best Management Practices (BMPs) to address energy efficiency and the use of renewable energy in agricultural operations and structures. Such BMPs would include criteria for the siting of new structures on land areas that have been previously disturbed to prevent the release of GHGs associated with soil disturbance or prevent the loss of forested areas that sequester carbon. Opportunities exist for harmonizing these objectives with Federal partners and funds through energy and related provisions in the 2008 Farm Bill.

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[70]U.S. Forest Service, State University of New York (Syracuse), Cornell University, American Forests, and Trees New York. 2004. Greening New York's Cities: A guide to how trees can clean our water, improve our air, and save our money.

[71]American Forests. 2003. Urban ecosystem analysis for the Delaware Valley Region: calculating the value of nature. Washington, DC.

[72]American Forests. [N.d]. Setting urban tree canopy goals. www.american forests.org/resources/urgnforests/treedeificit.php. (accessed 2008).

The State can also support research into the various ways greenhouses and other appropriate structures can be operated in an energy-efficient manner, in order to extend the growing season for locally grown foods without increasing carbon emissions or having any other negative impacts on natural resources. Such efforts would need to include the study of appropriate design parameters and siting criteria for "urban" greenhouses.

In addition to creating these new Agricultural BMPs, the State continues to support and promote, through programs like Jersey Fresh, the purchase of in-season food grown locally, in an energy efficient manner. The State will continue establishing linkages between New Jersey farmers and nearby food processors to maximize energy savings and reduce the travel distance of produce intended for food-processing operations as well as expand outreach to consumers on the GHG benefits of locally-grown and locally-processed food.

Related Action(s) with Climate Benefits:

Explore the development of a statewide conservation restriction registry

Conservation restrictions are important components of New Jersey's land preservation and stewardship efforts. The term "conservation restriction" can include conservation easements, deed restrictions and other legally-binding limitations imposed on land in order to limit certain types of uses or development of a property while preserving in perpetuity one or more of its natural attributes. Conservation easements are held by nonprofit or government entities, which are responsible for ensuring their stewardship and enforcing the restrictions, but the remainder of the underlying property interest continues to be held by private property owners. In New Jersey, conservation restrictions can also be created by regulatory bodies, as well as held by county and local governments, most often as a result of planning or zoning decisions.

Although conservation restrictions are most often memorialized as part of deeds or other documents filed with the appropriate county clerks, subsequent purchasers are often not well-informed about their details or significance. Moreover, in New Jersey there is no centralized source of information that can be accessed by members of the public or government officials interested in determining either the extent of easements in a community or whether an individual property is subject to a conservation easement. As a result, lack of monitoring, enforcement and even knowledge of the existence of individual easements has been reported in various parts of the country, including New Jersey[73].

With the implementation of the RGGI carbon offset program, afforestation projects of the type recommended in this Report will undoubtedly be proposed throughout the region. An important planning tool for identifying potential areas of afforestation, as well as vetting specific properties as appropriate for afforestation and not in conflict with other limitations, would be a geospatial registry of tax parcels linked to deed restrictions already in place. Establishment of a central registry would allow the State to establish a terrestrial carbon sequestration baseline for New Jersey which, in turn, will help facilitate project development, as well as enforcement.

[73]Stephens, J. and D.B. Ottaway. 2003. Developers find payoff in preservation. Donors reap tax incentive by giving to land trusts, but critics fear abuse of system. Washington, D.C.:Washington Post. December 21, 2003. p. A1.

Continue to preserve, expand and restore New Jersey's green infrastructure

The State's land and cultural assets constitute a valuable infrastructure, as much as highways and bridges, and as such require a recurring, broad-based investment in stewardship. This "green" infrastructure (of forests, meadows, watersheds and wildlife habitats, freshwater wetlands and tidal marshes, working farms and agricultural landscapes) has an even more vital role than physical infrastructure in that it provides essential ecosystem services including climate regulation and carbon storage and sequestration.

Since 1961, New Jersey has been a leader in open space preservation, using public funding provided by a series of voter-approved bond acts. The Garden State Preservation Trust (GSPT) is the current open space financing authority, using several rounds of funding approval since 1998. Since its inception, the GSPT has created momentum in conservation by using its funds to provide the incentive for local government, regional and non-profit agencies to raise money for preservation through local open space taxes and other means. As a result of the combined efforts of the State, counties, municipalities and nonprofit land conservation organizations over the last 50 years, conserved land (e.g., forests, parks, wildlife refuges, preserved farms) totals an estimated 1.4 million acres - one third of New Jersey's dry land mass. These lands embody a substantial amount of carbon storage. The United State Department of Agriculture estimates that New Jersey forests alone store about 304 million metric tons of CO_2eq.[74]

Wetlands provide carbon storage and sequestration services, as well as mitigate against flooding caused by storms. A combined 1,000,000 acres of tidal and freshwater wetlands in New Jersey necessitate continued conservation, protection and restoration. These wetlands have considerable carbon storage potential (probably in the order of at least 60 million tons of carbon or 220 million tons CO_2eq in soil and biomass).[75] An important area for wetland restoration in New Jersey is restoration of Atlantic White Cedar forests with 42,000 acres recommended for restoration by a New Jersey Forest Service commissioned study[76]. Such wooded wetlands have high growth potential and therefore significant sequestration potential. Also promising for high carbon storage are the lesser recognized saline tidal marshes (approximately 163,000 acres) that may contain large amounts of CO_2 deep in the ground beneath the marshes.[77] These types of wetlands are highly effective in sequestering carbon as they release only negligible amounts of the other GHGs, methane and nitrous oxide, compared to that released by freshwater marshes. This important attribute of the tidal marshes requires that they be maintained in their natural, undisturbed condition. The IPCC

[74]USDA. 2004. U.S. Agriculture and Forestry Greenhouse Gas Inventory 1990-2001. Technical Bulletin #1907.

[75]Based on assumptions/parameters used in the 2008 Draft NJ GHG Inventory (Appendix H). See http://www.nj.gov/globalwarming/pdf/20080219inventory.pdf

[76]Far Horizons. 2003. Carbon sequestration and CO2 emissions credits: a market-based forest conservation program for New Jersey. Prepared for U.S. Department of Agriculture Forest Service Northeastern Area, State and Private Forestry, Morgantown, WV. Prepared by: Far Horizons Corporation, Princeton Junction, NJ.

[77]IUCN, 1999. *Background paper on wetlands and climate change*. The paper indicates that the carbon stores of peatlands in the temperate regions of the world are estimated to be 1,315 tons/hectare (532 tons/acre) in soil and 120 tons/hectare (48.6 tons/acre) in biomass. The carbon sequestration capacity of this type of wetlands ranges from 0.7 to 0.12 tons/hectare/year (0.4 to 0.7 tons/acre/year). See http://www.ramsar.org/key_unfccc_bkgd.htm

and the U.S. Climate Change Program both recommend wetlands protection and restoration as a strategy to sequester CO_2.[78]

County governments, municipalities and non-profit preservation trusts have leveraged GSPT funds to preserve acreage two or three times faster than land is being lost to development. Continuing to preserve and expand its existing green infrastructure network by assisting local and regional entities with open space and greenway creation through incentives, technical support, and project coordination and facilitation, is an important element of the State's efforts to sequester carbon. This includes protection and restoration of natural wetlands, including Atlantic White Cedar restoration projects as well as maintaining tidal marshes, to avoid release of CO_2 and methane in large quantities. On November 3, 2009 New Jersey voters approved the issuance of $400 million in State bonds to continue the legacy of the GSPT.

Work with the State Legislature to pass, and then comply with, amendments to the New Jersey Forest Stewardship legislation to ensure private forestlands remain under forest cover according to sustainable forestry practices

Instead of encouraging landowners to cut trees just to meet an income requirement, as under the current woodland management program, the regulatory incentives provided under the New Jersey Forest Stewardship legislation (Senate bill #713(SCS)) and the appropriate carbon credit economic opportunities would induce private landowners to keep their forestlands under continuous forest production or protection. If sustainable forestry (within the framework of a forest stewardship plan mandated by Senate bill #713(SCS)) is practiced to yield more significant co-benefits, such as watershed and biodiversity habitat protection, the incentives are amplified as other ecosystem service payments come into play. Improved management can accelerate growth rates in some situations, add trees to understocked forest sites, extend rotations to increase standing biomass, and maintain existing carbon stocks where forests might be cleared for other land uses. Forest products are potentially carbon creditable, as these can be linked to a sustainable forest management certification system specified in the legislation. Carbon benefit of full forest stocking would range from 2 to 10 tons of CO_2eq per acre per year.[79] Almost a million acres of private forest lands could potentially be involved in this program.[80]

GHG Emissions, Agriculture, and the Food Systems

The food system, which includes production, processing, shipping, storage, and preparation of food, accounts for about 10 percent of U.S. total energy consumption. In addition, agriculture is associated with a significant portion of emissions of methane (3 percent) and nitrous oxide (4 percent), both potent GHGs. So, at least 10 percent of the CO_2eq GHG emissions that a typical U.S. resident is directly and indirectly responsible for, (his or her "carbon footprint,") is associated with food in some way.

[78]Accordingly, the NJ Global Warming Solutions Fund Act also includes a 10 percent RGGI allocation for forest stewardship and tidal marshes.

[79]Sampson. 2007 *et. al.* Terrestrial Carbon Sequestration in the Northeast: Quantities and Costs. Part IV Opportunities for improving carbon storage and management on forest lands. Alexandria, VA.

[80]Far Horizons. 2003. Carbon sequestration and CO_2 emissions credits: a market-based forest conservation program for New Jersey

Tracing the energy inputs associated with foods, and adapting the information to regions such as New Jersey, is complicated and challenging due to data limitations and uncertainties. However, according to several studies, about 20 percent of the energy used by the food system is used for agricultural production, 25 percent to 30 percent is used for household storage and preparation, 10 to 15 percent is used for transportation, and the remainder is used by processing, marketing and restaurants. (Center for Sustainable Systems (CSS), 2007, *Factsheets: U.S. Food System*, CSS, University of Michigan, Ann Arbor, MI, http://css.snre.umich.edu); Hendrickson, John, 1997, Energy Use in the U.S. Food System: A Summary of Existing Research and Analysis, *Sustainable Farming,* Vol. 7, No 4, 1997 and references therein)

Within the agriculture sector, production of meats and other animal products consumes anywhere from two to greater than ten times as much energy as the production of grains, fruits, and vegetables (Smil, Vaclav, 1991, *General Energetics*, John Wiley & Sons, NY). Raising meat animals in confined feeding operations, e.g. feedlots, is more energy-intensive than pasture-based production (Note: New Jersey is well below the national average in proportion of agricultural production that is a confined animal feed operation). The energy-intensive nature of meat production is reflected in relatively high GHG emissions from the production of red meat and dairy products when compared with other foods. A dietary shift away from such foods can in general be a more effective means of lowering an average household's food-related GHG footprint in favor of buying locally-grown food (Weber, Christopher and H. Scott Matthews, 2008, Food-miles and the relative climate impacts of food choices in the United States, *Environ. Sci. Technol., 42*, 3508-3513).

It is important to consider the concept of "food miles," which is the distance food travels from where it is grown or raised to where it is purchased by the consumer or end-user. In industrialized nations like the U.S., food miles have increased significantly in the last 50 years. (Pirog, 2005. "Energy efficiency as an integral part of sustainable agriculture: food miles and fuel usage in food transport." Presentation at the ACEEE Forum on Energy Efficiency in Agriculture. November 16, 2005). To cite just one example, in California more than 485,000 truckloads of fresh fruits and vegetables travel 100 to 3,100 miles to reach their destinations (Hagen, J.W. et al, 1999. "California's produce trucking industry: characteristics and important issues). Considering the impact of food miles on fossil fuel consumption, developing or redeveloping a local or regional food system may help reduce fuel use and GHG emissions from food transport. However, it may be useful to bear in mind certain limitations when using the concept of food miles. First, higher food miles for certain foods do not always translate into higher energy use, such as when the food items are shipped by boat, barge or train instead of airplanes or trucks. Second, there is a need to apply life cycle analysis to agricultural products. Third, local foods grown in greenhouses might use more energy than foods grown in open fields and transported across the U.S. (Some of the referenced greenhouse data in the following discussion are based on climates colder than New Jersey, and may not reflect state-of-the-art technology.)

It is likely that eating a higher portion of locally-grown, fresh or relatively unprocessed grains, bean and vegetables, and less meat and processed foods will lower a person's food carbon footprint. Eating greenhouse grown fruits and vegetables out-of-season is likely to have the opposite effect, because heated greenhouse agriculture is energy-intensive. Growing vegetables in the field is estimated to consume between 25,000 and 100,000 megajoules (MJ) of energy per hectare, which translates to an energy input of approximately 1 or 2 MJ/kg; their refrigeration or preserving adds about 3 MJ/kg (Smil, 1991). Out-of-season greenhouse grown vegetables require considerably more energy input; in the range of 30 MJ to 40 MJ per kilogram of vegetable (Carlsson-Kanyama, Annika and Mireille Faist, Energy Use in the Food Sector: A data survey;Swiss Federal Institute of Technology, Zurich, Switzerland, downloaded 10/10/07 http://www.infra.kth.se/fms/pdf/energyuse.pdf; Barber, Andrew, 2003, Greenhouse Energy Use & Carbon Dioxide Emissions, MAF Technical Paper No. 2003/03, Ministry of Agriculture and Forestry, New Zealand). Heating Systems, http://www.uwex.edu/energy/gh_HS.html; Manitoba Agriculture, Food and Rural Initiatives, Greenhouse Energy Calculations, http://www.gov.mb.ca/agriculture/crops/greenhouse/bng01s01.html; Djevic, Milan, and Aleksandra Dimitrijevic, Greenhouse Energy Consumption and Energy Efficiency, http://www.ru.acad.bg/baer/BugGHRad.pdf).

Available data indicate that heated greenhouse-based production is much more energy-intensive than other aspects of the food system, including transportation, which makes a relatively modest contribution to the energy footprint of most foods. Transportation's contribution is described by Weber and Matthews in the article referenced above. According to this study, trucks consume about 2.7 MJ/ton-km and trains consume about 0.3 MJ/ton-km. So, trucking produce from California (~4800 km) would add about 13 MJ/kg to total for a food item, and trucking from Florida (~1600 km) would add about 5 MJ/km. Train shipment, even from California, would add only about 1.5 MJ/km. Substituting locally-grown out-of-season greenhouse crops for similar items imported from elsewhere in the nation or region is unlikely to reduce the size of the energy or greenhouse gas footprint associated with food, and may increase the size of the footprint considerably.

Implement farming and forestry practice recommendations to reduce GHG emissions

The State can implement a number of farming and forestry-related actions that will reduce energy usage, minimize the release of GHGs from soil tillage and other agricultural operations, and protect and promote natural carbon storage sinks. These include the following:

- *Encouraging, where practical, minimum tillage/no tillage/conservation tillage farming*: These methods minimize energy use in plowing, harrowing and cultivating of fields, resulting in significant energy savings. There is need to investigate options in the 2008 Farm Bill for funding these methods.
- *For conventional tillage methods, ensuring that farmers plant cover crops during the winter:* With the diverse cropping situations located throughout New Jersey, certain cropping practices will still require the use of conventional tillage. Planting harvested land with a grass or legume cover over during the winter preserves residue in the soil and thus stores additional carbon at relatively low cost. Cropland would benefit from cultivation of winter cover crops. Winter cover crops reduce erosion, nitrate leaching and fertilizer use during the summer growing season, making it a relatively cost-effective option. However, in order to sustain this type of practice, maintain healthy soils and increase the ability of the soil to retain nutrients, the implementation of a cost share program is essential. Through the efforts of the agricultural organizations in the State, options will be investigated and developed to cover the costs of the cost share programs, including the 2008 Farm Bill provisions.
- *Harmonizing the 2008 Farm Bill and New Jersey statewide GHG limits:* Investigate modifications to Soil and Water Conservation and Farm Bill program practices and funding priorities to align funded practices with the State's overall GHG limits. The New Jersey Department of Agriculture (NJDA) will work with appropriate State and federal partners to target Soil and Water Conservation funds provided through the 2008 Farm Bill to programs and practices that achieve measurable success in reducing GHGs. The 2008 Farm Bill includes, for the first time, an Energy Title and thus creates the opportunity to integrate related GHG mitigation criteria. The NJDA will also work with appropriate State and federal partners to target any funds provided through the 2008 Farm Bill Energy Title and other relevant Titles toward programs and practices that achieve reduction of GHGs. This includes work with the Natural Resources Conservation Service to review the Field Office Technical Guide (FOTG) for New Jersey with the end view of including a conservation practice standard for agricultural farming practices that reduce GHG emissions as well as enhance carbon sequestration. To the extent practicable, the FOTGs developed should cover all the counties of the State. Practices included in the FOTGs are incorporated in the Farm Conservation Plan that is required when farmers apply for funding and other incentives under the 2008 Farm Bill.

- *Providing demonstration and education programs for farmers on, and encourage the use of, methane abatement processes from livestock waste and techniques for managing nutrients back to the farmlands from livestock waste:* The agricultural industry has the unique capability to utilize farm-generated manure to stabilize anaerobic production of methane gas for energy. The waste streams from anaerobic methane gas production include treated effluents that can be discharged into the environment with little or no adverse effect while solid nutrient streams (biosolids) of nitrogen, phosphorous, and potassium can be used as a locally produced commercial fertilizer. The development of multiple waste-source-supply anaerobic methane gas production sites would enhance the economy of scale, waste disposal, and nutrient management while providing alternative energy production and sustainability of multiple industries. The NJDA will take the lead to develop demonstration sites and oversee the education program for the agricultural industry.
- *Investigating the feasibility of encouraging farmers to utilize certain fertilizer application methods which reduce the release of nitrous oxide:* Practices aimed at conserving carbon affect emissions of other GHGs. Of critical importance is the interaction of carbon sequestration with N_2O emissions, because N_2O is such a potent GHG. In certain conditions, carbon sequestration practices, such as reduced tillage, can stimulate N_2O emissions thus offsetting part of the benefit; in other situations, carbon-conserving practices may suppress N_2O emissions, amplifying the net benefit.
- *Managing overabundant deer population that impact forest regeneration and consequently forest carbon sequestration:* The proliferation of deer in the state has become a critical problem not only affecting agriculture and accelerating invasion of exotic species but threatening the establishment of new forests as well as the capacity of existing forests to regenerate, remain healthy, and continue to sequester carbon. Support will be provided to on-going initiatives and the adoption of legislation to expand hunting and further develop mechanisms to control overabundant populations of deer that would affect forest regeneration and health and impact the success of afforestation for GHG sequestration and emissions reduction; expand statute to include forests, to allow forest land owners to qualify for depredation permits, in addition to cultivated agricultural crops for areas where action can take place to reduce deer damage.

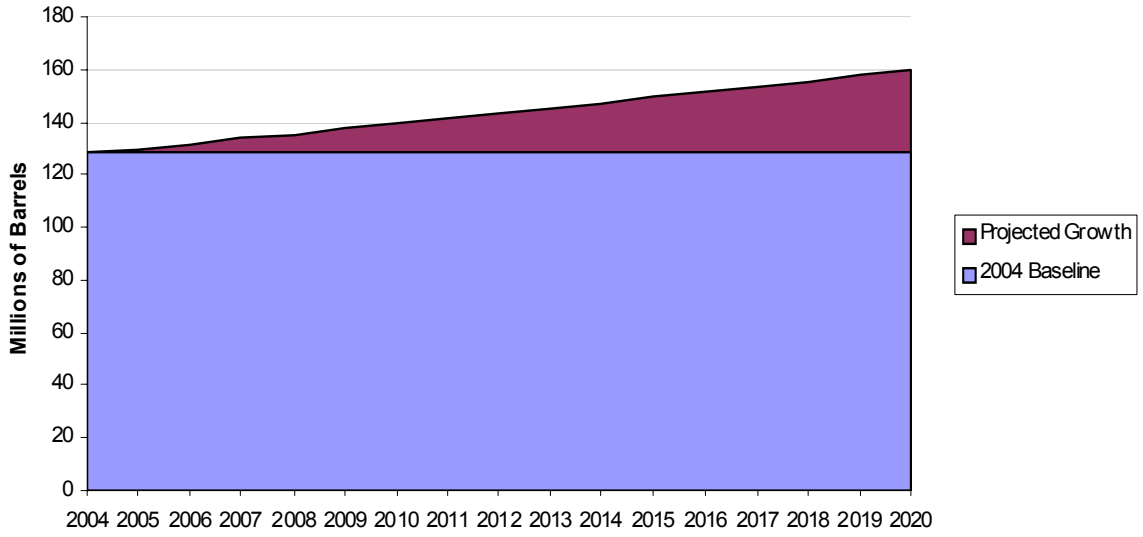
Transportation and Land Use

Today's travel patterns, both in New Jersey and nationally, raise serious problems related to increasing GHG emissions and other air contaminants. Too large a share of travel is done in single-occupancy automobiles, a relatively costly and inefficient mode. Too much "travel" time is spent by people sitting in traffic jams. Too many trips are carried out by people getting into a car to buy a quart of milk or a newspaper because they have no shops within walking or biking distance. Too many people are forced by limited housing options to live further and farther away from their jobs and social connections without access to viable automobile alternatives (e.g., cost effective and convenient mass transit), leading to long travel hours spent away from their homes and families. Too much of our goods and products are transported via conventionally-fueled trucks. Our vehicles – the mainstay of our travel and product transport – could be more fuel efficient. The conventional fuels used to power our vehicles today (primarily, gasoline and diesel fuels) are highly carbon intensive. Addressing these pivotal issues will have a direct and tangible impact on GHG emissions.

