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

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

Table of Contents

List of Figures

List of Tables

List of Appendices

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

---

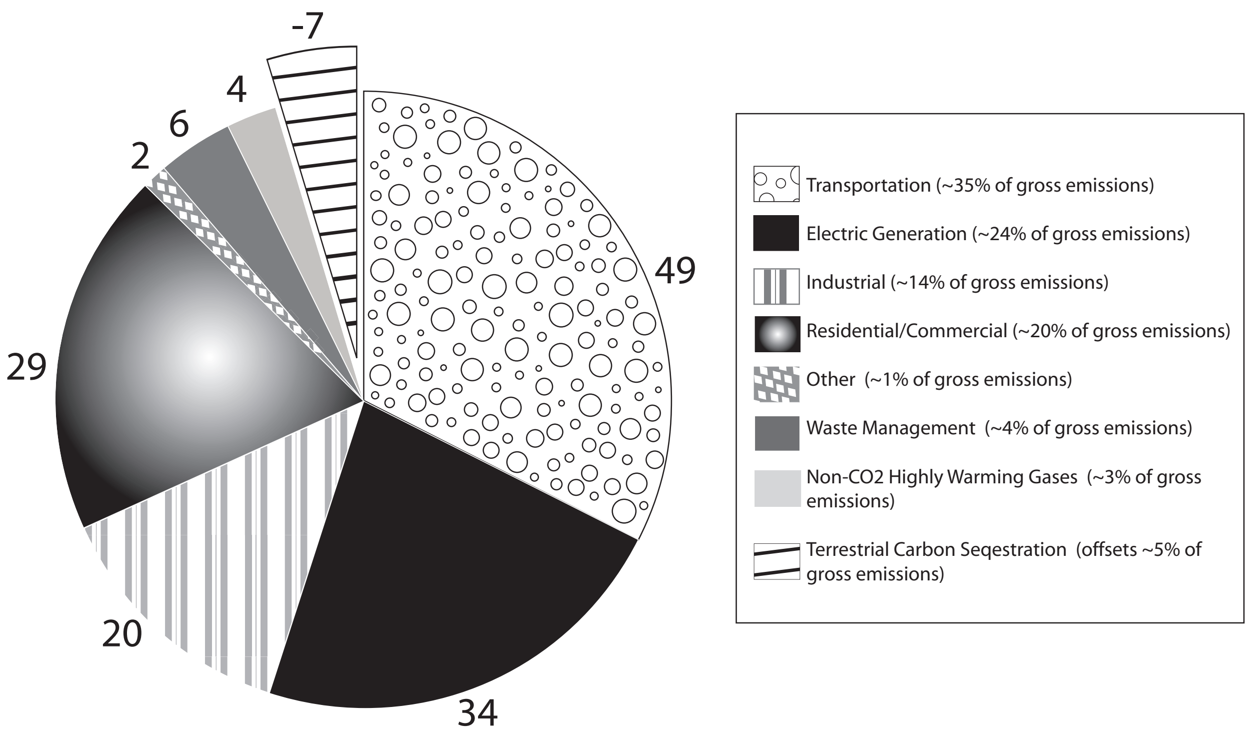
[1] Intergovernmental Panel on Climate Change, Climate Change 2007: Synthesis Report, Summary for Policymakers, Fourth Assessment Report, November 2007.