As shown by Figure 3.1, if nothing is done to change current trends, transportation-related petroleum usage is projected to increase from approximately 130 million barrels of gasoline and

diesel fuel in 2004 to approximately 160 million barrels in 2020 – an approximate increase of 30 million barrels.

Figure 3.1: New Jersey's Projected Transportation-related Petroleum Demand for 2020 Motor Gasoline and Diesel Fuel Only (excludes jet fuel)



Source: EIA, Petroleum to Prime Suppliers, accessed 2007
(Growth projection of 1.4% from the Annual Energy Outlook 2006 for total U.S. applied to the base year)

Many states that have been leading efforts in the U.S. to address climate change are now considering how to best relate statewide GHG limits to the transportation sector. [81] Like these states, New Jersey realizes that establishing some form of clear, measurable and enforceable GHG limits on the transportation sector would provide certainty for transportation sector GHG reductions over time. New Jersey's 2020 statewide GHG limit equals approximately a 20 percent reduction below estimated 2020 business-as-usual (BAU) emissions. Applying that degree of reduction to the on-road portion of the transportation sector would translate into holding emissions to approximately 40 MMT per year. Setting the transportation sector GHG limit at this level would result in reductions similar to those that would be achieved by applying the EMP goal of reducing New Jersey's overall projected energy consumption by 20 percent by 2020 to the transportation sector (approximately 12 to 15 MMT of CO_2eq).

Improving the sustainability of our transportation system, and reducing GHG emissions, will be a long-term effort requiring many measures and steps. In general, the future vision for a more sustainable transportation system can be guided by the following principles:

- People will have a wide variety of attractive, sustainable travel options, including walking, biking, ridesharing, and mass transit.
- Goods and products will be transported in the most efficient and environmentally sound manner practical.

[81] Emissions from on-road gasoline vehicles, on-road diesel vehicles, aviation, marine vessels, and railroad and other transportation sources totaled approximately 49 MMT tons of CO_2eq in 2004. These five subcategories of transportation combined contributed approximately 35 percent of the gross New Jersey GHG emissions in 2004. A subset of the total transportation sector, on-road gasoline and diesel emissions, is estimated to be approximately 46 MMT tons in 2004 and approximately 50 MMT in 2007.

- People will be able to live and work in well-designed, compact, sustainable, walkable, transit-friendly communities.
- People will be rewarded for choosing efficient travel modes.
- Technology (associated with the vehicles themselves and supporting infrastructure) will dramatically reduce the carbon footprint of high-energy travel modes.
- Market-based standards will drive innovation to produce fuel alternatives that are carbon neutral or less carbon intensive than existing options.
- Transportation financing mechanisms will support sustainable transportation by making it more cost effective to drive highly efficient vehicles and to reduce vehicle miles traveled.

Transportation Choices 2030 New Jersey's Long-Range Transportation Plan

In 2030 advanced technology and changes in land use have made transportation in New Jersey more convenient and efficient than ever before, sustaining the state's strong economy and high quality of life. Public transportation is available to most destinations for those who don't have cars or choose not to drive. While congestion has not been completely eliminated from the state's roadways, highway travel is less frustrating and more reliable. Energy consumption and greenhouse gas emissions have been significantly reduced since 2009.

In response to the enormous increase in the amount of freight moving through and within the state, the use of rail has been optimized, non-rush hour movements have increased, capacity along key truck corridors has been maintained and land use supports efficient freight distribution.

Highways in New Jersey are now "smart highways" that use ultra wideband radar transponders built into the highway that communicate with sensors, receivers, and processors installed in cars and trucks. The resulting cooperation between the highway and vehicle is now controlling many driving functions like steering, spacing between vehicles and speed. This technology is ensuring safety through measures like collision avoidance and is adding to highway capacity because more vehicles can be accommodated per lane.

Public transportation has become an even more welcome alternative to driving. The multimodal, integrated transit network is seamless and borderless to the people who use it; travelers can move from one system to another at convenient transportation hubs where rail, bus, ferry and local community service options are available. Using a regional smart fare card for all travel needs, including parking, transit, transfers and tolls, makes all travel easier for everyone.

Taking public transit to work and school, to shop, to attend to daily needs and to visit with friends and family takes less time than it did in 2009. New passenger rail tunnels under the Hudson River have made travel between New Jersey and New York City faster and more direct and have enabled new services and increases in service throughout the rail system. Buses can move at the speed limit on heavily traveled corridors at all times, and light rail is available to many in areas where growth policies have led to concentrated, transit-friendly developments.

Given a wealth of travel options and changes in land development patterns, New Jersey's citizens make fewer and shorter trips by car. A greater awareness of the implications of how they travel has led many to eliminate some trips through measures like compressed work weeks and teleconferencing, and to replace some car trips by walking and bicycling. Travel is particularly improved for people who have chosen to live in the numerous locations throughout the state where housing, schools and businesses are clustered together. These centers, created by local ordinances, make providing and maintaining infrastructure more cost effective. They also support transit, shorten or eliminate many auto trips and preserve precious open space. Neighborhood stores like cleaners, delis, and pharmacies are nearby, within a short and safe walk or bicycle trip.

New technologies and dependable, adequate funding sources for capital, operating and maintenance needs ensure the transportation system remains safe and in a state of good repair.

Efforts to reduce GHG emissions in the transportation sector have largely focused on increasing the efficiency of vehicles themselves (e.g., continued implementation of the State's LEV program) and reducing the carbon intensity of fuels (e.g., regional implementation of a Low Carbon Fuel Standard). However, in order to meet both the 2020 and 2050 limit, New Jersey needs to also turn its attention to other aspects of the transportation sector, namely stabilizing the annual growth in vehicle miles traveled (VMT), and expanding opportunities for New Jerseyeans to enjoy a high standard of living that is less automobile-dependent. New Jersey's efforts to aggressively develop and implement transportation and land use policies and initiatives to support attainment of the State's 2020 statewide GHG limits and set New Jersey on the path to attaining the 2050 statewide GHG limits need to focus on the following seven areas:

1. FACILITATE WIDESPREAD USE OF LOW AND ZERO EMISSION VEHICLES

Encouraging the purchase and use of low and zero emission vehicles, while simultaneously ensuring that New Jersey has an infrastructure that enables widespread use of these vehicles, will help ensure ubiquitous and rapid deployment of new vehicle technologies and business models in New Jersey. The deployment of zero emission vehicles (ZEVs)[82], as well as some of the other low carbon fuel alternatives technologies, includes the need for both *direct* infrastructure (related to fueling and servicing the vehicles themselves) and *support* infrastructure (related to fuel generation and distribution). Many potential combinations of technologies and business models are possible in this emerging field. State policy should seek to enable the widest possible array of potential combinations, while at the same time not creating an advantage for any single technology or business model. Specifically, New Jersey recommends the following for this area:

Climate-Specific Recommendation(s):

Recommendation #15: Determine needs for implementing infrastructure alternatives to conventional motor vehicle fuels (i.e., gasoline and diesel) in New Jersey

In order to meet the 2020 statewide GHG limit, New Jersey's portfolio of actions will need to include changes to the nature of vehicles we drive and the fuels used to power those vehicles. Other recommendations in this report address ways in which New Jersey will provide incentives for the purchase of cleaner and more efficient vehicles and establish standards for low carbon fuels in the transportation sector. In addition to these efforts, it is critical that the State consider what is needed from an infrastructure perspective to support a new generation of clean vehicles. Such consideration needs to address regulatory updates (e.g., modifications to building codes and standards to allow for plug-in devices), legislation, and funding (e.g., securing federal grant monies), as well as other technical considerations. To begin this process, the State could convene a multi-disciplinary task force to examine these issues and to develop a plan outlining the actions necessary to ensure infrastructure to support alternatively-fueled vehicles[83], consistent with standards established under a Low Carbon Fuel Standard. Such a task force would benefit from membership including both public and private sector participants, including, but not limited to, representatives from all relevant State agencies, as well as representatives from conventional and alternative-fueled automotive manufacturers, auto retailers and public utilities.

[82] ZEV technologies generally include electric vehicles and hydrogen fuel cell vehicles, provided that fuel supplies are created using non-polluting sources and technologies.

[83] For the purposes of this report, alternative fuels include CNG, LNG, LPG, hydrogen, electricity and sustainably-derived biofuels.

<u>Recommendation #16</u>: Implement transportation-related initiatives and demonstration projects

In order to meet the State's long term GHG limit, major structural changes need to occur to the New Jersey's transportation infrastructure to support alternative vehicles and fuels and to promote alternative transportation modes. New Jersey is committed to being a national leader by transforming its transportation infrastructure to one that not only supports, but that also promotes, the use of alternative fuels including electrification for cars and compressed natural gas, liquefied petroleum gas and/or hydrogen for fleets. This commitment necessitates immediate identification of resources and strategies to begin implementation of this transformation today.

The first steps toward implementing the necessary structural changes is determining which will work in New Jersey, and generating support for these new ideas with the public. The most productive way to do this is through demonstration projects. These projects will give the State the opportunity to determine the feasibility and acceptability of various structural changes, before committing significant State resources. In addition, these demonstration projects will provide an opportunity for the NJBPU to assess the expected infiltration of alternatively-fueled vehicles to the overall fleet, and the implication of that growing percentage on non-liquid fuel and electricity needs of the State. Finally, the data from these demonstrations will support the work of the multi-disciplinary task force discussed in the previous recommendation.

As part of this recommendation, the following projects are identified as being ripe for short-term implementation:

Supporting the introduction of electric vehicles – Given that several major automobile manufacturers plan to introduce electric vehicles into the marketplace over the next several years (the 2010 to 2012 model years), the State can work in partnership with utilities, communities and the private sector to undertake initiatives that provide infrastructure that accelerates the introduction and use of those vehicles in New Jersey. As part of these initiatives, an evaluation of the use of "smart charging" strategies, such as the use of smart meters and vehicle-to-grid (V2G) technologies, could also help provide valuable information to the NJBPU and the State's electric utilities. This recommendation may be coordinated with the New Jersey Transit's "Green Corridors" Program, which includes the development of infrastructure for plug-in electric hybrid vehicles at such locations as commuter park-and-ride lots.

Demonstrating various alternative transportation fuels for urban fleet use - Urban fleet vehicles traditionally run on diesel fuel, a high-carbon fuel with attendant criteria pollutant emissions, such as particulate matter. The State can develop a partnership with in-state low-carbon fuel producers to use sustainable biofuels produced from energy crops or food waste-based feedstock, compressed natural gas or liquefied natural gas technology utilizing landfill gas, and renewable hydrogen for fleet use, to reduce GHG and criteria pollutant emissions in New Jersey's densely populated urban centers. Urban delivery vehicles, waste hauling vehicles, and locomotives will be specifically targeted for fuel switching in this demonstration project.

"Green" the State-owned fleet - The State of New Jersey has a fleet of over 14,000 vehicles that support State operations. Gasoline and diesel-fueled vehicles represent 23 percent of the State government's total energy consumption in British Thermal Unit (BTU) value. The State Director of Energy Savings has outlined a comprehensive strategy for reducing fleet petroleum consumption and GHG emissions by 25 percent by 2020. This strategy includes: 1) reducing fleet size by retiring the older and inefficient vehicles; 2) increasing use of higher-efficiency vehicles, including hybrids; 3) right-sizing vehicle replacements to purchase the most fuel-efficient vehicles for the intended use; 4) increasing use of alternative fuels such as sustainably-derived biodiesel; 5) establishing a green driving policy to require fuel-efficient vehicle operation and maintenance; and 6) deploying new fuel monitoring technologies that will track vehicle fuel consumption, miles traveled and efficiency. One approach could be to establish a policy directive and strategy to achieve a mile per gallon average fuel efficiency standard for new state car purchases by 2016. Such a policy could raise efficiency standards for vehicles on state contract and establish requirements for state agency vehicle purchases.

2. REQUIRE INCREASING QUANTITIES OF LOW-CARBON FUELS

New Jersey is working with 10 other states in the region through the Northeast States for Coordinated Air Use Management (NESCAUM), as well as with the State of California, to develop a regional approach to establish a Low Carbon Fuel Standard (LCFS). A LCFS is intended to reduce the carbon-intensity of transportation fuels through a performance-based standard that optimizes cost-effectiveness, but does not mandate any specific fuel or technology. Under a LCFS, fuel providers would be required to track the carbon intensity of their transportation fuel products and meet, on average, a standard for GHG emissions which declines over time. The carbon intensity for each fuel type is measured on a CO_2eq per unit of energy basis and is a measure of all of the factors that affect GHG emissions, including lifecycle GHG emissions from the production and use of the fuel (including land use and agricultural elements) and the efficiencies of different vehicle engine types. For example, carbon intensity values account for the higher efficiency of the electric engine versus the internal combustion engine. The LCFS would require an overall reduction of carbon intensity over time. California is targeting a 10 percent reduction in carbon intensity by 2020, and estimates that reductions of 60-70 percent will be needed to meet their 2050 GHG reduction goal.[84] The LCFS would be complemented by a credit-trading program in which fuel providers may meet the standard in the most cost-effective manner. The credit trading system would be open to any provider of fuel used for transportation purposes, including electric utilities that provide electricity for use in plug-in hybrids or electric vehicles.

Climate-Specific Recommendation(s):

Recommendation #17: Develop and implement a Low Carbon Fuel Standard through a multi-state effort

The NJDEP continues to be active in the regional effort to develop and implement a LCFS and will assess regulatory approaches for implementing such a standard in New Jersey.

[84] "A Low-Carbon Fuel Standard for California - Part 2: Policy Analysis", Alexander E. Farrell, UC Berkeley and Daniel Sperling, UC Davis, Project Directors, August 1, 2007. See http://www.arb.ca.gov/fuels/lcfs/lcfs_uc_p2.pdf

3. TRANSITION TO LOW-CARBON METHODS OF GOODS MOVEMENT

To increase understanding of the goods movement issues, constraints, and opportunities facing the State now and in the future, the New Jersey Department of Transportation (NJDOT) has completed the first Comprehensive Statewide Freight Plan. This plan:

- Described the goods movement transportation network in New Jersey from a physical, operational, economic, and citizen's perspective.
- Produced a synthesis of previous work and outreach highlighting issues, trends, challenges and opportunities in goods movement in New Jersey.
- Identified, evaluated and recommended alternative options and policies that address constraints by mode.
- Increased public understanding of goods movement and logistics issues.
- Developed better tools and performance measures to evaluate freight issues and options.
- Strengthened partnerships and coordination with sister transportation agencies, other government organizations, private industry and the public.

Related Action(s) with Climate Benefits:

- **Investigate opportunities for rail shuttle operations**

  The State will continue to investigate opportunities in New Jersey for rail shuttle operations, which would move freight by rail rather than by truck. Rail shuttle projects would use short-line railroads to move freight from Port Newark/Port Elizabeth to inland freight centers, where it could be processed through value-added operations, re-sorted, and sent out via truck or long-haul rail. Moving goods by rail rather than truck would reduce GHG emissions as well as traffic congestion, air and noise pollution, safety impacts associated with increased truck traffic, and infrastructure wear and tear. The current Class I (large freight) railroad business model does not lend itself well to small-scale movements or movements less than 300 miles. Short-line railroads, however, are suitable for filling this niche.

- **Investigate the development of a New Jersey-based Marine Highway Program**

  The Port Authority of New York and New Jersey, the U.S. Maritime Administration, and others are considering a new generation of waterborne commerce as an alternative to truck and rail movements for some container movements. Containers could potentially be moved from New Jersey facilities in the Port of New York and New Jersey by barge or special vessels to Raritan Center, Camden, Paulsboro or Salem for example, reducing land traffic and potentially reducing vehicle emissions. Future developments could include port-to-port movements along the Eastern seaboard.

  Congestion in our transportation system costs Americans an estimated $200 billion every year, 4.2 billion hours in traffic, and 2.9 billion gallons of fuel. There are, on average, currently 10,500 trucks per day per mile on the Interstate Highway System.[85] By 2035,

[85]Federal Highway Administration, "Estimated Cost of Freight Involved in Highway Bottlenecks – Final Report" (Nov. 12, 2008)"

this is projected to more than double[86]. On the other hand, America's Marine Highway system is currently underutilized. The Marine Highway Program is designed to integrate coastal and inland waterways into the nation's surface transportation system, reducing congestion, improving air quality, and decreasing our dependence on foreign oil[87]. New Jersey is participating with the I-95 Corridor Coalition to study the utilization of the East Coast Marine Highway to reduce truck VMT growth on the I 95 Corridor.

The environmental implications of expanding the Marine Highway Program have not been well studied. The U.S. Department of Transportation Maritime Administration (MARAD) Interim Final Rule on America's Marine Highway Program (October 31, 2008) provided no environmental assessment and failed to quantify potential impacts on air pollutants regulated under the Clean Air Act. Further consideration of a New Jersey-based Marine Highway Program will rest in part on results of pending environmental assessments and MARAD's final determination on the Interim Final Rule. Taking into consideration any future final determination by MARAD on the Interim Final Rule, the NJDOT will conduct a study to investigate the feasibility of developing a New Jersey-based Marine Highway Program and will issue a report and recommendations, including estimates of GHG emission reductions.

Climate Change and the Port Authority of New York and New Jersey

The Port Authority of New York and New Jersey provides essential transportation services that support the region's economy, but also result in the emissions of GHGs. Total emissions associated with the Port Authority, including the operations of its tenants and patrons, amounted to nearly 5.9 million metric tons of CO_2eq in 2007. Of those emissions, approximately 300,000 metric tons stemmed from the Port Authority's own energy consumption. The remaining 5.6 MMT were generated by the airplanes, vehicles and ships that use the Port Authority's facilities.

The Port Authority recognizes the threat of climate change to the region. To deal with this threat, the Port Authority is implementing a comprehensive sustainability policy that calls for mitigation, carbon neutrality, and the development of adaptive strategies. Specifically, the Port Authority is committed to reducing GHG emissions from its facility activities by 80 percent from 2006 levels by 2050. The Port Authority is also working toward its near-term goal of becoming "carbon neutral" on an annual basis, with respect to emissions under its direct control, by 2010. In collaboration with other regional stakeholders, the Port Authority is developing strategies that reduce the risk posed by climate change to its facilities, its operations and the region.

For the Port Authority, investment in mass transit and a cleaner system of goods movement represent the most effective ways to fight climate change. The Port Authority's commitment to reducing GHG emissions is reflected in its 10-year, $29.5-billion capital plan. That capital plan includes the PATH System modernization and capacity enhancements, the ARC passenger rail tunnel, the expansion of the Port Authority Bus Terminal, and Express Rail. All of these projects will take cars and trucks off the road.

In addition to these capital investments, the Port Authority is developing programs that promote sustainability among its patrons and tenants. Already, drivers of fuel-efficient vehicles may take advantage of the new Green Pass Discount Plan, which offers a toll discount at the Port Authority's river crossings. The Port Authority is also concerned about flight delays and the resulting GHG emissions. The Port Authority's Flight Delay Task Force, an effort among public and private stakeholders, is working on ways in which airplanes can navigate more efficiently at the airports.

[86] http://www.marad.dot.gov/ships_shipping_landing_page/mhi_home/mhi_home.htm#
[87] http://www.marad.dot.gov/documents/America-s_Marine_Highways_Program_FAQs.pdf

And improving on-time performance. The Port Authority is also a strong supporter of the Federal Aviation Administration's Next Generation Air Transportation System (NextGen), which represents the most effective way to reduce GHG emissions from air travel. The Port Authority is seeking federal funding through the American Recovery and Reinvestment Act of 2009 and other sources for port-related projects that will help reduce GHG emissions as well as other air pollutants.

In addition, the Port Authority is undertaking an aggressive plan to reduce its own emissions through energy efficiency and renewable energy projects. New light-emitting diodes, which require less energy than conventional lighting, are replacing the existing fixtures at the Holland Tunnel and the George Washington Bridge. The first geothermal energy project at an airport is underway at John F. Kennedy International Airport. Hybrid diesel-electric shuttle buses are operating at the airports. The Port Authority's vehicle fleet is on pace to reduce GHG emissions by more than 10 percent over the next 3 years through the use of clean vehicles and biodiesel.

4. MAINTAIN GOOD STATE OF REPAIR IN ROAD INFRASTRUCTURE AND OPERATIONS WHILE MITIGATING GREENHOUSE GAS IMPACTS

Meeting New Jersey's statewide GHG limits will require the State to ensure that its aging transportation infrastructure is maintained through the principles of smart growth and "fix it first". Additionally, the State must address congestion, factoring consideration of GHG impacts into funding and design of transportation projects, educating the public in ways that they can lower their transportation-related "carbon footprint," and ensuring that projects that enhance and expand transit options are a high priority for investment. Most recently, these approaches are reflected in the State's capital budget for transportation as well as in the State's list of projects that will be funded using federal stimulus dollars under the American Recovery and Reinvestment Act. The following additional efforts would complement those already underway:

Climate-Specific Recommendation(s):

Recommendation #18: Establish a carbon footprint standard for transportation projects

In order for New Jersey to achieve its long term GHG limits, transportation investments need to give consideration to being consistent with the statewide GHG limits. Some states, Metropolitan Planning Organizations (MPOs) and regional planning entities are researching different ways to consider carbon impacts of transportation activities through development of methodologies by which transportation capital program scenarios can be compared for their carbon footprint impacts. A system needs to be developed to calculate the "carbon footprint" of projects to help decision-makers determine whether best design practices are being incorporated and whether GHG emission limits are being attained. Using the carbon footprint metric, planners and regulators can ascertain whether projects are consistent with local, state and/or regional GHG and VMT reduction limits, as well as to guide funding decisions.