[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

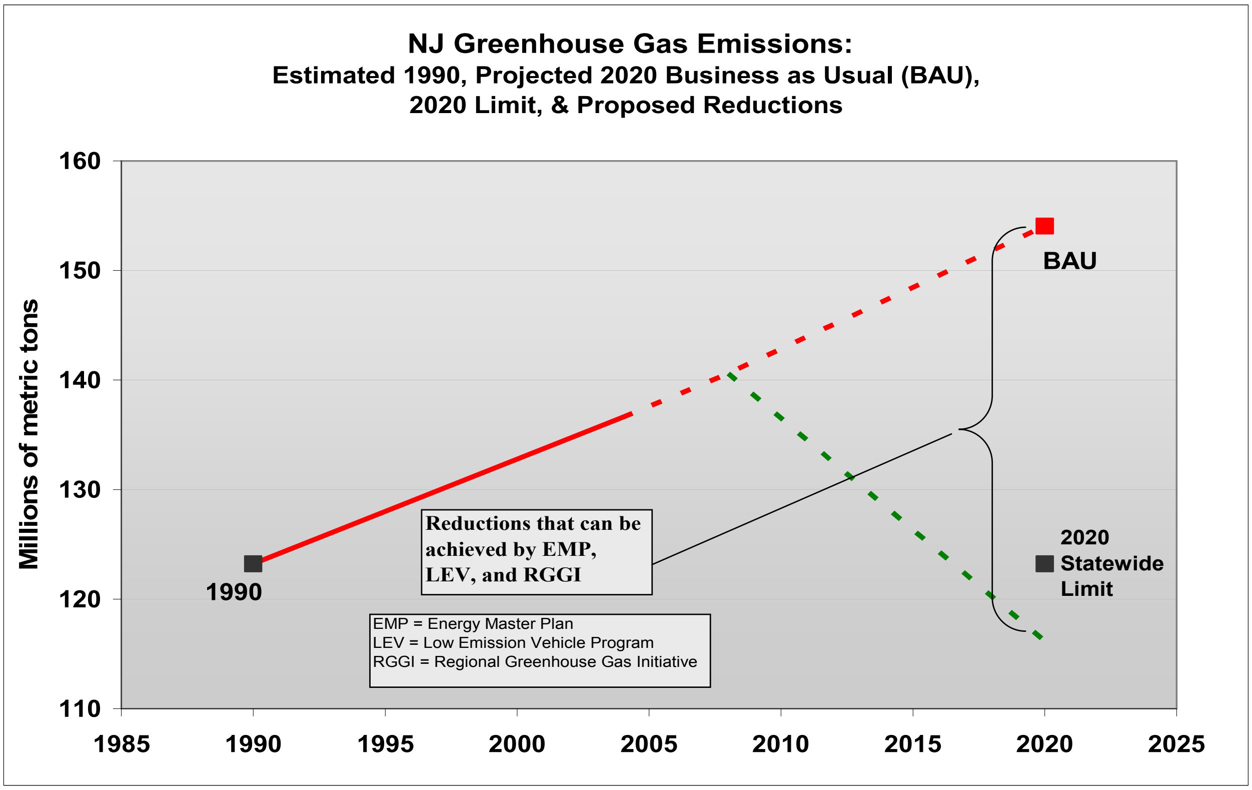
---

[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]

---

[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/.

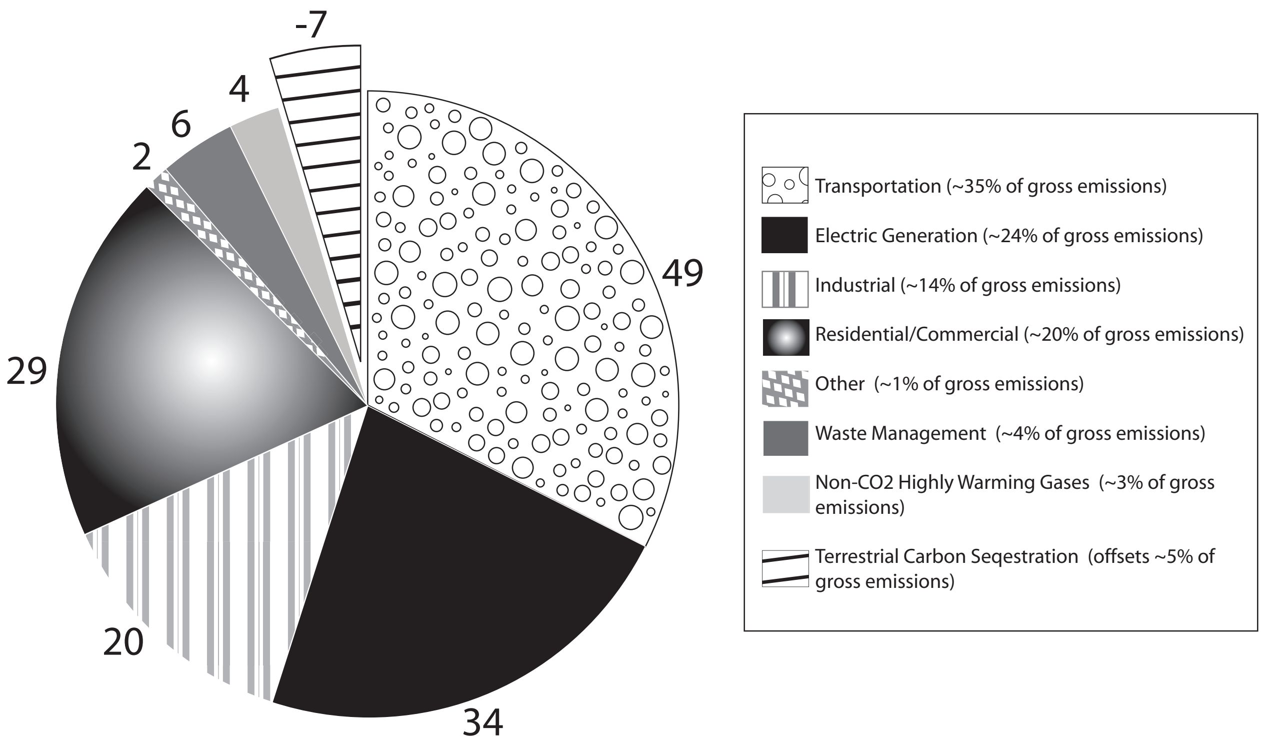
[54] The NJDEP met with stakeholders and interested parties to review and discuss a draft of this inventory on March 19, 2008 and accepted written comment.

[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.

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.