Clearly, any efforts to consider carbon footprint of transportation activities must include an agreed upon process that accounts for transportation agencies' need to meet basic system preservation, safety and mobility goals, such as System Preservation or Infrastructure Preservation projects (e.g., resurfacing, bridge replacement). Additionally, development of any method to consider carbon footprint of transportation activities will require an analysis of costs and benefits, as well as a lifecycle assessment approach, to ensure that desired results

(i.e. long term net GHG emission reductions) are, in fact, met. Consideration should be given to the extent to which existing policy tools, such as analysis under Executive Order 215, may serve as an effective vehicle for disclosing and mitigating CO_2 impacts of transportation projects. The NJDOT is working cooperatively with NJDEP, Rutgers University and other relevant state agencies to examine possible methodologies to effectively consider carbon footprint impacts of transportation projects using a lifecycle assessment. This project is also studying approaches to state policies that would effectively implement consideration of "carbon footprint" impact in transportation projects and planning.

Related Action(s) with Climate Benefits:

- **New Jersey Turnpike Authority "Green Corridor" Program**

  In January of 2009, the New Jersey Turnpike Authority (NJTA) adopted, as part of its overall 2009 Strategic and Capital Improvement Plan, a "Green Corridor" program consisting of policies and projects designed to facilitate meeting the GWRA's goal of reducing GHGs. Specifically, the NJTA's "Green Corridor" program encompasses the following actions:

  - Undertake an energy needs analysis for the entire Turnpike and Parkway system with a specific goal of identifying opportunities for renewable and other clean energy programs, and with a commitment to implement solar and/or wind power as part of new construction activities;
  - Work with the NJDOT and the NJDEP to explore the creation of "clean energy" fueling stations for vehicles alongside our traditional gas and diesel, including electric plug-in charging stations, compressed natural gas and other alternative fuels;
  - Establish a "Clean and Green" policy for new construction activities that will require green building design techniques and sustainable design elements;
  - Establish a policy requiring the retrofit and reconstruction of established service area facilities to "clean and green" standards;
  - Continue to maximize the use of EZ Pass and electronic toll collection to further reduce fuel consumption and GHG emissions;
  - Require that energy efficiency be considered when replacing existing light fixtures or installing new lighting fixtures. This will include the potential for the installation of compact fluorescent or LED roadway luminaries if their lighting characteristics are determined to meet the Authority's lighting criteria to ensure the safety of motorists;
  - To the maximum extent practicable, have existing barren NJTA properties planted and forested to not only help offset GHG emissions in the State, but also to offset the heat island effects of new pavement; and,
  - Commit to a vehicle maintenance wastewater reclamation system, which allows the recycling of wastewater. A pilot program is currently underway at the Clark Maintenance Yard.

  The NJTA has created an executive-level committee "Green Corridor Team" to shepherd this effort.

- **Expand Emergency Service Patrols**

  The use of Emergency Service Patrols (ESP) in high-traffic corridors for the purpose of incident management has been shown to reduce non-recurring congestion. The ESP's ability to help reduce congestion is accomplished by methods that range from calling the

police and towing services, helping to divert traffic around an accident, and pushing a stalled vehicle from a traffic lane to a shoulder to perform emergency repairs. Incident Management Teams respond quickly to traffic incidents and disabled vehicles, hastening the resumption of regular traffic flow through the site. ESP on the 395 miles of roadway currently patrolled will be expanded from 80 hours per week to 100 hours per week. This will increase the service from a weekday service to a weekday/weekend service.

This highly-visible and successful program has assisted nearly 90,000 customers in the past year and has a benefit-to-cost ratio of 19 to 1. The benefit-to-cost ratio is developed by calculating the time savings of motorists not stuck in traffic and dividing it by the actual program costs. For example, for every minute a lane is closed due to roadway debris or an accident, four minutes of delay results. ESP has historically responded to the majority of incidents in less than 10 minutes. Prior to ESP, the average for removal was 30 minutes. This 20 minute savings results in 80 minutes of delay avoided per incident. With the user cost-per-vehicle averaging approximately $12 per hour, a single ESP response to an incident on I-80 can save the motoring public approximately $115,000 (4 lanes x 1800 vehicle/hr./lane x $12/hr. x 1.333hrs). The resulting idling reductions will generate an annual fuel cost saving to consumers of approximately $400,000 based on a $2.50 per gallon fuel price.

- **Expand signal synchronization**

  Signal synchronization/optimization is an application that coordinates the timing of traffic signals to minimize delay, reduce congestion, and improve safety along high-traffic areas. While these improvements can range in cost from approximately $3,000 per retiming to $150,000 for complete unit replacement, synchronization and optimization represents a unique and comparatively simple opportunity to reduce fuel consumption, and consequently reduce GHG emissions.

- **Achieve reduction in diesel vehicle idling**

  Idling consumes fuel while moving no product, reduces engine life, requires additional engine maintenance, and pollutes the air. New Jersey will continue its efforts to reduce diesel vehicle idling through 1) encouraging the expanded use of truck anti-idling strategies, such as auxiliary power and truck stop electrification; 2) increased enforcement, including non-road vehicles; and 3) implementation of idling reduction technologies and policies for locomotives and marine vessels.

Three specific projects that will have GHG benefits are:

Expanded use of truck anti-idling strategies. Many long haul truck drivers idle their trucks to heat or cool their cab during the federally-required 10 hours rest period for every 11 hours spent on the road. As a result, heavy-duty diesel trucks idle approximately 28,000 hours per day in New Jersey. The State will encourage the expanded use of anti-idling strategies such as use of Truck Stop Electrification (TSE) and on-board Auxiliary Power Unites (APUs). TSE allows vehicles to hook up to units that provide heat, air-conditioning and other amenities. The NJDEP and its partners have funded the installation of 254 electrified spaces to date, with an additional 75 spaces planned along the New Jersey Turnpike. These spaces will save over a million gallons of fuel annually. As of May 1, 2008, vehicles were no longer allowed to idle in parking spaces that are equipped with

electrification technology. On-board APUs are installed on the truck and provide heat and air conditioning. Approximately 50 percent of trucks currently use APUs, which reduce fuel use (as compared to idling) by as much as 90 percent and are saving 2 million gallons of fuel each year in the state. APU use continues to grow as diesel fuel prices rise.

Increased enforcement. New Jersey will continue its efforts to reduce idling through increased enforcement of its anti-idling regulations, including its recently adopted rule amendments N.J.A.C. 7:27-14.3(b)6 that include a provision to sunset the exemption for idling trucks while using sleeper berths, effective May, 2010. In addition, over the next few years, the NJDEP will expand enforcement from its current focus on on-road diesel vehicles to include a focus on idling of non-road vehicles, particularly construction vehicles.

Implementation of idling reduction technologies and policies for locomotives and marine vessels. For locomotives, technologies are available to automatically shut down engines and maintain operating temperatures. Marine vessels can reduce idling by connecting to shore-side electrical power, which requires modifications to the vessel and provision of electrical power to the docks. New Jersey will continue to investigate the use of such strategies, from a technical and policy perspective, and seek ways to implement them on a more widespread basis.

5. REDUCE THE GROWTH IN VEHICLE MILES TRAVELED

The transportation sector makes up approximately 35 percent of New Jersey's gross GHG emissions; the passenger automobile contributes the vast majority of those transportation sector emissions. Because there is a direct correlation between sprawling land development patterns and personal vehicle use, as measured by vehicle miles traveled (VMT), the critical role that land use policies play in achieving the statewide GHG limits cannot be underscored enough. It will be difficult for New Jersey to meet its statewide GHG limits without a fundamental shift in the State's historic development patterns.

A recent report by the American Association of State Highway and Transportation Officials (AASHTO) observes that there are many factors that can affect the growth rate of VMT. AASHTO's *Primer on Transportation and Climate Change*[88] states that, "while technological change is essential to reducing GHG emissions, there is also a role for strategies that help to limit the growth in travel demand." Going forward, even a seemingly small difference in VMT growth rates - e.g., the difference between 1.5 percent and 2.0 percent annual growth - can make an enormous difference in the total amount of VMT on the roads in 2030 or 2050.

Energy use and carbon emissions can be reduced through smart land use and transportation policies. Mixed land use and higher densities can shorten distances between origins and destinations, which allow alternative forms of transportation and reduce automobile dependence, as well as provide the necessary population density to support public transit.

The Delaware Valley Regional Planning Commission undertook a regional growth scenario planning exercise to better understand how different development patterns affect land use, transportation, the environment and economic development. The three growth scenarios

[88] Primer on Transportation and Climate Change, American Association of State Highway and Transportation Officials (AASHTO), April 2008. See http://downloads.transportation.org/ClimateChange.pdf

examined included trend, sprawl and recentralization. The resulting report, *Making the Land Use Connection*[89], describes how recentralization (locating most population and employment growth in core cities and developed communities) offers the best solutions for a sustainable future. This scenario best prepares the region for combating global climate change and energy volatility. It improves quality of life for the region's residents by offering more mobility choices, while preserving open space and reducing household expenses.

The Urban Land Institute (ULI) projects that nationally, two-thirds of development expected to be on the ground in 2050 is not yet built, offering great promise for affecting change in this sector. While that estimate is likely to be lower in a highly-developed state like New Jersey, it is still clear that reversing the State's sprawling land use patterns is a significant part of the solution to meeting New Jersey's statewide GHG limits. The ULI points to sustainable land use patterns as having the potential to reduce driving from 20 to 40 percent and that people living in compact urban neighborhoods where cars are not the only transportation option drive a third fewer miles than those in automobile-oriented suburbs. The good news is that a recent land development study by Rutgers and Rowan Universities[90] confirms that sound state and regional planning policies, such as the Pinelands Comprehensive Management Plan, are effective in targeting development towards existing areas of infrastructure.

At the state level, New Jersey's objective is to develop consistent and coordinated state, regional and local land use strategies and to incorporate New Jersey's statewide GHG limits into the transportation sector. By developing preferred growth strategies that integrate smart growth objectives, state, local and regional land use planning can be the vehicle that ensures that land use and transportation planning is aligned with the statewide GHG limits. By incorporating attainment of other important public policy objectives (including affordable housing, economic growth and natural resource protection) the alignment of land use and transportation planning with the statewide GHG limits can serve to provide a unified foundation for sound growth management in New Jersey. Additionally, these efforts provide opportunities for the state, regional planning entities, Metropolitan Planning Organizations and local governments to consider specific strategies for adapting to climate change impacts as part of their on-going planning.

In light of New Jersey municipalities' strong home-rule authority, it is necessary to build capacity at the local level that leads to incorporation of GHG considerations into land use planning and decision-making. Many of New Jersey's municipalities are leading the way with plans and programs to reduce GHGs through energy efficiency, sustainable design and planning, and innovative programs. Recognizing this leadership at New Jersey's local level, 10 percent of RGGI auction proceeds are being made available by NJDEP to local governments through a grant program. The Local Government GHG Reduction Grant Program will be a funding source for municipalities striving to develop and implement both conventional and innovative smart growth policies that will reduce VMT and increase other mobility options.

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[89] Making the Land Use Connection, Regional What If Scenario Analysis, Delaware Valley Regional Planning Commission, September 2008. See http://www.dvrpc.org/reports/08059.pdf

[90] "Tracking New Jersey's Dynamic Landscape: Urban Growth and Open Space Loss 1986-1995-2002", Final Report, John Hasse, Rowan University and Richard G. Lathrop, Center for Remote Sensing and Spatial Analysis, Rutgers University, 2008. See http://www.crssa.rutgers.edu/projects/lc/download/urbangrowth86_95_02/HasseLathrop_njluc_final_report_07_14_08.pdf

Climate-Specific Recommendation(s):

Recommendation #19: Employ efforts for effectively implementing the SDRP

The State Development and Redevelopment Plan (SDRP), if implemented effectively can be a powerful tool to guide more sustainable land use policies, and in doing so can result in significant greenhouse gas emission reductions in the transportation sector.

The purpose of the SDRP is to "coordinate planning activities and establish statewide planning objectives in the following areas: land use, housing, economic development, transportation, natural resources conservation, agriculture, farmland retention, recreation, urban and suburban redevelopment, historic preservation, public facilities and services and intergovernmental coordination." (N.J.S.A. 52:18A-200(d))

To achieve its purpose, the SDRP is expected to receive "input from state, county and municipal entities concerning their land use, environmental capital and economic development plans, including to the extent practicable any state plans concerning natural resources or infrastructure elements" (N.J.S.A.52:18A-200 (c)). The goals and objectives of the SDRP are generally consistent with the GHG-reduction land use and transportation recommendations of this report, in that both the SDRP and this report propose a land use vision that encourages the development and redevelopment of centers and the creation of more compact, walkable and livable communities, while reducing development in areas outside of centers or more compact communities. In addition, the modification to earlier versions of the SDRP that is currently underway includes a new goal related to GHG emission reductions consistent with the Global Warming Response Act.

The SDRP is not intended to be regulatory document. Rather, it is intended to inform public investment, government spending and regulatory programs and tax policy decision-making. The SDRP can serve to facilitate the coordination and integration of practices, policies, plans and programs within State government's executive branch; provide a forum through which conflicts may be reconciled and increased accountability may be established; recognize and provide enhanced public benefit that is unlikely to be achieved through strict adherence to individual regulatory programs alone; and to provide a guide for land use decision-making by local government jurisdictions.

To realize the full potential of the SDRP when it operates in these capacities:

- The SDRP and its State Plan Policy Map must be kept current. Therefore, the process by which they remain up-to-date should be improved. For example, significant and far-reaching State government changes are currently underway with respect to the preparation of wastewater management plans, fair-share housing plans, and long-term transportation plans. The SDRP should be taking these changes into account in routine and predictable ways. Current limitations should be acknowledged and addressed and a process created to ensure consistency among the multiple State departments and agencies, their practices, policies, plans and programs.
- The SDRP requires an action-oriented implementation plan that describes the steps needed to ensure improved coordination and integration so that activities along with roles and responsibilities across multiple State departments and agencies as well as local jurisdictions are well-defined, transparent and more clearly understood. State departments

and agencies can employ the SDRP as a guide to inform their respective practices, policies, plans, and programs. State departments and agencies can be required to review their existing practices, policies, plans and programs and make appropriate modifications within the scope of their respective authorities to implement the SDRP as the sustainable growth plan for the State of New Jersey. For example, as a result of its Permit Efficiency Task Force's deliberation, NJDEP is considering how to create a rapid turnaround path for "green projects" in sustainable growth locations and plan-endorsed town centers.

- The SDRP is a guidance document that requires the strengthening of existing incentives and creation of new incentives to encourage its implementation. These incentives are especially important to encourage counties and municipalities to implement the SDRP. State departments and agencies can employ their authority with respect to both resource allocation and regulatory decision-making to strengthen and create these incentives to support the coordination, integration and alignment of county and municipal practices, policies, plans and programs with the vision and goals of the SDRP.

Recommendation #20: Undertake cooperative efforts with the State's Metropolitan Planning Organizations to assist them in incorporating GHG reduction targets into their plans and programs

Federal funds for transportation projects are funneled through the regional Metropolitan Planning Organizations (MPOs) which work with the NJDOT, NJ Transit and local and county governments to prioritize transportation projects. These efforts offer great promise to integrate recommendations discussed in this report that pertain to integrating the statewide GHG limits into statewide transportation and land use planning. To the greatest extent possible, the State, MPOs, regional planning entities and local governments must work together to ensure that all regional transportation planning and investments are consistent with progress toward the statewide 2050 GHG limit.

State agencies will continue to work cooperatively with the three MPOs to integrate New Jersey's statewide GHG limits into their plans and programs while maintaining consistency with their core mission of preserving the transportation system and maintaining mobility in the most environmentally sound manner possible. Additionally, NJDOT and the MPOs will determine how to best ensure that transportation infrastructure investment plans (e.g., New Jersey Long Range Transportation Plan, MPO Regional Transportation Plans, NJDEP and New Jersey Transit Capital Program, MPO Transportation Improvement Programs (TIPs), etc.) support attainment of statewide GHG limits.

Working in partnership with the MPOs, local governments and stakeholders, New Jersey could use a portion of RGGI auction proceeds to undertake pilot programs with counties and MPOs to integrate the statewide GHG limits into regional transportation planning. Such pilot programs could build on the county-level wastewater, transportation, and other planning initiatives now underway by offering targeted county grants to prepare strategic Sustainable Energy/GHG Reduction Plan elements as part of updated county master plans that will (a) meet targets for reduced VMT; (b) promote compact, sustainable growth in areas with infrastructure (and near transit where available); (c) reduce sprawl development; and (d) identify sustainable solutions for other high priority planning goals such as affordable housing and creation of job centers.

Related Action(s) with Climate Benefits:

- **The State will take actions to promote Transit-Oriented Development**

  Concentrations of high-quality, mixed-used development and business centers within walking distance of transit stations encourage transit use and residential and employment alternatives to sprawl development. Through state agency mechanisms such as model code ordinances, Plan Endorsement, and Water Quality Management Planning, New Jersey can promote higher density and Transit-Oriented Development (TOD), as well as encourage infill, compact and mixed use development (including clustering) that incorporates pedestrian and bicycle-friendly design. New Jersey Transit is seeking to partner with at least five communities each year along its existing bus and rail system where it has a station, terminal or major bus stop, to expand TOD planning efforts.

- **Working in partnership with state agencies and local governments, explore changes to the Municipal Land Use Law that are designed to incorporate the statewide GHG limits into local government master planning**

  There are a variety of ways in which the Municipal Land Use Law (MLUL) and other related land use laws could be amended to attain consistency with the statewide GHG limits. Such statutory changes could include:

  - Establishment of mandates and/or incentives for municipalities that incorporate provisions into master plan elements that are consistent with the statewide GHG limits;
  - Development of standards and incentives for municipalities to incorporate provisions in their local planning that fosters centralization of employment centers in relationship to mass transit; compact development in areas appropriate for growth and that discourage sprawling development patterns; and, walkable, mixed-use development;
  - Ability for municipalities to charge development fees for use in offsetting VMT and the loss of carbon sequestration associated with new development;
  - Availability of state legal support for local governments that are challenged for incorporating the statewide GHG limits into their planning;
  - Simplification of New Jersey's Transfer of Development Rights authorities in order to assist municipalities in directing development in more concentrated ways that avoid sprawl and maximize open space; and,
  - Establishment of programs to allow local governments to earn points for additional state dollars through the implementation of sustainable land use planning (similar to the Massachusetts CommCap Program).

- **Ensure that the Residential Site Improvement Standards are consistent with the GHG limits**

  Specific areas to evaluate to ensure that the statewide GHG limits and VMT reduction targets are tied into project design could include decreasing the required number of parking spaces associated with development and promotion of parking demand management strategies as well as encouraging infill and denser development.

- **The NJDEP and other state agencies are continuing to provide in-kind resources to support the New Jersey State League of Municipalities' *Sustainable Jersey* program**

  The NJ State League of Municipalities (NJSLOM) through collaboration with the NJDEP, NJBPU, Rutgers University and the Municipal Land Use Center at The College of New Jersey has created "Sustainable Jersey" program to encourage leadership in sustainable practices at the local level. With start-up monies from the Dodge Foundation and additional resources, the collaborative program establishes specific actions that NJ municipalities must successfully implement in order to receive designation as a "green community" by the NJSLOM. The primary purposes of the *Sustainable Jersey* Program are to 1) establish clear performance standards and actions for communities striving to be considered green; 2) provide guidelines and tools to assist in implementation; and, 3) create public and private incentives to encourage and facilitate greening action.

  Sustainable Jersey addresses issues such as climate change, air and water pollution, biodiversity, land use, water conservation, equity, buying local, local economies, and sustainable agriculture. A set of required and voluntary actions for Year 1 were developed by the convening partners with significant input from a group of involved mayors and other municipal officials, and efforts to develop a set of required and voluntary actions for Year 2 are currently underway. The partners' intent in developing these required and voluntary actions is to ensure that the *Sustainable Jersey* Program complements and supports the strategies being developed to achieve New Jersey's statewide GHG limits and the local government program using proceeds from the RGGI auction.

  - **The NJDOT commits to use and promote a "Complete Streets" policy to guide sound planning, engineering, operating and maintenance practices for all roadway projects by all transportation agencies in New Jersey**
    "Complete Streets" accommodate all modes of transportation, including walking and bicycling, resulting in reduced VMT and GHG reductions. Specifically, the NJDOT is ensuring that:
  - Planning, design, operation and maintenance of all road projects will result in a Complete Streets policy appropriate to local context and needs.
  - The Complete Streets policy is promulgated through design standards in the New Jersey Roadway Design Manual, the Smart Transportation Guidebook and similar publications.
  - The Complete Streets policy applies to both new and retrofit projects, including design, planning, maintenance, and operations, for the entire right of way. All streets are different and user needs will be balanced.
  - Complete Streets performance standards with measurable outcomes are established.
  - **The NJDOT will update the State Highway Access Management Code to encourage smart growth**
    The NJDOT commits to advancing all feasible revisions to the State Highway Access Management Code, and will evaluate proposals such as: creating a new "Main Street" classification; permitting developers to take advantage of a "multimodal transit credit" where appropriate; simplifying the process for creating and maintaining Access Management Plans; and revising the future vision for the state highway.

- **The NJDOT, in collaboration with the NJDEP and the NJDCA, will continue to provide planning assistance to local governments**
  This assistance will be administered through mechanisms such as New Jersey Future in Transportation (NJFIT), Mobility & Community Form, and the Transit Village Initiative Program to review new corridors for integrating transportation and land use planning as well as continue to transit-oriented development. Specifically, this action includes the following efforts:

  The NJDOT will develop and implement the next phase of its "New Jersey Future in Transportation" transportation and land use corridor planning initiative - The "Future in Transportation" (NJFIT) label is used to integrate transportation and land use planning at the corridor level. NJFIT also provides information to municipalities on development of Transit Villages and the use of people-centered community forms, both of which encourage greater use of non-auto dependent transportation. The NJDOT will re-commit to its NJFIT program by reviewing new corridors for smart growth project consideration.

  The NJDOT will continue to promote and assist communities with implementation of the Mobility and Community Form program – Mobility and Community Form planning looks to create better connections between the local system and the design of community facilities, buildings and open space. Benefits include economic vitality, pedestrian and bicycle access and land use patterns that support public transit, improve quality of life and foster a sustainable environment.

  The NJDOT will look for opportunities to enhance its current Transit Village Initiative Program – These enhancements will encourage transit-oriented residential and commercial/retail development in areas proximate to (within ½ mile of) existing rail stations, major bus stops and ferry terminals. The primary objectives of this program are to reduce traffic congestion and improve air quality by increasing transit ridership. To date, 19 communities have been designated transit villages and additional communities will be enrolled in 2009. The Transit Village Incentive Program is voluntary and provides only modest incentives to encourage transit-oriented development. However, the program can be used as a means to help local governments reform land use policies in station areas and to focus state investment programs to encourage the development of new housing at transit-supportive densities. To date, the Transit Village Initiative Program has concentrated primarily on residential development around transit stations/stops, thereby encouraging the creation of "transit village communities" for commuters. However, a separate but related effort has begun to encourage business development, capital investment and employment at Urban Transit Hub locations – projects within one-half mile of New Jersey Transit, PATCO or Port Authority Trans-Hudson (PATH) rail stations in nine urban municipalities. Tax credits for capital investments made where at least 250 people work can spur urban redevelopment, attract jobs and increase transit as a modal choice. Urban Transit Hub locations include areas such as Newark's Central Business District (CBD), Jersey City, Elizabeth, Hoboken, New Brunswick, Trenton and Camden.

6. ENHANCE LOW GHG COMMUTING PROGRAMS AND DOUBLE TRANSIT RIDERSHIP BY 2050

To complement New Jersey's aggressive efforts to reduce VMT, the State must make increasing transit and green commuting programs a cornerstone of its efforts to achieve the statewide GHG limits. In particular, New Jersey is committed to continue its investment in transit and to maximize ridership over the next ten years, and by implementing current and future capital programs, plans to more than double its transit ridership by 2050.

Climate Change and New Jersey Transit

An essential consideration in evaluating New Jersey Transit's (NJT) carbon footprint is the amount of carbon that is "avoided" because of reduced emissions and congestion relief that occurs when individuals choose to use mass transit instead of driving. NJT's carbon footprint, when measured using a transit industry proposed methodology, is the net of carbon emissions from total energy consumption from all NJT functions - bus, rail and light rail operations, stations, maintenance facilities and non-revenue vehicles - and the carbon avoided by NJT riders' use of transit, which results in avoided auto trips and reduced highway congestion. A July 2008 report evaluates, enumerates and represents NJT's role as a "key resource in reducing the larger regional CO_2 output from the transportation sector." ("A Comprehensive Assessment of NJ Transit's Carbon Footprint," by Science Applications International Corporation.)

As the use of public transportation in New Jersey continues to increase, so will NJT's energy consumption and carbon emissions. After applying the transit industry's proposed methodology, however, there is an actual and measurable clean air benefit to New Jersey that results from an increased reliance on public transportation. NJT is currently participating in the nationwide effort to quantify the amount that transit use serves as an "offset" to GHG emissions, based on vehicle miles traveled, congestion mitigation, and land use effects.

NJT has experienced unprecedented growth in service and ridership since 2000. The increased growth forecast for the years 2007-2010, and the consequent increased fuel and energy used, will result in an increase in actual GHG emissions for NJT each year in this period.

- NJT's CO_2 emissions from the operational component increased 26 percent between 2000 and 2006, or a 3.7 percent annual rate of growth. Much of this growth comes from an increase in service that resulted in growth in revenue miles and passenger miles.

- NJT's facility energy usage and CO_2 emissions have been stable from 2000-2006 in spite of an increase in the number of new facilities during this period. This stability is the result of an aggressive energy management plan instituted in 1996 that implemented a number of energy conservation measures and alternate fuel non-revenue vehicle purchases aimed at reducing energy consumption.

It is important to note that moving towards greater reliance on transit requires a companion commitment to increase investment in, and ensure a reliable, steady source of operational funds for transit so that both the capacity and day to day operations remain sufficient to carry passengers as they choose the alternative to driving alone.

With one of the most extensive transit infrastructures in the nation, New Jersey is ideally poised to capture the rising wave of demand for housing near transit and simultaneously rebuild its older communities. NJ Transit operates eight commuter rail lines serving 149 stations; three light rail lines serving 60 stations; and a statewide network of 242 bus routes. New Jersey is also served by two separate transit agencies—PATH and PATCO—that provide commuter rail service between Northern Jersey and Manhattan

and Southern New Jersey and Philadelphia, respectively. At 10.4 percent, New Jersey is third, trailing only the District of Columbia and New York, in the percentage of residents who use public transportation to commute to work.[91] Over the last 24 fiscal years (1983-2008), New Jersey has made major investments to connect previously independent private rail lines to create a cohesive network of rail services, build strategic light rail services, and increase frequency and reliability of all bus and rail location to major metropolitan job centers. These investments have resulted in a 64 percent increase in total ridership over that time period (159 million passenger trips to 260 million). Rail ridership has doubled since 1985, and is up 138 percent compared to 25 years ago (32 million to 76 million). Thanks to the extensive transit network, and the fact that 75 percent of New Jersey's population is within a half mile of a rail station or bus line, New Jersey residents have the opportunity to limit their single occupancy vehicle use.

There is a direct link between development density and transit. However, density alone will not act as the impetus for a shift to transit. Other transit friendly land use changes will be required to affect the demand for transit such that there is a continued shift from "drivers to riders" in New Jersey. For example, the abundance of low cost or free parking across the State is inefficient and impacts the demand for transit services. The current practice of under-pricing parking in many areas of the State increases automobile-dependency and reduces mobility alternatives. Parking management demand strategies that address more efficient use of existing parking, variable demand, and reduction of demand could reduce the amount of land needed for parking and the negative impacts of parking on transit ridership. NJ Transit estimates that by implementing its existing Capital and State of Good Repair programs, a net of more than 1 MMT of CO_2 would be avoided.

However, NJ Transit lacks the level of funding necessary to cover the operating costs of the existing system or to expand the system to accommodate the growth in ridership necessary to meet New Jersey's GHG limits. NJ Transit often utilizes funds from its capital budget to keep vehicles and infrastructure in working condition. In order to reach transit ridership targets set to achieve long-term GHG emission reductions, a stable source of funding for NJ Transit operations will be necessary.

Climate-Specific Recommendation(s):

Recommendation #21: The State will work in partnership with local and regional entities to assess infrastructure capacity of the 113 municipalities that will benefit from the ARC[92] tunnel as well as the municipalities that are served by, and feed, the Port Authority Transit Corporation (PATCO) rail and bus lines, and whose residents commute to Atlantic City, Camden and Philadelphia

These two assessments will complement the investment in transit, including the ARC tunnel and PATCO additions, by focusing state infrastructure investments around transit hubs on bus and rail lines feeding into the tunnel. These assessments will consider identifying transit

[91] 2007 American Community Survey data. See http://factfinder.census.gov/servlet/ADPTable?_bm=y&-geo_id=04000US34&-qr_name=ACS_2007_1YR_G00_DP3&-context=adp&-ds_name=&-tree_id=307&-_lang=en&-redoLog=false&-format=

[92] ARC stands for "Access to the Region's Core", a transit project designed to increase the capacity of the rail system under the Hudson River, which connects New York and New Jersey.

hubs with the greatest potential and needs. Working in conjunction with multiple state agencies and local governments, these assessments will consider infrastructure needs (including water, wastewater, stormwater, utilities, roadways, commuter parking, shuttle feeders, stations, residential site improvement standards, etc.) and, among other things, will inform local master planning and state prioritization of future spending for those localities benefiting from these transit upgrades.

Related Action(s) with Climate Co-Benefits:

- **Doubling Transit Ridership by 2050**

  Doubling of transit ridership by 2050 will require coordinated actions now, including building more infrastructure and increasing services of all transit options in New Jersey, from local services such as van pools, express bus and bus rapid transit[93], to commuter rail, light rail and ferry. However, meeting this goal will provide more New Jerseyeans with a choice to take transit instead of driving, especially if new residential, retail and job sites and activity centers are located close to transit services. To advance this goal, New Jersey Transit commits $41 billion dollars in its current 20-year capital program (2030) to:

  1) Maintain the existing transit system in a state of good repair;
  2) Construct the Access to Region's Core (ARC) Mass Transit rail tunnel;
  3) Complete other committed capital projects which have the potential to grow ridershipover time; and,
  4) Partner with other agencies to develop appropriate pricing policies to affect demand for transit.

  Estimates of the amount of vehicle trips reduced by funding NJ Transit's transit system state of good repair and implementing the capital program reach 165.6 million annually by 2020.

- **The NJDOT and New Jersey Transit will continue to work with their Transportation Management Association partners to further support existing commuter option programs, and encourage the implementation of new commuter option programs designed to encourage people to use their vehicles less**

  Voluntary commuter option program examples include incentives for low-carbon commuting options; carpool incentive programs, parking cash-out programs where parking fees are charged; location-efficient mortgages to facilitate home buying in non-automobile dependent areas; special parking fees and tags in transit lots (stations and park and rides) for scooters and motorcycles; telecommuting, flexible work hours and alternative work weeks; commute alternative subsidies (TransitChek, Commuter Tax$ave), tax incentives and value pricing; and incentives to encourage employees to utilize trip reduction programs (such as emergency rides home, preferential parking for carpoolers/vanpoolers, bike lockers and showers and financial incentives).

[93]Bus Rapid Transit (BRT) combines the quality of rail transit and the flexibility of buses. It can operate on exclusive transitways, HOV lanes, expressways, or ordinary streets. A BRT system combines intelligent transportation systems technology, priority for transit, rapid and convenient fare collection, and integration with land use policy in order to substantially upgrade bus system performance. As part of this Green Corridors effort, the State is committed to establish BRT route networks in Newark, Elizabeth, Paterson, Hackensack, New Brunswick, Camden and Trenton.

Specifically, the NJDOT is building on its existing program through efforts that will:

- Increase financial and other incentives to Transport Management Associations (TMAs) to create and promote commute option programs and to employees to use alternatives to driving alone to work.
- Expand the use of marketing techniques aimed directly at commuters to increase the effectiveness of commute option outreach efforts.
- Increase coordination related to travel demand management planning and promotion. Coordination efforts would include municipal, county and regional economic development agencies; Metropolitan Planning Organizations, business associations; chambers of commerce; elected and appointed officials; and TMAs.
- Encourage the use of travel demand management strategies as part of the local land development process. This can be done through ordinance revisions that require transit-friendly design and the provision for bicycle and pedestrian facilities and amenities as part of the site development process.

The State has also launched a "Green Commuting" initiative for State employees that promotes existing alternatives to solo driving and incorporates alternatives line those cited above.

The NJDOT's ongoing efforts would benefit from a detailed assessment of the extent to which gains in GHG emission reductions can be achieved through voluntary commuter option programs, as well as the extent to which New Jersey may need to consider mandatory commuter options programs and the relative cost and effectiveness of reducing GHG emissions for mandatory options.

- **New Jersey Transit's "Green Corridors" Initiative**

New Jersey Transit's "Green Corridors" program is a subset of its overall capital program, discussed in more detail above in the recommendation entitled "Doubling Transit Ridership". Taking a multi-modal approach and focusing on key corridors statewide with significant transit ridership (e.g. Routes 1, 9, 3/46, and Newark), the "Green Corridors" program builds on high transit ridership corridors and invests in improved bus service and facilities from express bus to full Bus Rapid Transit (BRT) services to increase the frequency, speed and comfort of transit trips. Coordinating with the NJ Turnpike Authority, the NJDOT, the NJDEP and the NJBPU on the development of the infrastructure for electric vehicles (see Recommendation entitle "Transportation-Related Demonstration Projects), NJ Transit can coordinate service and frequencies that attract customers to key multi-modal transportation hubs. Using new customer-friendly technologies and locating transportation hubs where there are intersecting bus routes will result in better customer access, as well as more frequent, comfortable and reliable bus service. Statewide, transportation hubs would operate at 3 different levels, from the community/neighborhood hub, to area-wide hub, to the major or regional transportation hub – each with increasing frequencies and levels of service. Local, paratransit and shuttle services feed the 'backbone' of express bus and BRT service, requiring coordination with the NJDOT, the TMAs and local county transit services. With supportive land use (from transit friendly planning to transit oriented development, development of key transportation hubs within communities near to the "green corridors") and renewable energy facilities (from electric plug-ins, and solar photovoltaic

power to real-time information on arrival and departure of local and regional transportation services) a network of interconnected services improves mobility and reduces single occupant vehicle trips.

7. DEVELOP PRICE-BASED INCENTIVES TO ENCOURAGE LOWER GHG EMISSIONS

Recent studies investigating policies to reduce CO_2 emissions have concluded that strategies which employ pricing as an incentive can have a powerful impact.[94, 95] Pricing strategies can be used to influence vehicle purchase decisions toward the purchase of cleaner vehicles, driver behavior toward lower emissions, and decisions on whether or when to drive by including more of the full costs of driving as a per-trip out of pocket cost to motorist, rather than as a hidden cost or a fixed cost of owning a vehicle.

Climate-Specific Recommendation(s):

Recommendation #22: Develop fuel-efficient vehicle incentive programs

Significant spikes in gas prices have an impact on consumer preferences for vehicles, resulting in people turning in their SUVs for more compact, fuel-efficient vehicles which produce fewer emissions and, in some cases, hybrid models. However, not only does the State need to provide incentives for efficient vehicle consumer choices, it also needs to establish policies that continue to drive the market in this direction in a way that is long-term and consistent. In general, such policies would be designed to transform the vehicle market towards the purchase of clean vehicles by creating financial incentives to purchase clean vehicles. These deliberations will benefit from stakeholder input to ensure that any incentives developed result in the desired impact of incenting consumers to purchase fuel efficient vehicles. Like other states, New Jersey will benefit from identifying programs, such as feebates and sales tax exemptions, designed to encourage the purchase of more fuel-efficient vehicles. A mix of incentives could result in a revenue-neutral set of policies that would complement the New Jersey LEV program. In particular, a feebate program (in which purchasers of more fuel-efficient vehicles receive a rebate while purchasers of inefficient "gas guzzlers" pay a fee) appears to be a promising and manageable policy for New Jersey to implement. Under such a program, fees paid by purchasers of high-emitting vehicles fund rebates for buyers of low-emitting vehicles.

In addition to feebates, these programs could include: modifications to existing tolls, fees, and surcharges, such as the State's existing surcharge on new luxury and fuel-inefficient vehicles and offering discounts on toll roads (such as the NJ Turnpike for hybrids or other types of fuel-efficient vehicles); pursuing additional federal funding for programs that encourage the retirement of older, less fuel-efficient vehicles; new surcharges, such as those on the purchase of inefficient vehicles, and exploring creating incentives to increase ZEV market demand, such as expanding the current ZEVs sales tax exemption.

Related Action(s) with Climate Benefits:

[94] European Conference of Ministers of Transport, "Transport and Environment: Review of CO_2 Abatement Policies for the Transport Sector" (2006), p. 7.

[95] R. Kopp, "Policies to Reduce CO_2 Emissions from the Light Duty Vehicle Fleet", in *Assessing U.S. Climate Policy Options*, Resources for the Future (Nov. 2007).

- **Assess feasibility of HOT Lanes**

  To complement other existing policies, New Jersey can assess the feasibility of a value pricing strategy called high occupancy toll (HOT) lanes, and of congestion pricing strategies generally. HOT lanes allow those who drive alone (also known as "single occupant vehicles" or SOVs) to use the HOT lanes if they pay a toll bypassing congestion in other lanes. High occupancy vehicles (HOV) containing two or more occupants may ride in a HOT lane for free. A HOT lane may use an existing lane or may require a lane to be added to the roadway.

- **Continue to Evaluate Usage Based Auto Insurance**

  Usage based auto insurance, sometimes called Pay-As-You-Drive or PAYD insurance, is an innovative insurance product that provides incentives to consumers to adopt safer and more environmentally responsible driving behaviors. A recent Brookings Institution study[96] concluded that if all drivers paid for insurance based on miles driven, overall driving would drop 8 percent in the nation and 13.5 percent in New Jersey. This same study found that usage based insurance would reduce total carbon emissions by about 2 percent. It is unclear, however, how many drivers would be willing to opt for this form of insurance coverage, how many insurers would be willing or able to adapt their systems to provide such coverage, or how successful such a program might be from an insurance business perspective over the long term.

  Efforts underway at the New Jersey Department of Banking and Insurance (NJDOBI) are seeking to evaluate the impact of usage based insurance products on VMT, traffic congestion and fuel-wasting aggressive driving behaviors in New Jersey, thereby reducing overall fuel consumption and GHG emissions.

  The initial evaluation will include information relating to an existing PAYD product offered by an insurance company to its New Jersey policyholders since August, 2008 as part of a pilot program. This company made this insurance available to its New Jersey customers if they install in their cars wireless devices that tell the insurer how many miles they drive, what time they're out on the road, and how often and how fast they accelerate and decelerate. The company is offering substantial rate discounts for their best drivers in this voluntary program, while potentially imposing moderate premium increases for those who engage in discouraged driving behaviors.

Overall Environmental and Economic Analyses

The State engaged the Center for Climate Strategies (CCS) and Rutgers University Center for Energy, Economic & Environmental Policy (CEEEP) to assess the GHG emissions reduction potential and economic impacts of the supporting recommendations and related actions discussed in this report. These analyses focused on a subset of the supporting recommendations and related actions that were sufficiently well-developed to be quantifiable.

Emissions Reduction Analysis

[96] "Pay-As-You-Drive Auto Insurance: A Simple Way to Reduce Driving-Related Harms and Increase Equity", Jason E. Bordoff, Policy Director, and Pascal J. Noel, Research Analyst. The Hamilton Project - Hamilton Project Discussion Paper, July 2008. See http://brookings.edu/papers/2008/07_payd_bordoffnoel.aspx

CCS used a variety of techniques to estimate the GHG emissions reduction potential of the quantifiable supporting recommendations and related actions. Those techniques are discussed in detail in Appendix 5 of this report. Table 3.2 lists the supporting recommendations and related actions analyzed for their emissions reduction potential[97], and the results for 2020.

Table 3.2: Estimated GHG Reduction Potential in 2020

Sector	Policy Measure	$MMTCO_2e$
Green Buildings	Green buildings (new)	1.70
	Green buildings (existing)	2.10
	Sector Total	**3.80**
Highly Warming Gases	HWG leak detection & repair	1.10
	Sector Total	**1.10**
Waste Management	POTW anaerobic digesters	0.40
	Increase recycling rate to 70%**	5.00
	Landfill gas management**	0.19
	Increase recycling rate to 50%**	2.61
	Sector Total	**8.20**
Terrestrial Sequestration	Green infrastructure**	0.75
	Forest stewardship to 2020**	0.03
	No net loss of forest land to 2020	0.004
	Urban forest cover to 2020	0.35
	Sustainable agriculture	0.02
	Sector Total	**1.15**
Transportation and Land Use*	Zero-emission vehicles	4.52
	Low-carbon fuels	4.53
	Low-carbon goods movement**	1.40
	Good state of repair/operation**	0.01
	Reduce vehicle miles traveled	3.41
	Double transit ridership**	0.65
	Less TLU overlaps w/ CA LEV	-2.32
	Sector Total	**12.20**
	Overall Total	**26.45**

* Rather than analyzing individual supporting recommendations and/or related actions for the Transportation and Land Use Sector, the Centers instead looked more broadly at six of the seven overarching areas identified in the this chapter as critical for reducing greenhouse gas emissions from this sector. Appendix 5 outlines which specific supporting recommendations and related actions were bundled into these area analyses.
** As discussed below, the costs and benefits of these related actions are not included in the summary of CCS's economic results presented in this chapter; they are however presented in Appendices 5-7.

Beyond the three core measures already accounted for in Chapter 2 and quantified in Appendix 1, Table 3.2 shows that the largest additional GHG emissions reduction potential lies in the transportation sector, followed by the waste management and building sectors. In evaluating the relatively low GHG emissions reduction potential of terrestrial sequestration, it is important to keep in mind that the measures in that sector are important for many reasons besides GHG emissions reduction, e.g., preservation of critically important natural capital. In addition, the

[97]The supporting recommendation to establish a minimum CO_2 emissions performance standard for electric generating units (EGUs) is not included in the summaries of results either here or in Appendix 5 to avoid double counting of emission reductions, as this measure is considered a complementary policy mechanism to the Regional Greenhouse Gas Initiative (RGGI) cap-and-trade program, a core recommendation.

terrestrial sequestration measures require longer lead times and will be important in the State's efforts to meet its statewide 2050 GHG limit.