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

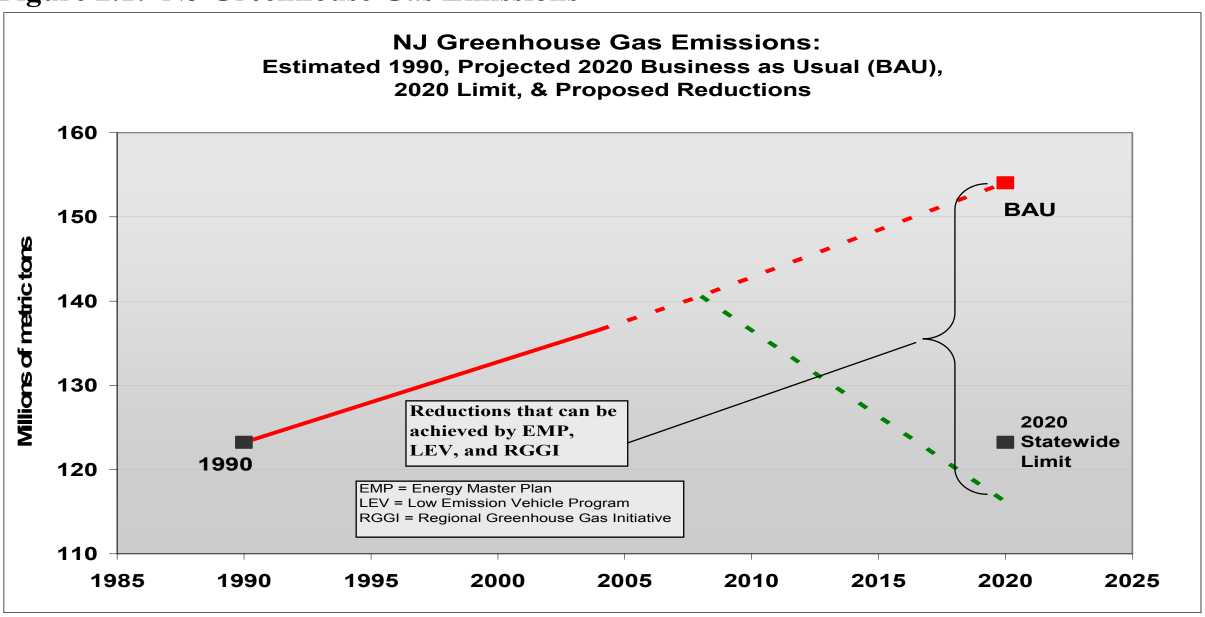
Three core measures form the backbone of New Jersey's plan to meet its statewide 2020 GHG limit. The core measures implement the:

- 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

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

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

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

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.

---

[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.

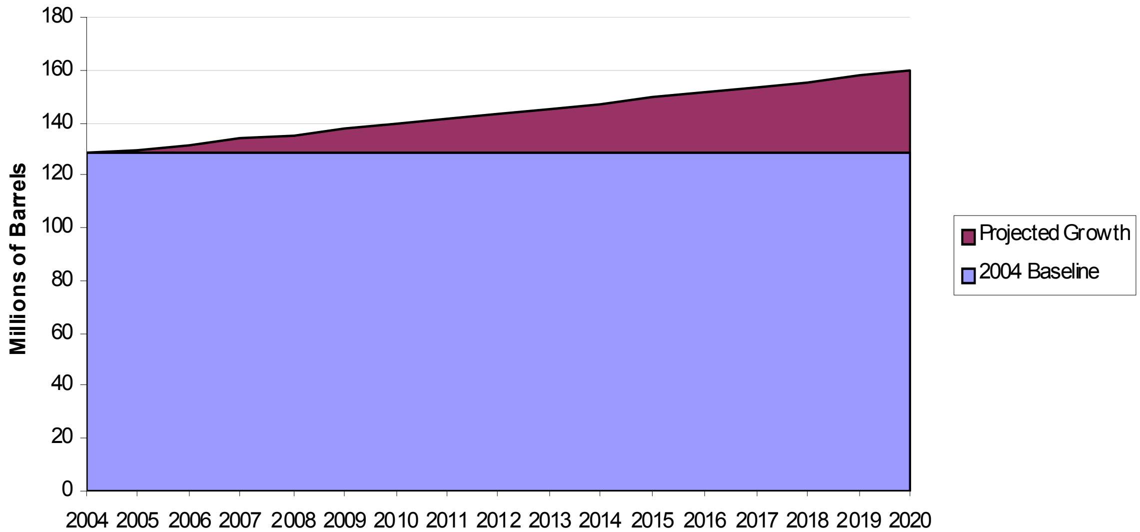
- *Providing demonstration and education programs for farmers on, and encourage the use of, methane abatement processes from livestock waste and techniques for managing nutrients back to the farmlands from livestock waste:* The agricultural industry has the unique capability to utilize farm-generated 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.

Recommendation #16: 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.

---

[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

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

<u>Recommendation #19</u>: 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.

<u>Related Action(s) with Climate Benefits</u>:

- **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.

---

[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.

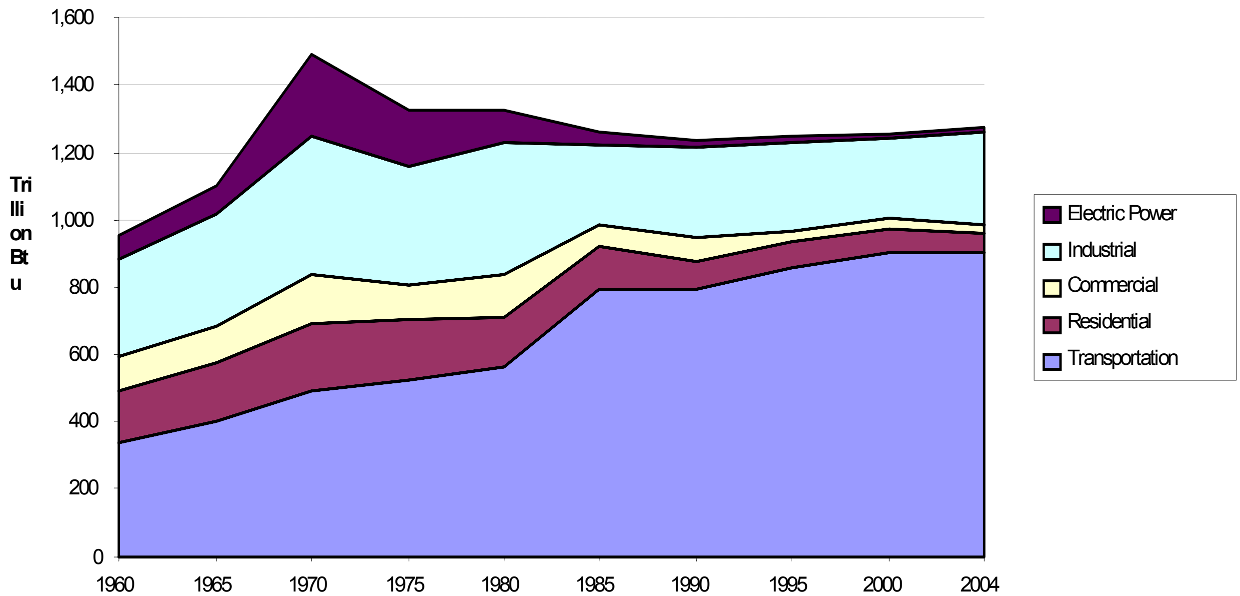
Key Policy Area 4: Reduced Reliance on Cars

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]

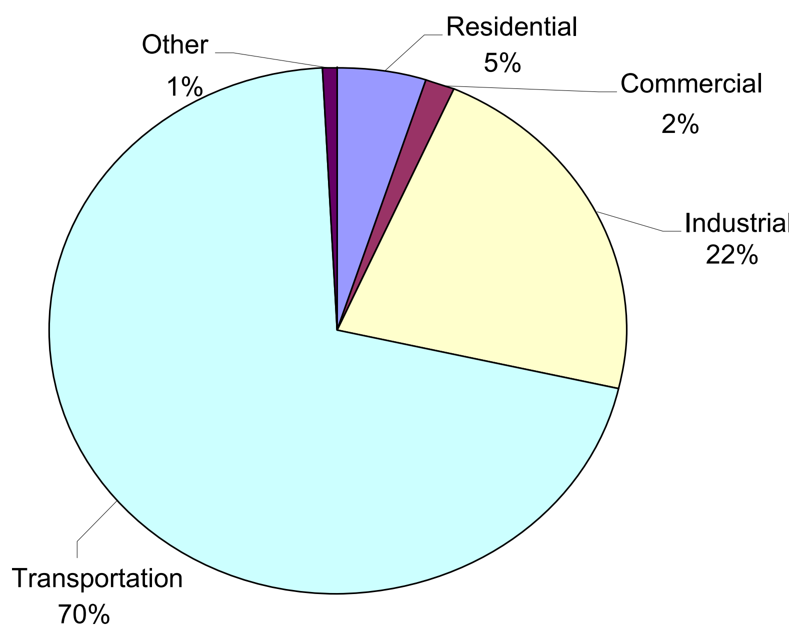
[119] The transportation energy use and per capita data used to generate Figures 6.1 and 6.2 (as well as Figure 6.3) are based on the total energy used by the transportation sector as reported by the USDOE/EIA. New Jersey's GHG inventory estimates for the transportation, presented in Chapter 2 of this 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