The results in Table 3.2 show that beyond the 38 $MMTCO_2eq$ of GHG emission reductions expected for 2020 from the core measures, an estimated additional 26 $MMTCO_2eq$ of reductions are expected in 2020 from the quantified supporting recommendations and related actions, for a total of 64 $MMTCO_2eq$ of GHG emission reductions in 2020. As noted in Chapter 1, the difference between the Business-as-Usual projection of 154 $MMTCO_2eq$ for 2020 and the 2020 limit of 123 $MMTCO_2eq$ is the amount of reduction needed by 2020. The reduction of 31 $MMTCO_2eq$ needed by 2020 will be achieved by the core measures if implemented fully and on time. Therefore, the supporting recommendations and related actions would provide an important start towards achievement of the 2050 limit.

Economic Analyses

To address stakeholder comments that the NJDEP should consider economic impacts, the State engaged CCS and CEEEP to perform several different types of economic analyses in an attempt to present a full picture of economic impacts. The full CCS analysis report is attached to this report as Appendix 5. The full CEEEP analysis report is attached to this report as Appendices 6 (microeconomic analysis) and 7 (macroeconomic analysis). The supporting recommendations and related actions that were included in the economic analyses are indicated in Table 3.2.

The types of economic analysis conducted by the Centers are as follows:

- CCS analyzed the direct costs and cost savings of the subset of supporting recommendations and related actions. As part of this analysis, CCS also calculated the cost-effectiveness of those recommendations and actions. Cost-effectiveness is defined as the total cost per metric ton of GHG emissions avoided.
- CEEEP analyzed certain co-benefits of the subset of supporting recommendations and related actions. When combined, the CCS and CEEEP results make possible a limited benefit-cost analysis in which the benefits are compared to the costs to determine which is larger.
- CEEEP also analyzed the impacts of the subset of supporting recommendations and related actions on the State's economy as a whole (i.e., a macroeconomic analysis) using a 300-equation model of the State's economy.

All of these analyses focused on the period from 2009 to 2020. To ensure accurate comparisons, the results from the individual years were "discounted" to 2009 using a 3% annual discount rate; this procedure, which is almost universally used in analyses of this kind, is explained in greater detail in Appendix 5.

As noted above, because of limits on resources, CEEEP's analysis only considered certain co-benefits, namely preservation of natural capital (which includes, for example, natural assets that provide goods such as fish and timber or ecosystem services such as carbon sequestration), avoidance of the negative economic impact or cost of GHG emissions, and the monetary value of reductions in sulfur dioxide (SO_2) and oxides of nitrogen (NO_x) as estimated from the avoided cost of allowance fees. Other co-benefits, e.g., the public health benefits from reduced pollution, were not considered. For this reason, the results presented below are more conservative than those that a more complete analysis would show. In this context, "more conservative" means that the true benefits are higher than those shown below.

Combined Economic Results of the Supporting Recommendations

Table 3.3 summarizes the combined cost and benefit results from the CCS and CEEEP analyses of the supporting recommendations[98] aggregated by sector. The measure-specific cost-effectiveness results are presented in Appendix 5.

Table 3.3: Net Present Value Benefits of Supporting Measures, 2009-2020

Sector	CCS $ millions cost savings	CEEEP $ millions co-benefits	Total net benefits $ millions	Net benefit $/MTCO$_2$e
Green buildings[1]	$1,176	$115	$1,291	$59
HWG leak detection & repair[2]	14	94	108	11
Waste management [3]	483	18	501	251
Terrestrial sequestration[4]	-244	476	232	114
Transportation and land use[5]	3,558	446	4,004	78
Total[6]	**4,987**	**1,253**	**6,240**	**72**

1. Co-benefits represent value of avoided SO_2 and NO_x emissions plus avoided GHG costs.
2. Co-benefits represent avoided GHG costs.
3. Co-benefits represent value of avoided SO_2 and NO_x emissions plus avoided GHG costs.
4. Co-benefits represent value of preserved natural capital plus avoided GHG costs; cost savings are negative, indicating that present value costs to 2020 exceed present value benefits through that year.
5. Co-benefits represent value of avoided SO_2 and NO_x emissions plus avoided GHG costs.
6. Figures do not include the EGU measure discussed above.

As Table 3.3 shows, the combined sector totals for the supporting recommendations analyzed by CCS and CEEEP, when considered in isolation, have benefits that exceed their costs. This is especially true in the case of the transportation and land use sector, where cost savings are expected from a reduction in vehicle miles traveled. Other benefits from the supporting recommendations include: energy savings that are expected to result from employing better building codes or waste management practices; savings on avoided costs of refrigerants no longer lost due to leak detection and repair for gases with high global warming potential; and fuel cost savings due to no-till agriculture or from the use of alternatively fueled vehicles. In total, the cost-benefit analysis shows an expected $6.2 billion in net benefits from the supporting recommendations, a finding which indicates that the benefits of these recommendations exceed their costs.

Macroeconomic Analysis and Results

As noted, the above summary deals with each sector of the supporting recommendations. CEEEP also analyzed the combined impacts on the New Jersey economy of the supporting recommendations and related actions taken together, using the Rutgers Economic Advisory Service R/ECON™ econometric model (see Appendix 7 for details). To provide a view of how all the recommendations in this report will impact New Jersey's economy, CEEEP analyzed the macroeconomic impact of the supporting recommendations and related actions in light of the predicted economy for New Jersey in 2020 (i.e., the 2020 economic baseline) and the 2020 core measures' macroeconomic analysis discussed in Chapter 2. These analyses are summarized in Table 3.4.

Table 3.4: New Jersey Economy under Baseline and Policy Scenarios

[98]The costs and benefits of the related actions were not incorporated into this analysis as they were underway by the State independent of climate policy.

	2020 Economic Baseline	2020 with core measures	2020 with all quantified measures**	Net impact of all measures	Net impact as % of 2020 baseline
Non-agricultural Employment (1,000s of jobs)	4,197	4,216	4,209	+12	+0.3%
Real Personal income*	$245	$245	$244	-$1	-0.4%
Gross State Product*	$474	$472	$469	-$5	-1.1%

*in billions of constant 2000 dollars
**includes both supporting recommendations and related actions

As Table 3.4 shows, the core and supporting recommendations and related actions taken as a whole are projected to result in a slight gain in total employment and slight decreases in personal income and Gross State Product (GSP) in 2020. The decreases in personal income and GSP result from the fact that the analysis assumes higher prices for zero-emission and low-emission vehicles and energy efficient homes; those assumptions are projected to lead to lower new vehicle registrations and residential building permits and consequently lower retail sales. It should be noted that these results do not reflect the environmental co-benefits described above such as preservation of natural capital or reduction of SO_2 and NO_x costs.

For several reasons, the projections summarized in Table 3.4 are probably on the conservative side. First, the costs of the measures analyzed tend to be incurred as up-front investments, while the resulting benefits accrue over a period of years. For example, planting trees to sequester carbon or putting infrastructure in place to reduce VMT are actions that have high initial costs, but will incrementally reduce the impact of GHG emissions, preventing even more expense in the future. Therefore, delays that would increase impacts to forests such as forest loss or damage or property loss from flooding result in even greater costs to respond to these losses in the future. Second, since the analysis uses a 2020 time horizon, benefits occurring in later years are not counted. Third, while costs can usually be estimated in monetary terms, some benefits such as quality of life and species preservation are difficult or impossible to quantify and hence cannot be included in an analysis of this type, including some environmental benefits.

To reach the 2020 GHG limit, the State will need to undertake a suite of policy measures, some of which are more cost-effective than others. The State is pursuing what are expected to be the most cost-effective measures first, namely the three core recommendations. The macroeconomic impacts of the core measures are negligible. The supporting recommendations and related actions described in this chapter are somewhat more expensive; but even with these more expensive measures, the overall net economic impact of the full suite of policy measures would still be negligible. Considering the major stakes New Jersey has in mitigation of climate change, the projected economic effects can be seen as a cost-effective insurance policy and as an investment in maintaining New Jersey's economic vitality and quality of life.

Chapter 4: Adaptation

Despite our best efforts to mitigate climate change in New Jersey, the State must develop a comprehensive plan to adapt to current and future changes in climate. CO_2 and other GHGs are known to remain in the atmosphere for decades, and even up to centuries, from the time they are emitted into the atmosphere.[99] Even if all emissions were stopped immediately, there would be a lag between mitigation of emissions and cessation of warming. Thus, New Jersey is expected to face many public health, ecological and economic impacts with specific consequences noted by the Northeast Climate Impacts Assessment[100].

Predictions are that in coming years, sustained higher temperatures during the summer months will make our citizens especially vulnerable to heat-related illness. Warmer temperatures and increases in short-term droughts are expected to have impacts on agriculture and water supply availability. Warmer temperatures will lead to more intense rain events which, coupled with rising seas, will leave our coastal and riparian areas especially vulnerable to flooding, with additional repercussions for water supply. Sea level rise will impact coastal communities and coastal habitats. Non-climate stresses, such as dense population, high impervious cover, high nutrient loading, and high flooding potential, or a combination of these factors, will exacerbate vulnerability to climate change.[101] These are just some examples of the long-term impacts we expect concurrent with our efforts to mitigate GHG emissions.

Thus, a comprehensive adaptation policy must be developed as a key component of any long-term climate change action plan. Addressing these issues today just makes sense; they are complicated and require thoughtful approaches. It is hard to predict precisely which of the losses to New Jersey might be irreversible, yet, we must acknowledge that some may be permanent. Still, we cannot, as some say, "wait it out." While climate change might cause irreparable losses in some areas, it may also create economic opportunities in others. For example, spending to construct and/or adapt buildings and homes for storm resilience may be a good investment for property owners in terms of personal safety and financial exposure, while providing a positive outcome for communities in terms of reduced emergency services and preservation of a neighborhood. Similarly, water conservation measures for protection against more intense droughts in the long-term can certainly result in benefits for mitigation of droughts in the short-term.

Comprehensive adaptation planning for climate change is beginning to take hold in various regions around the United States and the world.[102,103,104,105] Adaptation planning at all levels of

[99]IPCC.2007. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[100]Frumhoff, P.C., J.J. McCarthy, J.M.Melillo, S.C. Moser, and D.J. Wuebbles. 2007. New Jersey. State Summary. Prepared from: Confronting Climate Change in the U.S. Northeast: Science, Impacts, and Solutions. Synthesis Report of the Northeast Climate Impacts Assessment (NECIA). Cambridge, MA: Union of Concerned Scientists (UCS).

[101]IPCC. 2007. Summary for Policymakers. In: Climate Change 2007: Impacts, Adaptation and Vulnerabilty. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. M.L. Parry, O.F. Canziani, J.P. Palutidof, P.J.Van Der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK. 7-22.

[102]London Climate Change Partnership. 2006. Adapting to Climate Change. Lessons for London. Greater London Authority. Authority. London. www.london.gov.uk/climatechange/partnership.

[103]King County. 2007. King County Climate Plan. B. Adaptation. February 2007. King County, Washington,

government is key to minimizing the public health, environmental and economic damage that is expected to increase in the coming years.

Approaches to adaptation planning and priority setting involve systematical and identification of key sectors, planning areas, vulnerabilities, exposure, and the adaptive capacity of each sector, as well as consideration of the probability of an event or impact[106]. In addition to this risk assessment, a key aspect of this planning process is inclusion at the outset of a broad regional coalition of representatives from all levels of government, the private sector, academia, and non-governmental organizations who must be prepared to develop mechanisms to respond to climate change issues "on the ground."

The State proposes to engage experts from academia, government, non-governmental organizations, and the business community in developing policy recommendations on the most pressing adaptation policies New Jersey should adopt to significantly reduce the State's risks from climate change impacts. There will be issues unique to all ecosystems and regions throughout the State. These actions will need to be customized to specific regions, and eventually tailored to municipalities throughout New Jersey. By bringing together various constituencies to develop a statewide climate change adaptation plan, New Jersey can be proactive in fostering adaptive capacity of the built, natural and human systems statewide to respond to climate change. Table 4.1 gives examples of sector-based adaptation issues that New Jersey faces with respect to climate change that could be considered through a systematic planning process. Clearly, these issues are wide-ranging; timely commencement of an adaptation planning process is needed to complement the mitigation actions set forth in this plan.

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[104]Kirshen, P., R. Matthias, W. Anderson, T.R. Lakshmanan et al. 2004. Infrastructure Systems, Services and Climate Change: Integrated Impacts and Response, Strategies fore the Boston Metropolitan Area. EPA Grant Number: R.827450-01 also known as Climate's Long-term Impacts on Metro Boston (CLIMB) CLIMB Final Report. August 13, 2004. Civil and Environmental Engineering Department, Tufts University; School of Public Policy, University of Maryland; Center for Transportation Studies, Boston University; Metropolitan Area Planning Council.

[105]Ligeti, E, J. Penney, and I. Wieditz. 2007. Cities Preparing for Climate Change. A Study of Six Urban Regions. Clean Air Partnership. Toronto, Ontario.

[106]Center for Science in the Earth System (the Climate Impacts Group). Joint Institute for the Study of the Atmosphere and Ocean University of Washington and King County, Washington. In association with ICLEI-Local Governments for Sustainability. September 2007. Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments.

Table 4.1: Potential Adaptation Considerations for New Jersey[107]

Public Health, Safety & Emergency Preparedness	Freshwater Quality & Supply	Energy, Land Use & Capital Infrastructure	Biodiversity, Ecosystems & Agriculture	Finance & Economics	Outreach & Education
-Heat-health action plans -Emergency medical services -Improved climate-sensitive disease surveillance & control -Safe water & improved sanitation -Coupling desalination with alternative energy -Urban forestation, light surfaces & green roofs to reduce urban heat island effect -Exposure reduction to toxics/pollutants via water-wastewater interaction or from landfills, industry, & contaminated sites impacted by climate change -Increased frequency & magnitude of storms leads to increased acute and chronic disease potential from contaminated water; chemical discharges & migration from contaminated sites, industrial facilities, and commercial/residential equipment -Acute illness from	-Expanded rainwater harvesting; water storage & conservation techniques -Water re-use -Desalination -Water-use & irrigation efficiency -Water supply planning -Land preservation (stable funding source) -Dam integrity/safety (implications for public health and ecosystem issues as well) -Link with New Jersey Geological Survey salt water intrusion monitoring in Cape May, Raritan Bay & Lower Delaware	-Stormwater management including local homeowner downspouts, rain barrels, etc. -Address adaptation in State Plan Endorsement process -Assess flood control zoning approaches -Climate change design standards for infrastructure -Sewage capacity -Realignment & relocation of transportation corridors -Design standards & planning for roads, rail, and other infrastructure to cope with floods & other likely effects of increased temperature & precipitation -Identify water supply & treatment, wastewater management, bridges, tunnels, roads, pipelines, electricity transmission & other critical infrastructure vulnerable to extreme environmental conditions (e.g.,	-Adjustment of planting dates & crop variety -Crop relocation -Improved land management, e.g. erosion control & soil protection through tree planting -Farmland Preservation -Community Supported Agriculture expansion - Pest management adaptation -Irrigation system upgrades -Localize research on crop/adaptation (e.g., cranberry, peach, tomato, blueberry) -Forest/ silvicultural practices including reforestation and afforestation -Assess likely habitats and species at risk and concomitant regulatory/policy shifts for adequate species protection such as instream flow changes; horseshoe crab	-Assess extent to which State of NJ investment portfolio at risk from climate change -Long-term economic impact of climate change in vulnerable communities -Impacts to many aspects of NJ coast -Diversification of tourism attractions & revenues -Artificial snow-making -Improve access to urban waterfronts & establishment of passive recreation: canoeing, kayaking, biking, hiking -Changes to migratory bird distribution & impacts to ecotourism in Cape May and other important birding areas -Potential shifts in fish populations such as shad with local	-Identify key areas for institutionalization of adaptation planning at Municipal and State government levels -Guiding principles, i.e., substitution/ adaptation must be carbon neutral -Hazard awareness & hazard education; -Early warning communication systems -Outreach to municipal and county utility and transportation managers -Effective risk communication on cumulative impacts (i.e., subsidence influence of sea level rise (SLR) in addition to SLR; development contributing to storm impact/runoff) -Effective communication on citizen action -Monitor adaptation strategies to assess effectiveness & communicate that with public

[107]Modified and expanded from IPCC 2007 and Frumhoff et al. 2007 (cited above).

Public Health, Safety & Emergency Preparedness	Freshwater Quality & Supply	Energy, Land Use & Capital Infrastructure	Biodiversity, Ecosystems & Agriculture	Finance & Economics	Outreach & Education
climate change impacts include heat stress, waterborne pathogens, mold, respiratory illness from fires & smoke, West Nile virus, & spread of pathogens from warming climate - Improve planning for management of disaster debris -Emergency plans to provide energy in times of peak demand &/or storm events -Relocation, seawalls storm surge barriers & other barriers or adaptive techniques in coastal and riparian areas -Dune reinforcement -Land acquisition & creation of marshlands/wetlands as buffers against sea level rise and flooding -Greater model precision to identify relocation areas and timetable -Improved precision of New Jersey impacts in evacuation planning -Blue Acres (NJDEP program to acquire storm-damaged property for storm protection, and recreation and conservation purposes)		flooding, heat, soil moisture/chemistry changes) Priorities for bridge, culvert, and highway tunnel adaptation projects -Highway vegetative community adaptation needs -Adaptation plans for ports and airports -Roadway management to address erosion and seasonal extremes -Mass transit improvements/ access -Telecommuting -Strengthening of overhead transmission & distribution infrastructure; -Underground cabling for utilities -Energy efficiency -Use of renewable sources consistent with GHG Plan and Energy Master Plan -Reduced dependence on single sources of energy -Capital improvement & maintenance projects to address	population/red knot extinction, etc. -Adaptation strategies for terrestrial and aquatic ecosystems on public and private lands -Assess need for defensible space criteria alternatives related to forest fire hazard -Assess need for controlled burning in areas such as the Pinelands to ensure forest fire hazard reduction	economic consequences along the Delaware -Adapting commercial and industrial facilities located within vulnerable areas including areas with significant source water manufacturing intakes -Need for encouragement, perhaps driven by institutional or regulatory change of proactive insurance policies & elimination of regressive policies and practices (e.g., which inadvertently encourage rebuilding in flood-prone areas)	

Public Health, Safety & Emergency Preparedness	Freshwater Quality & Supply	Energy, Land Use & Capital Infrastructure	Biodiversity, Ecosystems & Agriculture	Finance & Economics	Outreach & Education
-Rolling Easements (concept that there is a public easement that would "roll" landward as the shoreline moves landward). -Retrofit buildings to address floods and higher temperatures -Improved building code standards & certification -Increase Green Building retrofit/construction -Historic preservation and cultural resources issues -Adapt to potential migrant influxes from other states if climate change impacts industry, agriculture, and water availability elsewhere -Beach replenishment and coastline sand flux evaluation - Light Detection and Ranging Mapping (LIDAR anticipated Fall 2010) to improve precision in coastal hazard mapping -Utility Adaptation Assessment		climate change risk			

Chapter 5: Public Outreach and Education

Meeting the statewide GHG limits established by the GWRA and implementing the recommendations set forth in this report will require the participation, collaboration and cooperation of a broad spectrum of State agencies, private businesses, organizations and public officials, as well as the citizens of New Jersey. The crucial role that a well-conceived public outreach and education program will play in the successful implementation of the efforts laid out in this report was emphasized at every one of the State's six stakeholder sessions held in January 2009 to discuss the draft recommendations. The participants in these stakeholder sessions were critical of the lack of a strong overarching communications plan to complement the more technical recommendations in the report, and encouraged the State to include a plan to foster a broad awareness of climate change issues (including co-benefits, such as clean air and public health) in the final report.

Efforts to educate the public about climate change would focus on four areas:

- Increase the general public's overall awareness of climate change, its potential environmental, social, economic and political impacts on the State of New Jersey, the need to reduce the emissions of the GHGs which lead to climate change, and the specific actions they can take to help the State achieve its statewide GHG limits. The aim of this goal is to evaluate, design and deliver education/information to New Jersey's general public using the most cost-effective means practical, including mass media if feasible. Increasing the public's awareness of the impact and problems associated with climate change and engaging them in actions to reduce GHG emissions in their personal and professional lives is critical to the State's ability to meet the GWRA statewide GHG limits. Given current resource constraints, the State can focus its efforts on identified opportunities for reaching large audiences that are cost effective, including increased use of websites (e.g., the State's Global Warming Website), blogs, social networking tools (e.g., facebook, myspace, etc.), wikis, etc. The State can also explore partnership opportunities with state agencies and other organizations (including the green schools and green jobs networks in New Jersey) that can help deliver climate change messages.
- Educate specific target audiences critical to the successful implementation of the GHG mitigation actions in this report (e.g., direct communication with regulated communities regarding pending rulemaking initiatives). Within the context of an overall outreach effort some outreach activities need to be specifically shaped to the needs and potential of target audiences. The State can work with these sectors in developing appropriate messages and can solicit their assistance in sharing messages and information with their memberships or associates. These target audiences include:

    - Policy makers and administrators (includes legislators, executive office, and State and local government agencies)
    - Community leaders (includes businesses, institutions, municipalities, and universities and colleges)
    - Community-based organizations (includes nonprofit advocacy and education organizations, faith based organizations, foundations)
    - Transportation management associations and planning organizations

- Energy producers and suppliers
- Developers and the construction industry
- Manufacturing, commercial, industrial, and residential sectors
- Agricultural and farming communities and organizations
- Waste and recycling sectors
- The media

- Ensure that climate change is addressed in New Jersey's revised 2009 Core Curriculum Content Standards and that climate change curriculum and instructional resources are made available and are promoted to New Jersey schools and youth-oriented educational efforts. The goal of this component of the outreach and education plan is to engage the natural curiosity and enthusiasm of young people by raising their level of understanding of climate change so that they can act individually and collectively in their schools and communities to help reduce the GHG emissions. New Jersey's schools, colleges and universities, as well as non-formal education institutions, constitute a pre-existing structure for educating New Jersey's youth.