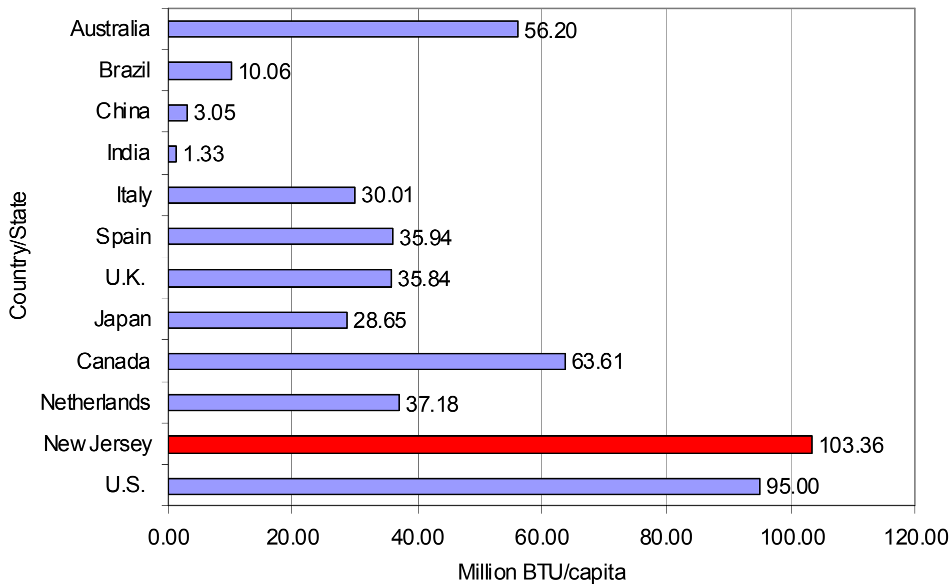
Source: US Dept. of Energy, Energy Information Administration

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

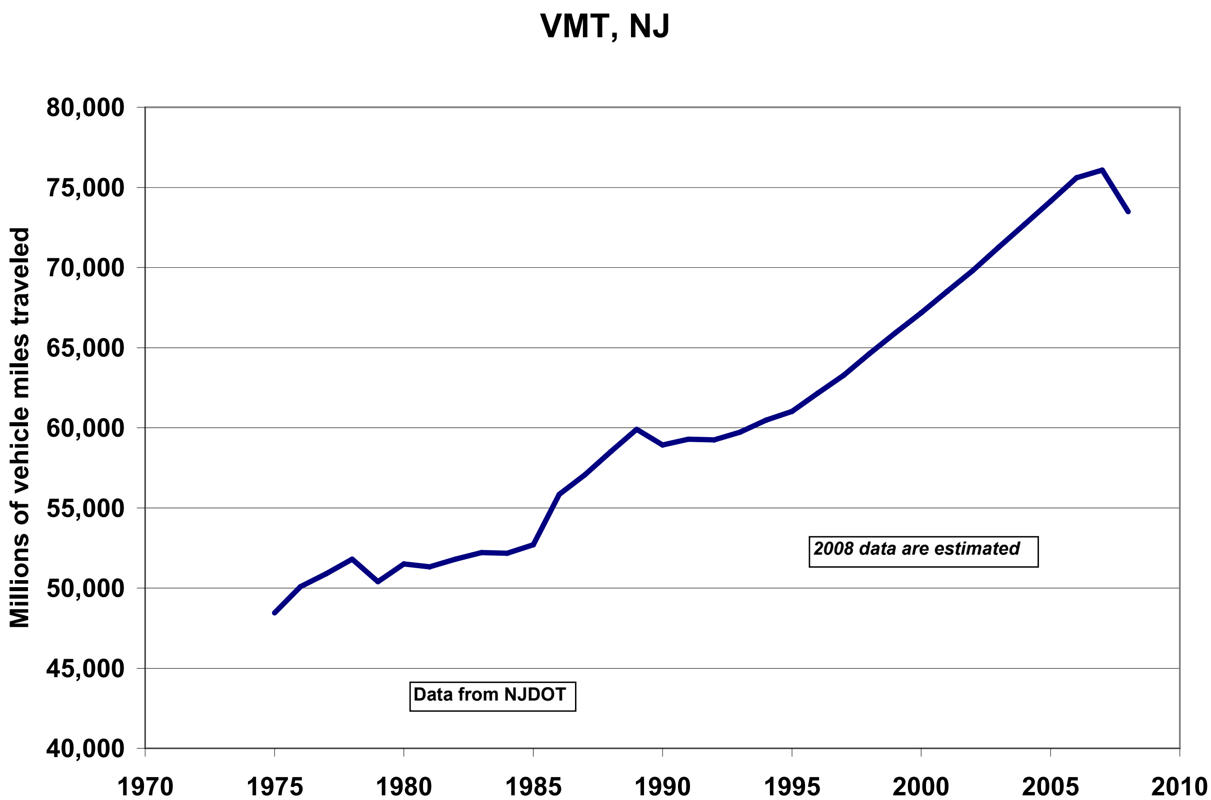
To date, the State's ever-increasing consumption of energy from this sector has been attributed to both: 1) the annual increase in the number of miles driven each year by New Jersey motorists (known as vehicle miles traveled or VMT) since 1990[120]; and 2) the fact that fuel efficiency gains from cars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