While this component of the outreach and education plan would address the educational needs of students in both formal and non-formal instructional settings (including K through 12 and higher education, youth and scout groups, museums, science and nature centers, home schoolers, and education organizations), the primary aim would be to ensure the inclusion of climate change content in the State's revised 2009 core curriculum content standards. The promotion and availability of support resources for formal and non-formal education needs, such as curriculum supplements and teaching aides, professional development opportunities and specialized expertise, and technology and community-based program models, are needed to aide the delivery of climate change content and activities to New Jersey youth.

- Begin to develop a complementary plan that focuses on communicating the need for adaptation strategies in New Jersey. Carbon dioxide and other GHGs persist in the atmosphere for decades, and even up to centuries, from the time they are emitted. For this reason, even dramatic emission reductions cannot prevent the warming effects of the GHGs already in the atmosphere. Today's emissions will have future public health, ecological and economic impacts in New Jersey. Therefore, it is necessary to develop mechanisms to cope with the affects of climate change. As with the State's mitigation efforts, a key to the success of that adaptation policy will be a comprehensive outreach and education plan that dovetails with, and enhances, the other education efforts outlined in this chapter. To do this, the State would need to determine how best to communicate risk and health impacts, ecological impacts, economic impacts and adaptation strategies. These communication strategies would be developed in parallel with the development of the State's adaptation policy itself, and would build upon the outreach and education materials developed to meet the other goals in this chapter.

The remainder of this chapter outlines the rationale for each of these four goals and the State's next steps in terms of implementing a comprehensive climate change outreach and education plan. It also identifies the outreach and education actions currently underway in New Jersey.

Next Steps:

The following steps could provide a solid foundation for a comprehensive outreach and education plan:

- Begin to inventory reputable information sources and materials (both general and scientific) in an effort to create a clearinghouse of climate change information and education resources (possibly through the State's Global Warming Website at http://www.nj.gov/globalwarming/). This clearinghouse would list groups and agencies engaged in activities related to climate change, as well as websites, current publications on climate change, and contact information for organizations which address global climate change.
- Work to enhance the State's Global Warming Website so that it is more comprehensive and in line with the coordination efforts outlined as mitigation actions in this report.
- Work to develop or enhance existing outreach materials (flyers, pamphlets, etc.) on climate change and its impacts on New Jersey, as well as the actions that can be taken either individually or collectively to reduce GHG emissions.
- Continue educational and information exchange forums (meetings, public hearings, seminars, discussions, workshops, etc.) with target audiences, particularly those impacted by the mitigation actions outlined in this report.
- Identify additional target audiences, including community-based organization and trade associations that would enhance the State's climate change outreach efforts.
- Coordinate the outreach and education actions of the various state and local agencies and organizations involved in implementing the mitigation actions in this report.
- Identify existing resources and programs to implement climate change education measures.
- Identify additional needs and supplemental sources of funding for climate change education measures.
- Evaluate communication outlets, including mass media and other less traditional modes (e.g., State and outside organization newsletters, fairs and other events, etc.) to assess the best, most cost-effective methods for communicating with both general and targeted audiences.
- Coordinate with the New Jersey Department of Education to align climate change education resources with New Jersey revised Core Curriculum Content Standards and related implementation tools and resources.
- At universities and colleges, encourage research on global climate change and its solutions.
- Integrate climate change into existing and new education competitions, such as science fairs and higher education competitions.
- Explore the potential for the use of new media (social networking sites, blogs, wikis, etc.) as outreach tools.
- Explore leveraging opportunities for mass media communications, where feasible.

Chapter 6: Beyond the 2020 Recommendations and Related Actions: Setting the Stage for 2050 and Implementation in the Coming Months

While achieving the statewide 2020 GHG limit will require a firm commitment across the public and private sectors, the State is confident and certain that the means to do so are clear and doable. The essential steps are prompt action and an ongoing dedication to results. However, the 2020 limit is an interim milestone intended to stabilize emissions. The 2050 limit – reduce emissions to a level 80 percent below 2006 emission levels (approximately 26 MMT CO_2eq) – presents the more critical goal because it represents the emission level necessary to avoid the worse potential effects from climate change.[108] The 2020 actions will provide a foundation for reaching the 2050 limit. Bolder and more far-reaching actions will clearly be required to actually attain it.

Toward a New Paradigm

In a seminal work, Researchers at Princeton University have put forth a position that the challenge of achieving critical GHG emission reductions in the long term requires a paradigm shift in three broad categories:[109] energy efficiency and conservation; renewable electricity and fuels; and creation of natural carbon sinks. A fourth category, reduced reliance on cars, it is considered to be an aspect of efficiency and conservation in the Princeton paper; however, it is discussed separately in this chapter because the policies associated with it are inherently different than those policies associated with energy efficiency and conservation.

The requisite policies associated with such a paradigm shift will:

- Extend many of the 2020 actions more deeply and broadly across the public, private, residential and business sectors;
- Compel us to think more closely about our choices and use of energy;
- Insist that we re-examine how we value greenfields and open space to ensure that their total worth is fully characterized; and,
- Prompt us to assess market signals to ensure that inherent incentives exist for carbon-neutral options in all sectors of the economy.

In other words, citizens of New Jersey will have to govern, work and live much differently than we do now, with an emphasis on smarter and greater efficiency. The policies, practices, behaviors, and technologies that brought us to the current problems will obviously not lead to their solutions.

[108]It is understood that New Jersey's independent achievement of the 2050 limit will not preclude local climate change impacts; New Jersey recognizes its obligation to be part of the necessary global response if impacts are to be avoided.

[109]Pacala, S. and R. Socolow. 2004. Stabilization Wedges: Solving the climate problem for the next 50 years with current technologies. Science 305:968-972.

Market Transformation and the Green Economy

New Jersey's long-term shift in the ways we produce and use energy, from electricity to transportation fuels, will bring other far-reaching and society-strengthening benefits, including bolstering our economy through the creation of markets for energy efficiency and clean energy technologies, spurring technical innovation and "green" jobs growth, and reducing the cost of energy by becoming more efficient and increasingly meeting our energy needs through in-state generation. Economically-driven market transformation policies include stricter building, appliance and auto efficiency standards, rebates and/or pricing mechanisms for efficient vehicles and low-GHG fuels, financial incentives for the manufacture of energy efficient products and demand side management programs which create incentives for consumers' choice of "climate friendly" products and services. The sooner the transition to a "green" economy begins, the greater the benefits to the economy and the climate.

In the long term, New Jersey, as well as the rest of the nation, must consider the extent to which its economy provides inherent incentives for climate friendly markets. A recent General Accountability Office (GAO) panel survey of economists found that all surveyed agree that establishing a price on GHG emissions using a market-based mechanism should be considered as a GHG policy[110]. Market-based mechanisms refer to all mechanisms (voluntary or mandatory) that affect demand for or supply of energy and/or carbon emissions, either through prices, regulation or information. Also referred to as "price mechanisms", market-based mechanisms include taxes, subsidies and green pricing.

Investing in energy efficiency, green collar jobs, and new climate-neutral technologies is not just a way to reduce GHG emissions, but also a means to develop a robust and climate-friendly economy at both the Federal and State level. For example, anticipated State investment in New Jersey energy infrastructure as a result of the Energy Master Plan is estimated to result in the creation of 20,000 jobs between now and 2020.[111] These jobs will consist of operations and maintenance jobs, and construction jobs directly related to the State's energy infrastructure.

Science, Research and Innovation

Achieving New Jersey's statewide 2050 GHG limit also brings the potential payoff from research and development. New Jersey recognizes that as the State moves forward in confronting climate change there will continue to be important long-term research needs for our region related to emissions sources, electricity storage, models, measurement methods, mitigation practices, alternative technologies and adaptation strategies. Assessment of carbon capture and storage technologies, which are intended to capture carbon from large point sources (such as fossil fuel burning power plants) and store it in deep geological formations, is an important research area that shows promise for GHG mitigation. To that end, the State will join the U.S. Department of Energy's Midwest Regional Carbon Sequestration Partnership and will perform an initial assessment of New Jersey's potential for storing CO_2 in geologic and terrestrial reservoirs. Other critical research and development issues that will need to be

[110]U.S. Government Accountability Office. 2008. Climate Change: Expert Opinion on the Economics of Policy Options to Address Climate Change. GAO-08-605.

[111]"New Jersey Energy Master Plan", October 2008. See http://www.state.nj.us/emp/

addressed include alternative energy projects such as pilot projects to harness wave and tidal energy in the New Jersey coastal region, and biofuels research and demonstration projects. All energy-related research will need to quantify the net energy and carbon balance of the overall process, and identify any significant non-energy-related impacts. Research is needed regarding adaptation to a changing climate, such as impacts to coastal communities and agricultural industries.

Key Indicators

The following represents an initial set of long-term indicators for tracking New Jersey's progress toward meeting its statewide 2050 GHG limit:

- The use of renewable energy sources in the State's energy portfolio will continue to increase aggressively until majority of sources of electricity generation in New Jersey come from carbon neutral sources.
- All new buildings constructed after 2030 will have a net zero energy consumption through a combination of energy efficiency requirements and renewable energy sources.
- The current level of terrestrial carbon sequestration will increase by 1.53 million metric tons (MMT) CO_2 annually by 2020 and by 3.14 $MMTCO_2$ per year by 2050. This will raise the sequestration capacity from 7 $MMTCO_2$ to at least 8.53 $MMTCO_2$ annually by 2020 and to at least 11.67 $MMTCO_2$ annually by 2050. This will result from both an (a) expansion of the green infrastructure[112] and the implementation of the other supplemental terrestrial carbon sequestration measures[113] recommended in this report, and (b) investment[114] on at least half of the approximately 700,000 acres of state lands that are being incorporated in the forest and tidal marsh stewardship and restoration program under the Global Warming Solutions Fund (GWSF) law. Moreover, New Jersey will further increase its terrestrial sequestration in 2050 (by an additional 2.39 $MMTCO_2$ annually) through new natural sink enhancement measures on forest lands thereby raising the total target capacity to 14.06 $MMTCO_2$ annually.
- VMT growth between now and 2020 will be limited to a rate of no more than 1 percent per year, and will stabilize thereafter.
- All vehicular VMT in New Jersey will be "green" VMT within the next 15 years.[115]
- By 2050, ninety percent of development in New Jersey will occur in areas already served by public infrastructure, and 99 percent of that development will be in the form of redevelopment.
- By 2050, at least 90 percent of all buildings in New Jersey will be fully occupied.

[112]Increase in area of preserved forestlands, wetlands, and associated agricultural landscapes by at least 10,000 acres annually for 10 years through Garden State Preservation (GSPT) acquisitions. This projection assumes that there is no further re-authorization of the GSPT after the 10 -year period.

[113]Forest Stewardship, No Net Loss Reforestation, Forest Cover/Tree Canopy Requirement, and Sustainable Agriculture

[114]Applying proceeds from the RGGI auctions as directed by the Global Warming Solutions Fund law (N.J.S.A. 26:2C-50 et. seq.) in the first 5 years.

[115]The NJDEP defines a "green" vehicle as a car or light duty truck with a California 2009 GHG score of 9 or greater (currently, this roughly translates to 33 miles per gasoline gallon equivalent (GGE)).

- Transit ridership will double by 2050, and green commuting options will be expanded such that all New Jerseyeans will have alternative transportation options to get to work other than single occupancy vehicles.

Policies for a New Paradigm

Key Policy Area 1: Energy Efficiency and Conservation

and

Key Policy Area 2: Renewable Energy and Fuels

The New Jersey EMP, released in October of 2008, lays out aggressive actions for the State to take between now and 2020 and serves as a blueprint for New Jersey's attainment of the 2020 statewide GHG limit. New Jersey needs to build on the foundation of these EMP actions as it looks beyond 2020 to achieve its 2050 GHG limit.

The future of energy in New Jersey can be viewed through two lenses: generation and consumption. While we can only speculate about our energy generation and consumption post-2020, the policies laid out in the EMP give us direction as to what types of technologies and energy sources to expect over the next 40 years, as well as what our energy demands might look like. Specifically, the EMP[116] states that the anticipated 2020 electricity usage and the sources of that electricity will be:

- 44 percent nuclear;
- 30 percent conventional fossil fuel and Combined Heat and Power (CHP) (using fossil fuel); and,
- 26 percent renewables (13 percent wind, 10 percent biopower and waste incineration and 3 percent solar).

In 2020, almost 90 percent of space heating and other heating needs will still be met with fossil fuels. We can then work from this anticipated point to project a range of possibilities for 2050.

In the energy consumption and generation scenarios presented in Table 6.1 below, it is clear that New Jersey must strive to stabilize its energy consumption in order meet its demand through renewable and non-carbon based energy sources. The EMP prioritizes energy efficiency initiatives for both the residential and commercial/industrial sectors. Recommendations included in this report, such as developing green guidelines for all new and existing construction to meet State green guidelines, are designed to support the EMP's energy efficiency goals, and will go a long way towards reducing the State's overall energy demand. Ultimately, the State must move towards the indicator established in this report, where all new buildings constructed in the State after 2030 will have a net zero energy consumption. By reducing their energy demands as much as possible, and supplementing energy generation through the addition of on-site renewable

[116]From the Modeling Report for the New Jersey Energy Master Plan, Table 22; portion of generation utilized in-state, http://www.nj.gov/emp/docs/pdf/10122208ceeepModEMP.pdf

sources (e.g., solar power), such buildings will no longer need to pull additional power from the State's energy grid and will be self-sustaining from an energy standpoint.

It is likely that such further gains in energy efficiency and conservation are possible. The EMP calls for a 20 percent reduction in energy consumption below what would otherwise be consumed under a business-as-usual scenario by 2020. This translates to a rate of reduction in energy consumption of approximately two percent per year. If progress at a similar rate could be maintained until 2050, dramatic reductions in energy use could result that could eliminate the need for the growth in generation sources as substantial as that depicted in Tables 6.1 and 6.2.

On the generation side, the potential sources of electricity generation by 2050 include renewables (wind, biopower, solar and new and emerging technologies, such as small hydro and ocean power), CHP, nuclear, and fossil fuel with carbon capture and sequestration or use. In order to determine what mix of these sources would be needed to meet our 2050 energy consumption needs, the NJBPU, with input from the NJDEP, developed a range of 2050 energy consumption projections. Table 6.1 shows the various 2050 energy consumption scenarios considered, as well as an assessment of how those energy demands might be met.[117] Table 6.2 shows how the State predicts it could meet those various 2050 energy consumption scenarios compared to how the State's overall energy demands are currently met, and also depicts the 2020 scenario expected to result from implementation of the EMP. Both tables project that for 2050 the State can meet its energy needs through a mix of renewable and carbon-neutral energy sources.

Table 6.1: 2050 Energy Estimates

	Consumption		Generation		
Scenario	Low End* (GWh)	High End** (GWh)	Renewables/ Biopower (GWh)	Low End Additional Need (GWh)	High End Additional Need (GWh)
Electricity Needs	78,000	105,000	106,000	N/A	N/A
Electricity Plus Transportation***	104,000	145,000	106,000	N/A	39,000
Electricity, Transportation and Partial Heating Support****	149,000	190,000	106,000	43,000	84,000

* assumes electricity use would stabilize at the 2020 level through 2050.
** assumes electricity growth would occur at a rate of one percent per year from 2020 to 2050.
*** assumes 100 percent electrification of the transportation sector; low end estimate of total electric consumption by this sector is 26,000 GWh/year; high end is 40,000 GWh/year.
**** assumes 25 percent electrification of the heating sector.

[117] This table is based on extending the modeling done for the EMP to 2050.

Table 6.2: Energy Estimate and Source Comparison over Time

	2004		2020 EMP		2050 Low Growth Scenario		2050 High Growth Scenario	
	GWh	% of Total	GWh*	% of Total	GWh*	% of Total	GWh*	% of Total
Nuclear & Fossil w/sequestration	27,082	34.5	34,000	43.6	31,300	21.0	70,600	37.2
Fossil	27,749	35.3	12,000	15.4	0	0.0	0	0.0
On-Site (Includes CHP)	1,227	1.6	12,000	15.4	12,000	8.1	12,000	6.3
Imported Electricity	21,421	27.3	0	0.0	0	0.0	0	0.0
Subtotal Non Renewable	**77,479**	**98.6**	**58,000**	**74.4**	**43,300**	**29.1**	**82,600**	**43.5**
Solar	10	0.0	2,000	2.6	20,200	13.6	20,200	10.6
Wind	0	0.0	10,000	12.8	74,700	50.1	74,700	39.3
Biopower	0	0.0	7,000	9.0	9,000	6.0	9,000	4.7
Refuse Drived Fuel	1,051	1.3	1,000	1.3	0	0.0	0	0.0
New & Emerging Technologies	0	0.0	0	0.0	1,800	1.2	3,500	1.9
Subtotal Renewable	**1061**	**1.4**	**20,000**	**25.6**	**105,700**	**70.9**	**107,400**	**56.5**
Total Generation	**78,540**	**100.0**	**78,000**	**100.0**	**149,000**	**100.0**	**190,000**	**100.0**

* Values from 2020 and 250 have been rounded to nearest 100 GWh.
An insignificant amount of the imported electricity in 2004 was generated by renewable sources.

Based on the commitments in the EMP, the State expects that that renewable and biopower generation could produce approximately 106,000 gigawatt hours (GWh) of electricity[118]: enough to meet both the low and high ends of the 2050 non-transportation electricity consumption range, as well as the low end of the transportation sector consumption range. This highlights the enormous potential that renewable energy has to address the statewide 2050 GHG limit, making the EMP's push for increasing these renewables even more critical for the 2050 timeframe. For those scenarios where additional energy generation beyond renewable and biopower sources would be needed, the possible sources would include converting the CHP facilities to use hydrogen that is generated from non-carbon emitting sources, such as nuclear power or fossil fuel (coal or natural gas) with carbon capture and sequestration.

[118]Currently, there is not a convenient and economical way to store electricity generated by renewable or conventional energy sources. This estimate assumes that current electricity storage issues have been resolved and that some energy loss would occur through that process.

Table 6.2 projects aggressive goals for renewable electricity sources, including wind and solar. For example, providing 74,700 GWh of electricity from wind power by 2050 would call for the construction of approximately 25,000 megawatts (MW) of wind capacity by then. This represents 5000 wind turbines of 5 MW each, which would have to be installed at a rate of at least two per week between now and 2050. Should such dramatic growth in renewable sources not occur, other sources, including nuclear power, must be considered if energy use grows as projected between 2020 and 2050.

The State is confident that a combination of a variety of additional sources would produce enough additional capacity to meet the State's 2050 electricity, transportation and heating needs, even under the high usage scenario. Continued progress in energy efficiency and conservation would mean that economic growth could continue without consumption reaching the high usage scenario.

This conceptual assessment gives perspective on what the generation-related Energy Efficiency and Renewable Energy indicators established above might show in the future. Meeting all of these scenarios relies heavily on an ever increasing supply of renewable energy sources, and the elimination of our State's reliance on carbon-based energy sources that do not have the ability to sequester that carbon safely and efficiently.

Meeting the State's electricity needs with renewable, biopower, nuclear or carbon neutral fossil fuel generation, electrifying the transportation system from these same sources along with a portion of the heating needs could eliminate most of the current GHG emissions from the electricity generation, residential, commercial, industrial, and transportation sectors. If this were done, and if most of the industrial process energy needs now provided by fossil fuel combustion were converted to electric power, if emissions of halogenated gases were reduced to de minimus levels, if emissions from natural gas transmission and distribution systems were essentially eliminated, if carbon sequestered by forests was held steady or increased, and if landfill emissions were to continue their long-term decline, the State's GHG emissions could be held to below 26 $MMTCO_2eq$ in 2050, allowing the State to meet the reduction goal of 80 percent below 2006 emissions.

Key Policy Area 3: Creation, Maintenance and Enhancement of Natural Sinks

As noted previously, terrestrial sequestration of CO_2 is estimated to offset 5 percent of New Jersey's gross GHG emissions (approximately 7 MMT of CO_2e from New Jersey's atmosphere). The challenge is to create, maintain and enhance a sustainable network of natural sinks within the state's terrestrial domain. This presumes halting the statewide loss of forest land and maintaining New Jersey's wetland resources. Knowing that development continues, a suite of additional measures including land preservation, specific reforestation activities and sustainable forestry and farming practices, all of which have the potential to alter carbon sequestration processes, are recommended to meet the statewide 2020 limit. As noted, the actions to be taken in the medium-term seek to establish a stable base for sustained carbon sequestration in the long-term. This will be supplemented by innovative efforts to increase biomass and soil carbon densities given the limited availability of land. The use of forest residues and woodwastes for high value durable and long-lived products that also store carbon will also be explored.