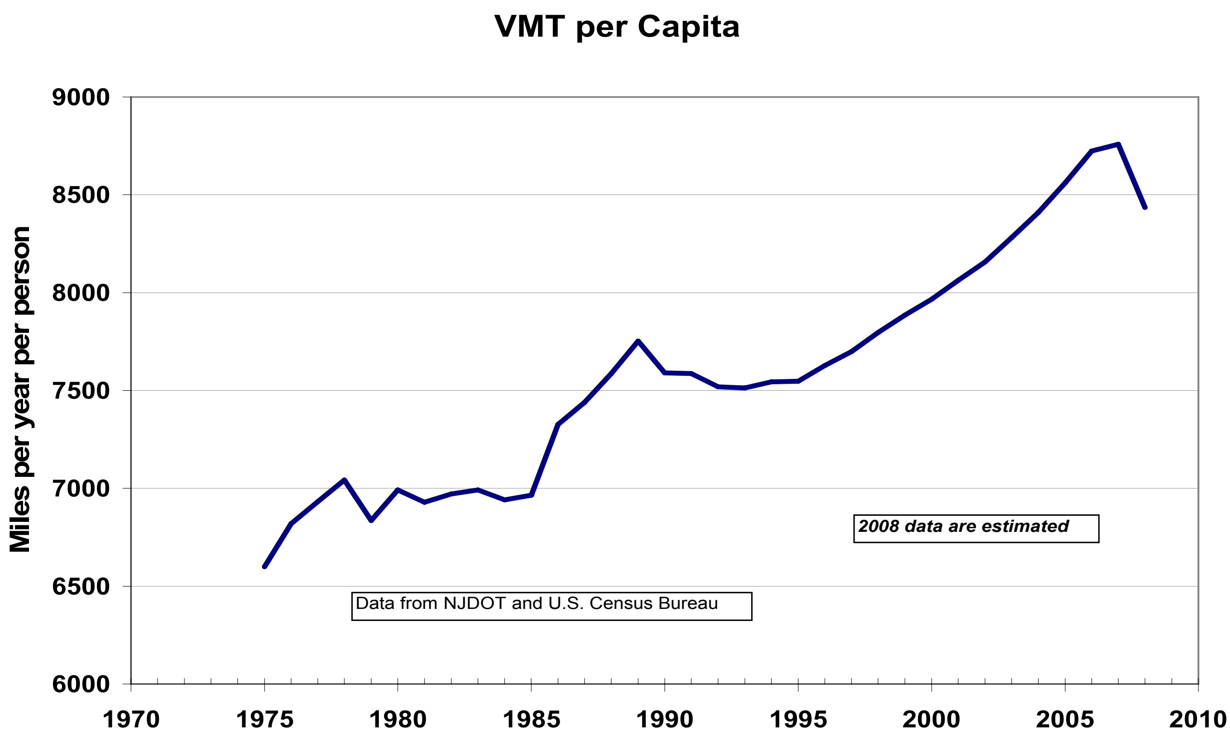
Figure 6.4: Vehicle Miles Traveled, New Jersey (1970 – 2010)



[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.

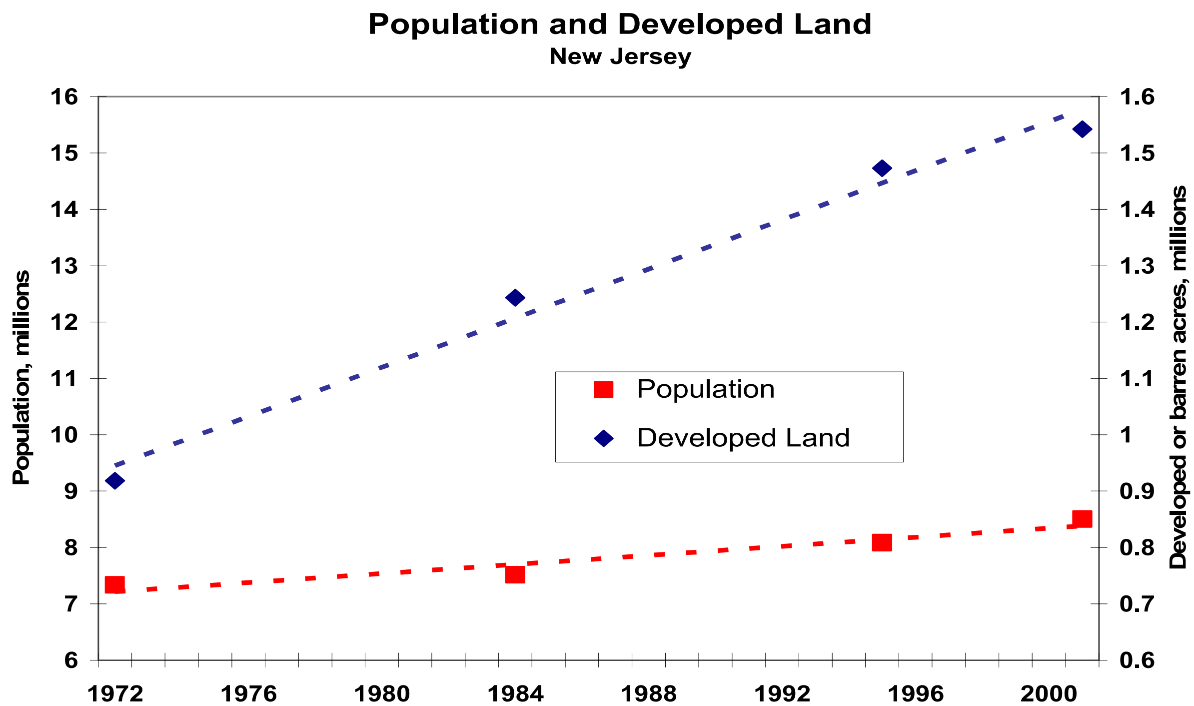
---

[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

Appendix 1

Anticipated Greenhouse Gas Emission Reductions Expected by 2020 from the Core Recommendations

As discussed in Chapter 2 of the State's final Global Warming Response Act Recommendation Report (hereafter referred to as the main report) three core recommendations, if fully successful and fully implemented on schedule, would enable the State to meet the statutory 2020 limit.

1. Much of the greenhouse gas (GHG) emission reduction necessary to meet the statewide 2020 GHG limit is expected to be accomplished through the implementation of New Jersey's Energy Master Plan (EMP). The chief goals of the EMP are to reduce projected energy use by 20 percent by 2020 and meet 22.5 percent of the State's electric needs with renewable energy sources by 2020. Based on the data and analysis in the EMP, this can be achieved with a combination of energy efficiency, conservation, and renewable energy resources.

2. New Jersey has implemented a cap-and-trade program developed through the Northeastern and Mid-Atlantic States' Regional Greenhouse Gas Initiative (RGGI) that imposes a cap on carbon dioxide (CO_2) emissions by electricity producers in the region. Specifically, RGGI caps regional power plant emissions at approximately current levels from 2009 through 2014 and then reduces those emissions 10 percent by 2018.

3. The State has adopted a Low Emission Vehicle (LEV) Program modeled after the California program. This program requires automakers to reduce fleetwide GHG emissions from the vehicles they sell in New Jersey 30 percent by 2016.

These 3 measures are listed and briefly described, and their approximate expected emission reductions are quantified, in Table A1.1. Note that these estimates are preliminary, and are subject to revision based on additional input. The total reduction, if all reductions shown in the table are fully successful and fully implemented on schedule, is approximately 38 million metric tons (MMT) of carbon dioxide equivalent (CO_2eq) below the estimated business-as-usual emission of 154 MMT CO_2eq. This reduction would result in statewide emissions of 116 MMT CO_2eq by 2020, which would allow the State to meet its Statewide 2020 limit of 123 MMT CO2eq, (the estimated 1990 emission levels).

Additional reductions could be achieved by extending energy efficiency measures and implementing the other measures outlined in Chapter 3 of the main report. Long-term emission reductions sufficient to meet the 2050 limit, which is 80 percent below the 2006 GHG emissions level, will require more far-reaching measures.[1]

[1] The estimated reductions in this Appendix are based on the State's first GHG inventory, which analyzed 2004 emissions. The state has completed the GHG inventory estimates for 2005, 2006 and 2007. Data show that differences between the 2004 and 2007 totals are not significant enough to warrant recalculation of the reduction estimates in this Appendix. The inventory reports are available at http://www.nj.gov/globalwarming/.

<u>Table A1.1</u>: Anticipated 2020 GHG Reductions per Action, (MMT CO_2eq)
Preliminary estimates – subject to revision based on additional input

Action	Discussion	Approximate GHG Reduction (MMT CO_2eq)
RGGI	RGGI caps carbon dioxide emissions from electricity producers in the region. Reductions attributable to RGGI are difficult to quantify at a statewide level because the RGGI limits are regional. For the purpose of estimating anticipated reductions by 2020, the emissions from NJ facilities covered by RGGI are considered to be equal to NJ's share of the total emission reductions attributable to RGGI.	8.5[2]
EMP	The EMP relies on many approaches to reduce energy use and to expand the State's renewable generation capacity. Measures include a Renewable Portfolio Standard (already in place), additional use of biofuels, and a variety of efficiency measures for existing and new buildings. Renewable energy sources are expected to generate over 18,000 gigawatt hours (GWh) of NJ's electricity by 2020, including over 2000 GWh from solar, over 6,700 GWh from biomass, and over 9,500 GWh from wind. This electricity is projected to come from growth in all renewable sectors, including development of offshore wind to a total of 3,000 megawatts capacity. It is assumed for this analysis that GHG emissions from wind and solar are essentially zero, and that emissions from biomass sources are equal to those from the combustion of biodiesel. A number of efforts are expected to result in increased energy efficiency. One effort is the expansion of capacity of on-site generation, which is expected to be based largely on combined heat and power units. On-site generation is expected to produce over 12,000 GWh per year of electricity by 2020. In addition to supplying electricity, combined heat and power units translate waste heat to useable thermal energy, which can displace fossil fuels. The EMP projects that, because of expanded renewable capacity and energy efficiency measures, the State will be a net exporter of electricity by 2020. Exported electricity has been factored into the total emissions quantity as a negative number, and would theoretically be balanced by additional emissions representing imported electricity into another state's inventory. The interrelationship of RGGI limits and projected exported electricity cannot be estimated with precision without knowing the state to which that electricity is exported, which is uncertain at this time.	19.4

[2] This reduction could be further increased if the following are taken into account: (a) reductions due to additional terrestrial sequestration (estimated at about 270,000 metric tons CO_2 annually) resulting from investment of RGGI auction proceeds on strategic management of state lands for forest and tidal marsh stewardship and restoration; (b) GHG reductions from energy efficiency, renewable energy and combined heat and power projects in the commercial, institutional, and industrial sectors, also funded by RGGI through the Economic Development Authority; and (c) GHG emissions reduction, avoided emissions, and carbon sequestration from local government grant projects likewise supported by RGGI proceeds (through the NJDEP) as directed by the Global Warming Solutions Fund law (N.J.S.A. 26:2C-50 *et.seq.*).