Increasing the terrestrial carbon sequestration capacity to 14.06 MMT CO_2 annually through an increase in biomass and soil carbon uptake is a target the State strives to achieve by 2050, not only because of the sequestering capacity of terrestrial resources that helps to offset the emissions of GHG sources, but also because it avoids releasing GHGs by preventing the destruction of our terrestrial resources (estimated to be 1.1 MMT of CO_2e based on annual land clearing data for New Jersey). Some examples of measures that could be implemented additionally to help the State attain its 2050 terrestrial sequestration target are:

GHG Reduction and Carbon Sequestration Potential of Agriculture

Agriculture is an energy-intensive sector of the economy. Energy is interlinked with all aspects of agriculture, both *directly* as diesel fuel, electricity, and propane, and *indirectly* in energy-intensive products such as fertilizer, other agricultural chemicals, and animal feed.

The large on-farm energy users include tillage, transportation, irrigation, inorganic fertilizers, petroleum based pesticides, plastics and grain drying. There are a number important ways that the agricultural sector and farming community can take to reduce both direct and indirect energy use. Fossil fuel energy can be conserved on-farm by following certain practices such as:

- Reducing tillage operations
- Reducing trips to field
- Reducing fertilizer, pesticide and plastic inputs
- Conservative grain drying
- Irrigation use efficiency
- Recycling
- Substituting renewable energy for fossil fuels

These practices are already being applied to a certain extent and agriculture has already made significant strides to mitigate GHGs (e.g., in programs supported by the USDA Natural Resource Conservation Service). Efforts in this area can be increased considerably.

Many of these practices also conserve soil and water. Saving energy and water include measures that reduce runoff, reduce chemical inputs, and reduce crop water requirement. Saving energy and reducing crop fertilizer requirements involve use of crop rotations, cover crops, residue management and manure management (Aschmann, S. 2005. Energy Savings through Cropping Systems. A Look at the NRCS Energy Estimator. Presentation at the ACEEE Forum on Energy Efficiency in Agriculture. November 2005).

Minimizing direct energy use and minimizing losses of soil, water, and farm chemicals (embodied energy) are main thrusts of on-farm management for energy efficiency. Another key element of on-farm energy is photosynthetic energy that is the basis of agricultural/cropping processes. The aim here would be optimizing photosynthetic energy for greater farm productivity and capturing carbon through improved crop and soil management and related innovative technologies. Thus, agriculture also has significant potential for enhancing the natural process of carbon sequestration [USDA 2004. U.S. *Agriculture and Forestry Greenhouse Gas Inventory: 1990-2001.* Global Change Program Office, Office of the Chief Economist, U.S. Department of Agriculture, Technical Bulletin No. 1907. March 2004]).

Creating carbon offsets in agriculture can be viable provided the projects are verified as meeting appropriate criteria or standards (See General Accounting Office. 2008. CARBON OFFSETS The U.S. Voluntary Market Is Growing, but Quality Assurance Poses Challenges for Market Participants). The potential for creating carbon offsets in agriculture is most significant in three areas: a) increasing

the use of continuous conservation tillage; b) reducing the cultivation of organic soils; and c) converting marginal cropland to permanent grassland or forest (Sampson, R. Neil. 2004. Potential for Agricultural and Forestry Carbon Sequestration in the RGGI Region). Conversion from conventional tillage to continuous conservation tillage is estimated to sequester carbon at rates equivalent to around 0.1 tonne of carbon (tC) per acre per year or about 0.3 to 0.4 tonne of CO_2 equivalent (see USDA. 2004 above) to about 0.2 tC per acre per year or about 0.7 to 0.8 tCO_2e per acre per year (Lal *et al*. 1998. *The Potential of U.S. Cropland to Sequester Carbon and Mitigate the Greenhouse Effect.* Chelsea, MI: Sleeping Bear Press)). The opportunity exists to encourage land use change that significantly increases carbon sequestration, such as the conversion of cropland to permanent grass or the conversion of cropland to forest. However, the primary competition for this land is development so there needs to be significant incentives for landowners to convert land from agricultural use to conservation or forest use instead of taking the high prices offered by developers. Natural Resource Conservation Service (NRCS) incentive programs to retire marginal lands to grasslands are examples of how to address this need.

Another aspect of agriculture that has GHG implications is livestock production. Livestock waste currently contributes about 8 percent of human-related methane emissions in the country (USEPA. 2006. U.S. Emissions Inventory 2006: Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 - 2004). In 2005, it was estimated that waste from just the nation's 9 million dairy cattle released approximately 25 million metric tons (in CO_2 equivalent) of methane (International Dairy Foods Association [IDFA] webpage. 2007. Anaerobic digestion captures methane emissions from confined animal waste. An average anaerobic digester that processes livestock manure waste can capture methane and generate up to 2,900 megawatt-hours of electricity thereby potentially displacing approximately 4,000 metric tons of CO2 equivalent annually (Environmental Law and Policy Center. 2007. Measuring the Potential GHG Savings of the Farm Bill's Energy Title Programs). New Jersey has a small livestock industry, particularly dairy, for which a centralized anaerobic digester system (for animal waste disposal, energy production, and GHG reductions) might be considered. Potential digester opportunities also exist for waste generated in the State's equine industry.

- *Sustaining management of forestlands (private and public, beyond those that are incorporated into the state lands program) to improve biomass carbon density, while preserving important ecological co-benefits***.** By relying on conservation-based forest management, which uses natural forest management or sustainable forest management practices, including restocking of understocked areas/sites and forest stand improvement, and depends on a combined management regime (active and passive forest management), the State could increase forest growth and help accelerate storage of carbon, while continuing to generate other important co-benefits.
- *Experiment with new roadside vegetation management strategies to improve air quality and carbon sequestration***.** The NJDOT could work with the NJDEP to scope out a research project to identify roadside plant materials and soils that have low maintenance costs (mowing and landscape maintenance), ensure safety (clear zones and sight distances), and are environmentally sound (mindful of wetlands, wildlife habitat, native plant species, etc.), but that also provide improved air pollutant filtering and carbon sequestration.
- *Explore the viability of urban carbon sinks including development of a New Jersey Green City or vacant land stabilization program***.** The State could explore the creation of a vacant land stabilization program that would partner with municipalities to green and stabilize vacant land and create urban/suburban forests and/or increase terrestrial carbon sequestration. This could be modeled, in part, after a Pennsylvania Horticultural Society Program, whereby community groups maintain the properties.

- *Research the potential for restoration of degraded soils to improve soil carbon density and enhancement of marginal farmland into permanent terrestrial carbon sequestration*. The State could invest in research and demonstration projects to explore the conversion of marginal farmland to permanent terrestrial carbon sequestration, including conversion for grassland habitat for wildlife and/or conversion for growth of native, non-invasive species such as switchgrass or other second generation biofuel stock as well use of biochar materials for soil stabilization and fertilization. Depending on the type of vegetation to be introduced, degraded soils of such farmland (soil groups D and E as identified by the State Farmland Evaluation Advisory Committee) could be improved with measurable gains in soil carbon.
- *Reduce conversion of woodlands to agricultural uses on Soil Groups D and E*. Rather than losing mature woodlands to cultivated crops and other agricultural uses, the State could implement one or more of the following options:
  - Prevent land use conversions through the purchase of conservation easements requiring land to stay in forest use.
  - Use agro-forestry practices which combine agriculture and forestry technologies to create more integrated, diverse, productive, profitable, healthy and sustainable land-use systems.
  - Encourage property owners to participate in the NJDEP's Forest Stewardship Program.
  - Prevent mature forest loss through legislative and/or regulatory reform.

Carbon storage is the absolute amount of carbon held within a carbon reservoir at a specified time (a reservoir is a system capable of accumulating and releasing carbon, such as forest biomass). Sequestration, on the other hand, is the uptake of carbon or the process of increasing the carbon content of a carbon reservoir and is measured as a rate, i.e., mass per unit time (e.g., tons carbon per year). Internationally, the measurement of terrestrial storage and sequestration is an emerging field.

The NJDEP is working with academic partners to quantify more accurately the sequestration capacity of New Jersey forests (Lathrop, R. *et. al.* 2008. Assessing the Potential for New Jersey Forests to Sequester Carbon and Contribute to Greenhouse Gas Emissions Avoidance. This is a research project being conducted by Rutgers University in collaboration with the New Jersey Forest Service/NJDEP). Additionally, other work is underway in New Jersey to better understand carbon storage and sequestration. New Jersey is home to the USDA Silas Little Experimental Forest, one of 140 sites on five continents participating in FLUXNET, to quantify spatial and temporal variation in carbon storage in plants and soils, and exchanges of carbon, water, and energy in major vegetation types across a range of disturbance histories in the Americas. The carbon sequestration potential of agriculture is discussed in the sidebar entitled “Energy/GHG Saving and Carbon Sequestration Potential of Agriculture”. Data regarding the storage and sequestration potential of other vegetative cover types is being synthesized by NJDEP. In the meantime, this report relies on preliminary estimates from the New Jersey GHG Inventory and Reference Case Projections 1990-2020 (Technical Appendix H of the Draft Inventory describes the estimation procedure for forestry and land-use. See http://www.nj.gov/globalwarming/pdf/20080219inventory.pdf).

Changes in carbon stocks and net GHG emissions over time can be estimated using some combination of direct measurements, activity data (e.g., amount of forest products harvested; area of forests/plantations), and models based on accepted principles of statistical analysis, forest inventory, remote sensing techniques, flux measurements, soil sampling, and ecological surveys. Methods for measuring non-CO_2 GHG emissions are less well developed. It is important for emerging methods of measuring terrestrial storage and sequestration to consider net GHG emissions results since some activities designed to enhance CO_2 storage may increase emissions of other highly warming gases such as use of fertilizer to enhance tree growth (possible N_2O emissions); wetland restoration

(possible increase in CH_4 emissions); use of nitrogen fixing trees (possible increase in N_2O emissions); and use of biomass (wood and crops) as energy feedstock to offset CO_2 emissions from fossil fuels (possible increase in N_2O emissions). As an evolving area, measurement of terrestrial carbon sequestration includes different methods that entail assumptions and some level of uncertainty, which need to be recognized.

In addition to these examples, there is a significant challenge in understanding the uncertainties that are associated with vegetative resources. In particular, these include accounting for impacts from unforeseen circumstances such as drought, fire or pest outbreaks that could have a profound effect upon terrestrial vegetative resources as well as impacts to wetland resources from rising sea level or coastal erosion from severe storms. The State recognizes it needs to establish standards and indicators for long-term and more detailed terrestrial carbon sequestration (vegetative biomass, soil, and long-lived wood-based products) accounting which includes measurement and monitoring and ultimately allow for risk management to address the uncertainties that vegetative systems face. Approaches can be land-cover based, program-element based, or carbon-cycle based.

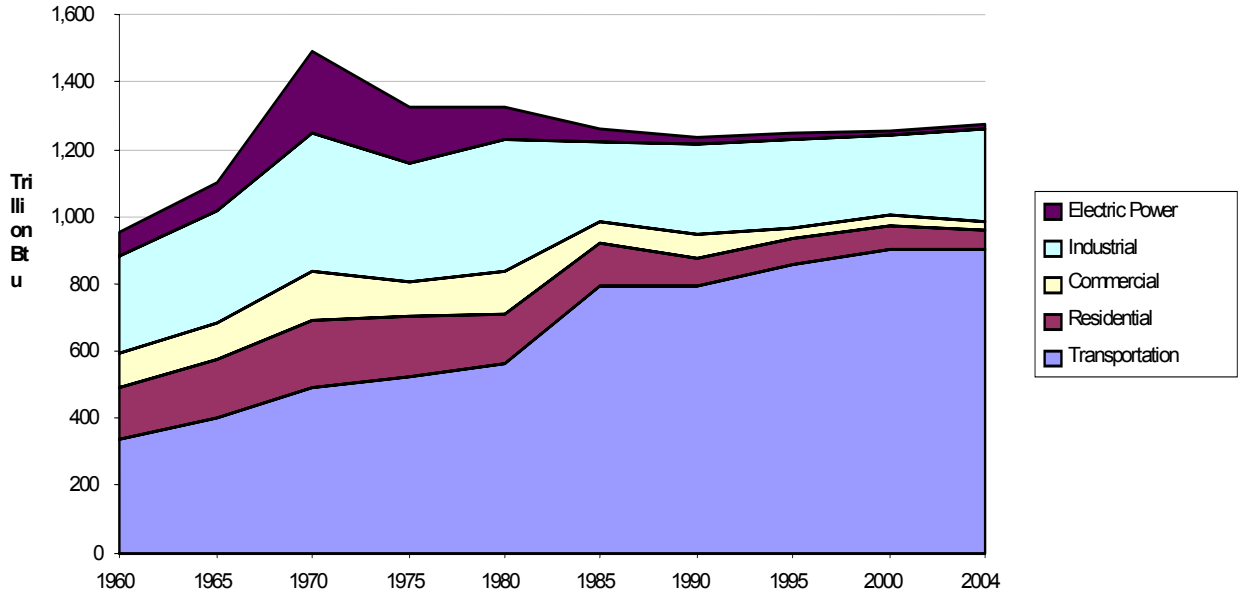
Key Policy Area 4: Reduced Reliance on Cars

Comments received from stakeholders on the draft version of this report called for earlier action on policies associated with integrating the statewide GHG limits into land use and transportation planning. As a result, much of the discussion on land use and transportation planning from the 2050 section of the draft report has been moved to the 2020 supporting recommendations outlined in Chapter 3. However, those 2020 supporting recommendations are clearly just the beginning as New Jersey considers how to best undergo the long-term paradigm shift that will result in land use patterns which will reduce reliance on cars to help achieve the statewide 2050 limit.

The transportation sector in New Jersey was responsible for about 35 percent of the State's gross GHG emissions in 2004, and approximately 30 percent of the total energy consumed in the State. Transportation is not only the largest sector of New Jersey's GHG emissions; it is also the fastest growing sector. Figures 6.1 and 6.2 show the portion of petroleum consumed by New Jersey's transportation sector.[119]

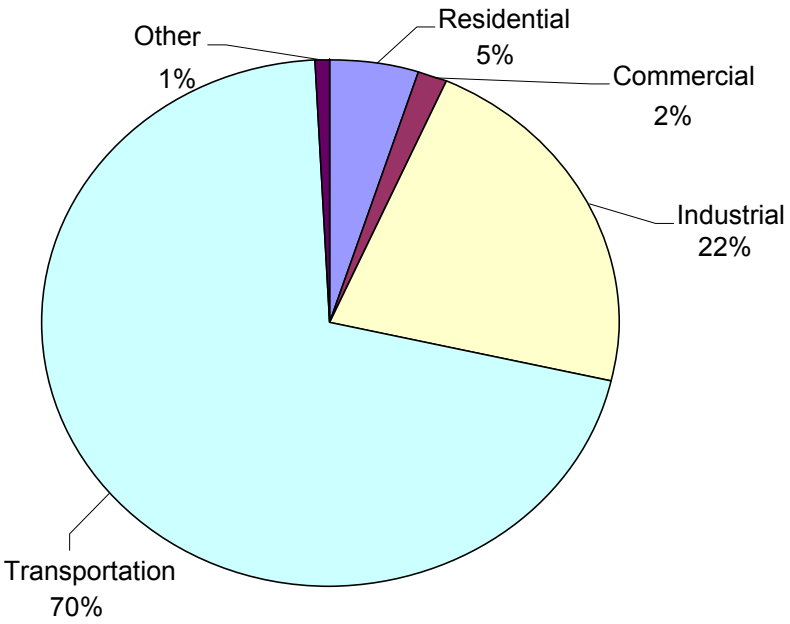
[119] The transportation energy use and per capita data used to generate Figures 6.1 and 6.2 (as well as Figure 6.3) are based on the total energy used by the transportation sector as reported by the USDOE/EIA. New Jersey's GHG inventory estimates for the transportation, presented in Chapter 2 of this report, rely on a somewhat lower total energy use that does not include all of the jet fuel used in New Jersey's airports or the fuels used by the marine shipping sector. This lower total was used because NJDEP recognizes that much of the use of these fuels is a result of national and international travel and commerce, and is not under the direct control of New Jersey.

Figure 6.1: New Jersey Petroleum Consumption by Sector, 1960-2004



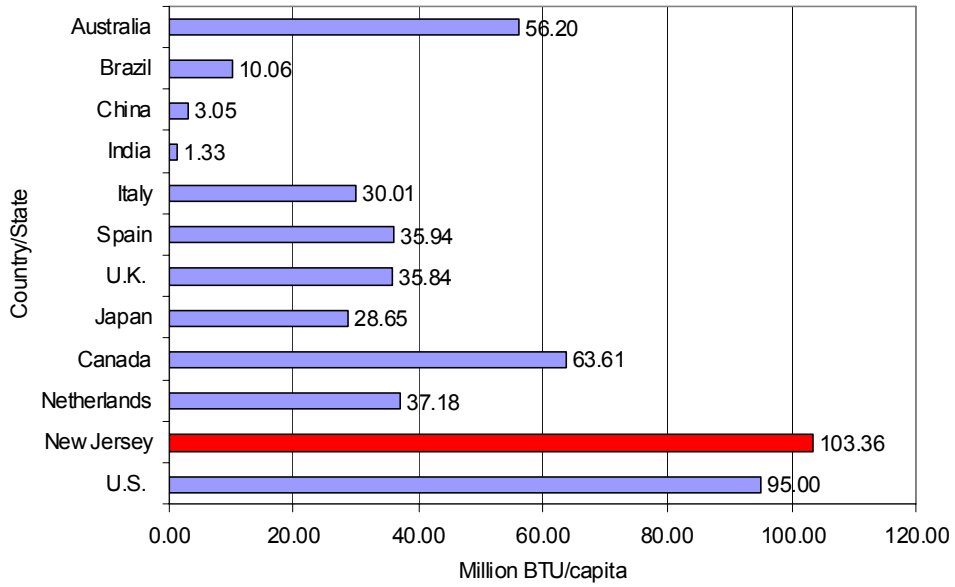
Source: US Dept. of Energy, Energy Information Administration

Figure 6.2: New Jersey Petroleum Consumption by Sector, 2004



Compared to other states, New Jersey ranks 17th in per capita transportation petroleum usage and 20th in per capita total transportation energy usage. Compared to other countries, New Jersey's per capita energy use in the transportation sector is high (see Figure 6.3).

Figure 6.3: Per Capita Petroleum Consumption in Transportation Sector, 2004



Sources: US Dept. of Energy, Energy Information Administration; US Census Bureau

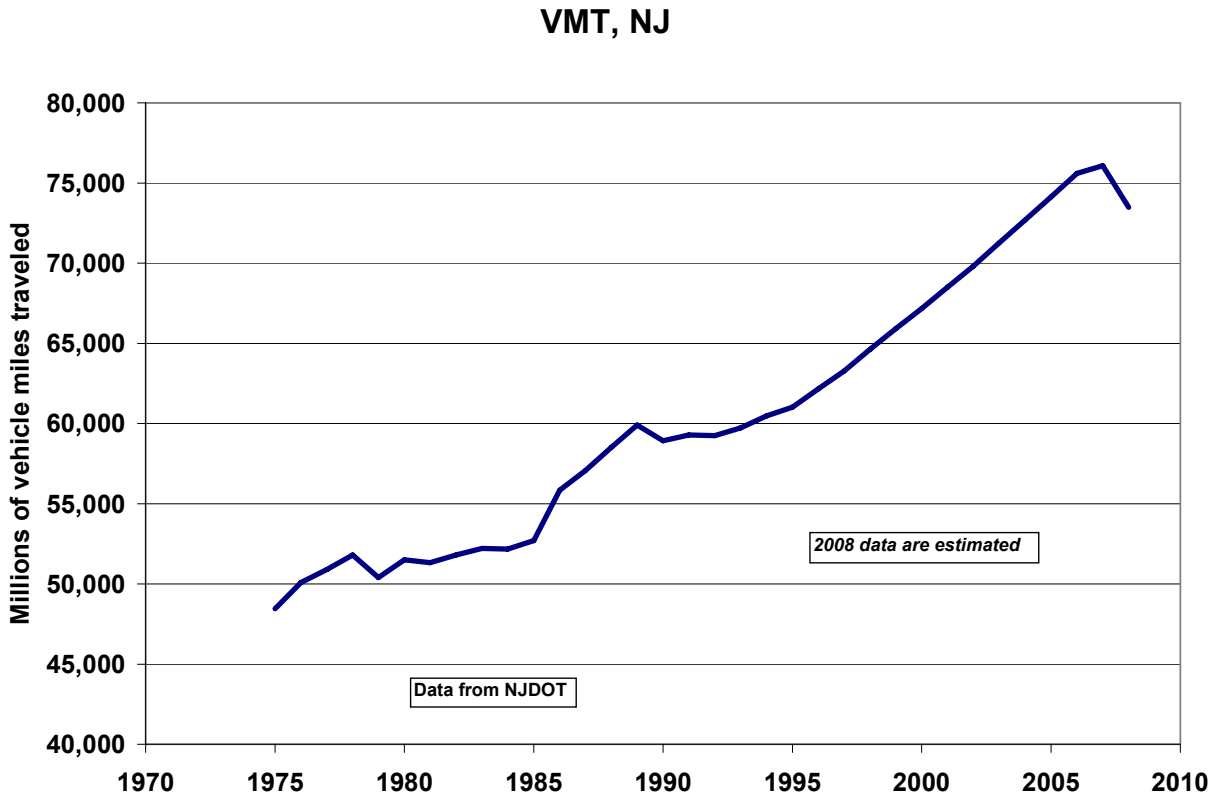
To date, the State's ever-increasing consumption of energy from this sector has been attributed to both: 1) the annual increase in the number of miles driven each year by New Jersey motorists (known as vehicle miles traveled or VMT) since 1990[120]; and 2) the fact that fuel efficiency gains from cars over time have been negated by the increased use of light trucks (e.g., sport utility vehicles).[121]

In 2004, almost 73 billion vehicle miles[122] were traveled on the State's more than 38,000 miles of roads[123], ranking New Jersey 12th in the nation in terms of total vehicle miles traveled. Over time, the rate of VMT increases in New Jersey has outpaced the rate of population growth. As shown in Figure 6.4, VMT increased in New Jersey between 1992-2007 at approximately 1.7 percent per year[124]. Figure 6.5 shows a steady increase in VMT per person in the State, until 2007. The Urban Land Institute (ULI) reports that, since 1980, the number of miles Americans drive has grown three times faster than population, and almost twice as fast as vehicle registrations. According to ULI, sprawling development patterns are a key factor in that rate of

[120] New Jersey's Annual Certified Public Road Mileage and VMT Estimates (1975-2006), NJDOT - Bureau of Transportation Data Development, Roadway Systems Section.
[121] Information obtained from a 2007 Energy Information Administration/Department of Energy (EIA/DOE) presentation ("Trends and Transitions in the Diesel Market" by Joann Shore and John Hackworth for the 2007 National Petrochemical and Refiners Association (NPRA) Annual Meeting). For more information, go to www.eia.doe.gov.
[122] US Department of Transportation, Bureau of Transportation Statistics.
[123] Ibid.
[124] The NJDOT, Bureau of Transportation Data Development, Roadway Systems Section.

growth.[125] This pattern can be seen in New Jersey, where, between 1975 and 2005, the State's population increased by 20 percent while VMT increased by 50 percent.[126]
Even though total VMT in New Jersey from 2007 to 2008 declined by approximately 3 percent, it is likely that this decrease is related in part, to a 26 percent increase in gasoline prices during the same period. If historic trends hold true, VMT declines associated with spikes in gasoline prices will be reversed once gasoline prices drop.

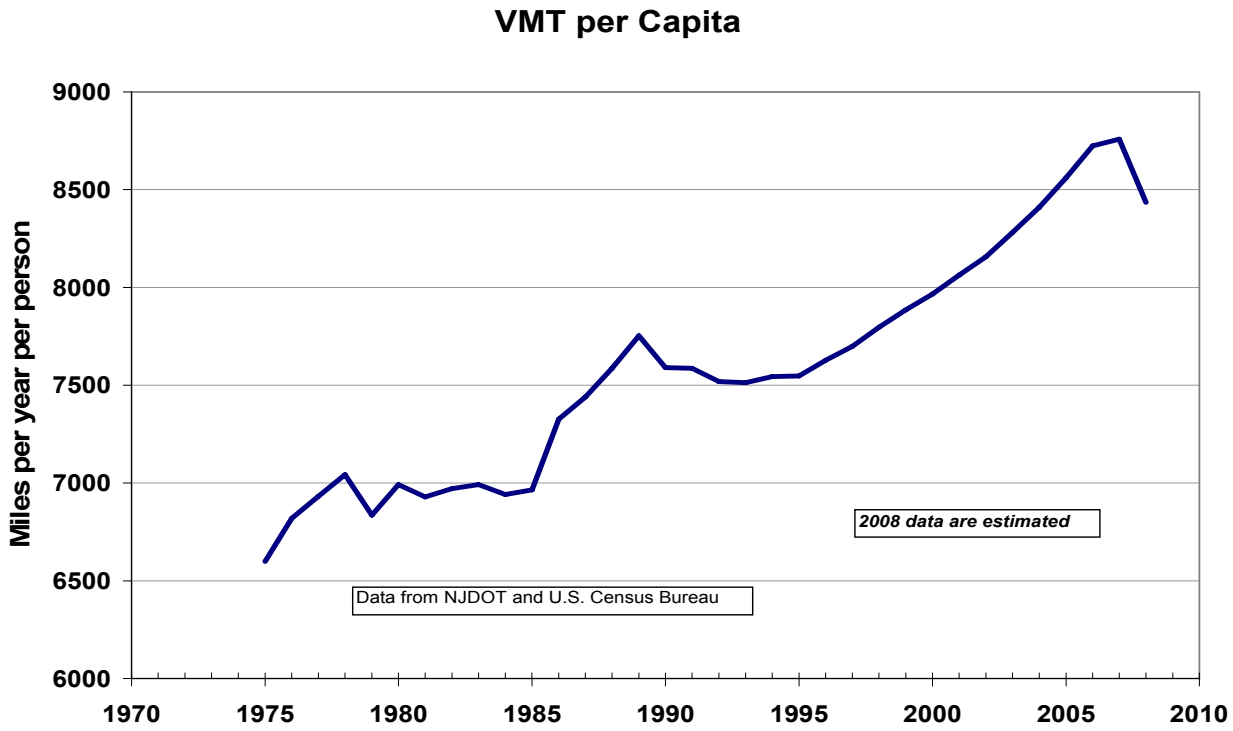
Figure 6.4: Vehicle Miles Traveled, New Jersey (1970 – 2010)



[125] Ewing, R., K. Bartholomew, S. Winkelman, J. Walter and D. Chen. 2007. Growing cooler: the evidence on urban development and climate change. Washington, DC: Urban Land Institute.

[126] http://www.state.nj.us/transportation/refdata/roadway/vmt.shtm, http://www.wnjpin.net/OneStopCareerCenter/LaborMarketInformation/lmi25/pub/NJSDC-P3.pdf *and* http://www.census.gov/popest/states/tables/NST-EST2005-02.xls

Figure 6.5: Vehicle Miles Traveled Per Capita, New Jersey (1970 – 2010)



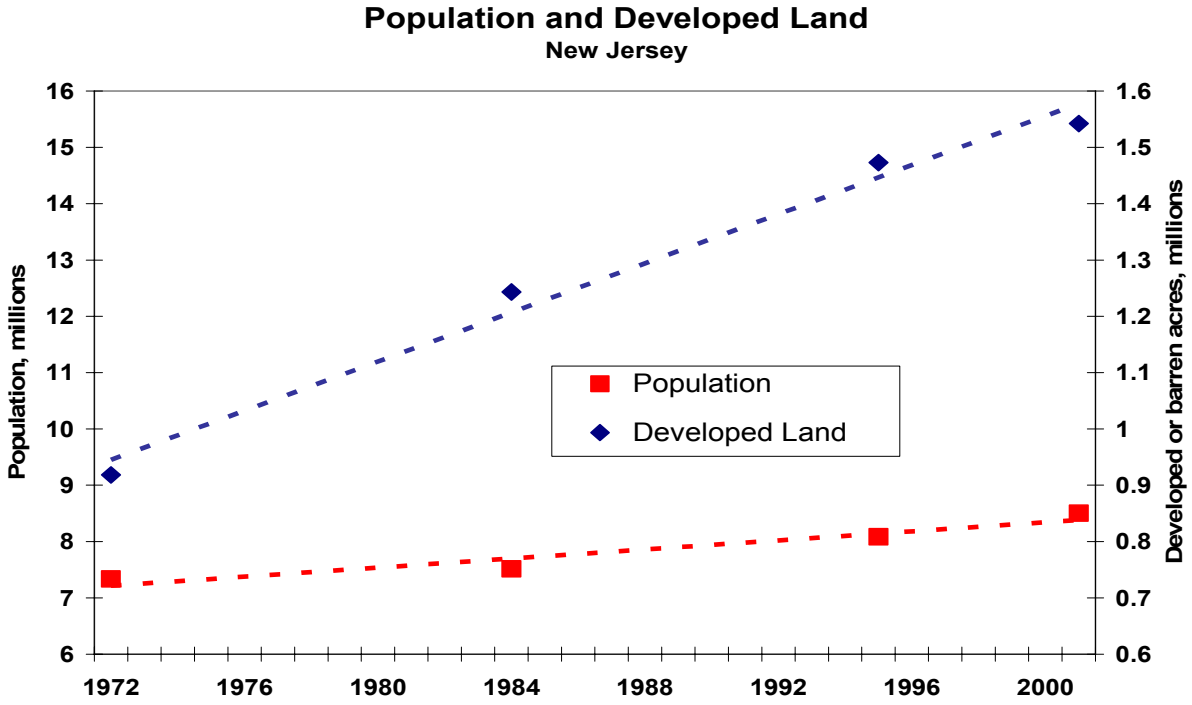
The ULI warns that if sprawling development continues to fuel growth in driving, the projected 48 percent increase nationally in the total miles driven between 2005 and 2030 will overwhelm expected gains from vehicle efficiency and low-carbon fuels. A 2008 study done by researchers at Rowan University and Rutgers University[127] describes the changes to New Jersey's landscape between 1986 and 2002. The patterns in land development revealed that between 1986 and 1995, approximately 15,540 acres per year of farmland, forests and wetland were lost to development. This pattern held for the period from 1995 to 2002, in which the annual net loss of farmland, forests and wetlands was 15,676 acres.[128] Additionally, as illustrated in Figure 6.6 below, over 600,000 acres of land were developed in New Jersey during the 29-year period from 1972 to 2001. This represents an increase of about 68 percent in the amount of developed land in the State.[129] During this same period, population grew by only about 16 percent.

[127] "Tracking New Jersey's Dynamic Landscape: Urban Growth and Open Space Loss 1986-1995-2002", Final Report, John Hasse, Rowan University and Richard G. Lathrop, Center for Remote Sensing and Spatial Analysis, Rutgers University, 2008. See http://www.crssa.rutgers.edu/projects/lc/download/urbangrowth86_95_02/HasseLathrop_njluc_final_report_07_14_08.pdf

[128] Ibid.

[129] NJDEP 1986 and 2002 Landuse/Landcover data files, http://www.nj.gov/dep/gis/listall.html

Figure 6.6: Population and Developed Land, New Jersey (1972 – 2000)



In a series of case studies illustrating how land use choices affect GHG emissions, a Rutgers University professor posits that "while debates over global GHG emissions caps, national carbon taxes, appliance and vehicle efficiency standards, and innovation policy play out, local planners can get to work on their part of the program."[130]

Recent data appear to indicate that the current downturn in the economy has slowed the national mobility rate to historically low levels.[131] However, there are no data to suggest that New Jersey's sprawling land use patterns of the past two decades are permanently reversing. Rather than seeing a sustained reversal of growth to cities and towns, it would appear that the current economic climate is making relocation an economically unfeasible option. Urban residents are appearing to "stay put" rather than relocate to sprawling new developments. Additionally, while New Jersey's cities, towns and boroughs are starting to catch up to the statewide growth rate, that indicator does not translate to the end of a long-term trend of sprawling land use patterns. New Jersey's fastest growing townships over the past eight years - Woolwich, Upper Freehold, Mansfield, Lopatcong, and Barnegat - all continued to outpace the statewide growth rate between 2007 and 2008, in some cases significantly so.[132] First-place Woolwich's 2007-08 population growth rate was more than 8 times the state rate. Using land use/land cover data from

[130] Andrews CJ. (2008 November). **Greenhouse gas emissions along the rural-urban gradient.** Journal of Environmental Planning and Management;51(6):847-870.
[131] http://www.census.gov/press-release/www/releases/archieves/mobility_of_the_population/013609.html
[132] Email correspondence with Tim Evans, New Jersey Future, July 22, 2009

2002[133] to estimate each municipality's build-out percentage, New Jersey Future found that of the 20 fastest-growing municipalities in New Jersey over the 2007-08 time period, 16 of them were more than 50 percent built-out, and 11 of them were more than 80 percent built-out. This is a change from earlier this decade; for the period 2000-2008 only 6 municipalities are among the top 20 fastest-growing (at least 50 percent built-out), and none of them being 80 percent built-out or more.[134]

While possibly less than in years past, that trend is still steady and is still dependent on consuming a proportionally larger share of undeveloped land as compared to compact and transit-oriented development. Overall the long-term statewide trend continues to point to a strong signal in New Jersey that sprawl is still a sustained land use pattern in the Garden State not only in terms of stretching out to locations with little or no existing infrastructure as well as in terms of being contrary to compact development in cities, towns and villages. A recent Lincoln Land Institute[135] study on the effectiveness of state's smart growth efforts supports this finding: "The population density in 2000 of New Jersey's newly urbanized territory (the land developed between 1990 and 2000) lagged all the other states except Indiana. This stands in marked contrast to the density of the state's already urbanized territory, which in 1990 was the highest of all eight states in the study. The inescapable conclusion: While the Garden State starts with certain historical advantages in terms of compact development, new suburban development here has looked a lot like — and maybe even less dense than — new suburban development elsewhere."

Equally as important, in terms of climate change, to the number of vehicle miles accumulated in the State is the number of individuals in each vehicle. Private automobiles remain the most commonly used mode of travel for people living in the United States, and this is true for New Jersey residents as well. According to data from the U.S. Census Bureau, most New Jersey workers (71.8 percent) drive alone to work.[136] While this rate is lower than that of most U.S. workers, including those workers living in Pennsylvania and Connecticut, it is higher than that of workers living in New York State. Slightly over 10 percent of New Jersey workers take public transportation to work, while 9.2 percent carpool, 3.2 percent walk to work and 3.3 percent work at home.[137]

New Jersey operates one of the largest public transit agencies in the country, providing regional rail service, light rail service (Hudson-Bergen, River Line, and Newark Light Rail lines), and bus service throughout the State. Other providers operating transit service in New Jersey include the Port Authority of New York and New Jersey and the Port Authority Transit Corporation of Pennsylvania. While this system is impressive, its focus on the central core of the State from New York to Philadelphia leaves room for improvement. This is evident from statistics from the

[133] http://crssa.rutgers.edu/projects/lc/urbangrowth/
[134] Email correspondence with Tim Evans, New Jersey Future, July 22, 2009
[135] http://www.lincolninst.edu/pubs/smart-growth-policies.aspx, page 33.
[136] 2007 American Community Survey data. See http://factfinder.census.gov/servlet/ADPTable?_bm=y&-geo_id=04000US34&-qr_name=ACS_2007_1YR_G00_DP3&-context=adp&-ds_name=&-tree_id=307&-_lang=en&-redoLog=false&-format=
[137] Ibid.

2000 Census, which show that while 70.6 percent of New Jerseyeans working in Manhattan took public transportation to work, as did 24 percent of those who worked in Philadelphia, only 5 percent of people who worked in New Jersey used transit to get to work.[138] These data are complemented by recent research from New Jersey Future which indicates that "in 1980, two out of three employed New Jersey residents (65.3 percent) drove to work alone; by 2000, it was three out of four (75.1 percent)."[139] The same New Jersey Future report indicates that the number of New Jerseyeans carpooling to work decreased from 18.6 percent in 1980 to 10.9 percent in 2000.[140]

In summary, New Jerseyeans consume significant amounts of higher carbon intensity petroleum, due to their reliance on cars as their preferred mode of transportation. Reliance on higher carbon intensity fuels, cars and distance to daily activities need to be directly addressed in order for the State to reach its statewide 2050 GHG limit. There is a need for a public discussion on larger-term transportation and land use policies that will contribute to attainment of the 2050 statewide GHG limit.

Independent Research Panel

The State recognizes the need to make the paradigm shift to transforming its economy as a fundamental lever to achieving the 2050 limits, having identified four key policies to focus on as most essential to achieve the 2050 limits. The Global Warming Response Act directs the NJDEP in cooperation with other State agencies to "prepare a report [by 2010] recommending the measures necessary to reduce GHG emissions to achieve the 2050 limit." Development of recommendations to achieve the 2050 limit can greatly benefit from specific expertise and informed judgment. Recognizing such, the Global Warming Response Act also provides for creation of an Independent Research Panel (IRP) to evaluate the recommendations and provide an assessment of the ecological, economic and social impacts that may result. The panel can play an important role in guiding the State towards development of specific actions to achieve the State's long-term GHG limits in ways that promote economic prosperity and improve quality of life for New Jerseyeans. To that end, the deliberations of the IRP can address the four key policy areas identified herein from both a macro-perspective while also addressing issues on a micro-scale. Among other things that can be considered, the IRP can:

- Provide recommendations to the State for meeting the initial set of long-term indicators;
- Explore policy options for pricing mechanisms that incentivize development of climate-friendly markets;
- Establish emissions targets for the transportation sector;
- Assist in assessing uncertainty in vegetative systems with respect to terrestrial sequestration measurement; and
- Provide recommendations regarding how to best take advantage of the voluntary offset market in New Jersey while providing for discrete, rigorous and verifiable standards that will ensure real GHG reductions while providing consumer protection for offset purchases.

[138] Evans, *Getting to Work: Reconnecting Jobs to Transit,* New Jersey Future. 2008.
[139] "Getting to Work: Reconnecting Jobs with Transit," New Jersey Future, November 2008.
[140] Ibid.

Next Steps

This report lays out a significant public policy agenda that affects many sectors of New Jersey's economy. The path ahead for New Jersey to achieve its statewide greenhouse gas limits is challenging. Delay is not an option. It is this generation – not the next – that is already beginning to face pressing and economically devastating effects of climate change, with the Northeast expected to be particularly affected. With continued action, the benefits to transforming the state's economy to one based on energy efficiency, conservation and clean technologies are significant.

Moving forward demands leadership, consensus building, vision and persistence. In general, this report provides a template reflecting significant stakeholder input and unique collaboration among many state agencies. In essence, this report serves as a blueprint for the State to move forward in key areas including regulation, education, stakeholder engagement, research and clean energy market development. Additionally, the State has yet to tap the voluntary offset market which, if addressed through discrete, rigorous and verifiable standards and protocols, offers promise for emission reductions and investment in clean technologies. Issuance of this report is an important step in New Jersey's path to attainment of its statewide limits, and its release is certain to engender important dialogue in moving forward. The Global Warming Response Act contemplated a collaborative process for New Jersey moving forward in the form of an Independent Research Panel (IRP) which is intended to engender an informed dialogue to assist the State in attaining its 2020 and 2050 limits. With continued dialogue and leadership, New Jersey can fulfill the promise of sustainable development with a strong economy and a clean environment for this generation and generations to come.

Abbreviations and Acronyms:

APU	Auxiliary Power Units
ARC	Access to the Region's Core
BMP	Best Management Practices
BRT	Bus Rapid Transit
CAFE	Corporate Average Fuel Economy
CBD	Central Business District
CEEEP	Center for Energy, Economic & Environmental Policy
CEMF	Clean Energy Manufacturing Fund
CCS	Carbon Capture and Sequestration
CH_4	Methane
CHP	Combined Heat and Power
CO_2	Carbon Dioxide
CO_2eq	Carbon Dioxide equivalent
EGU	Electric Generating Unit
EMP	Energy Master Plan
ESP	Emergency Service Patrols
GAO	General Accountability Office
GHG	Greenhouse Gas
GSPT	Garden State Preservation Trust
GWh	Gigawatt hours
GWP	Global Warming Potential
GWRA	Global Warming Response Act
GWSF	Global Warming Solutions Fund
HDSRF	Hazardous Discharge Site Remediation Fund
HFCs	Hydrofluorocarbons
HVAC	Heating, Ventilation and Air Conditioning
HVACR	Heating, Ventilating, Air Conditioning and Refrigeration
HOT	High Occupancy Toll
HOV	High Occupancy Vehicles
IPCC	Intergovernmental Panel on Climate Change
IRP	Independent Research Panel
LCA	Life Cycle Assessment
LCFS	Low Carbon Fuel Standard
LDAR	Leak Detection and Repair
LEV	Low Emission Vehicle
LFG	Landfill Gas
MARAD	U.S. Department of Transportation Maritime Administration
MCF	Mobility and Community Form
MJ	Megajoules
MLUL	Municipal Land Use Law
MMT	Million Metric Tons
MSW	Municipal Solid Waste
MW	Megawatts
NECIA	Northeast Climate Impacts Assessment

NESCAUM	Northeast States for Coordinated Air Use Management
NJBPU	New Jersey Board of Public Utilities
NJDA	New Jersey Department of Agriculture
NJDCA	New Jersey Department of Community Affairs
NJDEP	New Jersey Department of Environmental Protection
NJDOT	New Jersey Department of Transportation
NJEDA	New Jersey Economic Development Authority
NJEIFP	New Jersey Environmental Infrastructure Financing Program
NJFIT	New Jersey Future in Transportation
NJTA	New Jersey Transit Authority
NJSLOM	New Jersey State League of Municipalities
N_2O	Nitrous Oxide
NO_x	Oxides of Nitrogen
ODS	Ozone Depleting Substances
PATCO	Port Authority Transit Corporation
PATH	Port Authority Trans-Hudson
PAYD	Pay-As-You-Drive
PFCs	Perfluorocarbons
POTWs	Publicly Owned Treatment Works
ppm	parts per million
RGGI	Regional Greenhouse Gas Initiative
SDRP	State Development Redevelopment Plan
SF_6	Sulfur Hexafluoride
SLR	Sea-level Rise
SO_2	Sulfur Dioxide
SOTA	State of the Art
SOVs	Single Occupancy Vehicles
TMA	Transportation Management Association
TOD	Transit-Oriented Development
TSE	Truck Stop Electrification
ULI	Urban Land Institute
USEPA	United States Environmental Protection Agency
V2G	Vehicle to Grid
VMT	Vehicle Miles Traveled
ZEV	Zero Emission Vehicle