LEV	The State implemented the New Jersey Low Emission Vehicle Program in 2009. This program, modeled after the California Low Emission Vehicle Program, requires automakers to reduce fleet-wide greenhouse gas emissions from the vehicles they sell in NJ 30 percent by 2016. Assuming that 1) VMT growth in the State will be in the range of 1 percent per year until 2020, and 2) NJ residents continue to acquire new vehicles at the current pace, overall GHGs emissions from the motor vehicle fleet are expected to be reduced by approximately 22 percent below what they otherwise would be by 2020.	10[3]
	Approximate total reduction if all reductions occur as listed above	**37.9**

[3] As discussed in more detail in Chapter 2 of the main report, a federal motor vehicle control program was jointly proposed by the USEPA and the U.S. Department of Transportation on September 28, 2009. This federal rulemaking, if adopted, will be different than the State's Low Emission Vehicle 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.

Appendix 2

Economic Model Results of Core Recommendations

Memorandum

To: Jeanne Herb, New Jersey Department of Environmental Protection; Office of Policy, Planning & Science

From: Nancy Mantell, Ph.D., Erin Coughlin and Frank Felder, Ph.D., Center for Energy, Economic & Environmental Policy, Edward J. Bloustein School of Planning and Public Policy; Rutgers, The State University of New Jersey

Date: 11/21/2008

Re: Low Emission Vehicle Model Results

New Jersey is implementing California's Low Emission Vehicle II (LEV) standards to reduce greenhouse gas emissions from passenger cars and light duty vehicles. The New Jersey Department of Environmental Protection solicited the Center for Energy, Economic & Environmental Policy and Rutgers Economic Advisory Service to assess the economic impacts of the LEV standards, similar to California's, in New Jersey.

R/ECON Model

R/ECON™ is an econometric model comprised of over 300 equations, based on historical data for New Jersey and the United States, which are solved simultaneously. The historical data covers the period from 1970 to 2006, with some updated through 2007. The following sectors are included in the model:

- Employment and gross state product for 40 industries;
- Wage rates and price deflators for major industries;
- Consumer price index;
- Personal income and its components;
- Population, labor force and unemployment;
- Housing permits, construction contracts, and housing prices and sales;
- Energy prices and usage;
- Motor vehicle registrations and stocks;
- State tax revenues by type of tax, and current and capital expenditures.

The heart of the model is a set of equations modeling employment, wages, and prices by industry. In general, employment in an industry depends on demand for that industry's output and the state's wages and prices relative to the nation's. Demand can be represented by a variety of variables including (but not limited to) New Jersey personal income, population, sectoral output, or U.S. employment in

the sector. The data for the U.S. comes from Global Insight, Inc., a national leader in economic forecasting.
R/ECON Model and the New Jersey Energy Master Plan

R/ECON™ was used to model the macroeconomic effects of New Jersey's Energy Master Plan (EMP) initiatives, using Business as Usual and Alternative Scenarios under different fuel price scenarios. As a part of the EMP modeling, the Regional Greenhouse Gas Initiative was utilized as the carbon dioxide policy for 2010 and 2015 and a national carbon dioxide policy was used for 2020. R/ECON™ does not account for environmental externalities and therefore understates the positive economic impacts of emission reductions. As demonstrated by the R/ECON™ simulations, the economic effects of the EMP were negligible when the environmental benefits of the Energy Master Plan were not accounted for.

R/ECON Model and Low Emission Vehicles

The effects of implementing California LEV standards were also modeled using R/ECON™. Building on the previous EMP work, the assumptions and inputs used for the EMP Business as Usual and Alternative Scenarios were used as a baseline for the LEV simulations. Additional LEV-specific input data were used in conjunction with EMP data.

The model inputs were calculated using the incremental costs of passenger cars and light duty vehicles from NESCAUM's <u>Northeast State GHG Emission Reduction Potential from Adoption of the California Motor Vehicle GHG Standards</u>.[1] California's LEV greenhouse gas emissions standards for carbon dioxide, methane, nitrous oxide, and hydrofluorocarbons leakage from air conditioning systems result in an increase in the cost of passenger cars and light duty vehicles. For modeling purposes, it was assumed that the LEV standards would be implemented in New Jersey on January 1, 2010.

Models

Four R/ECON™ simulations were run to determine the effects of California's Low Emission Vehicle greenhouse gas standards in New Jersey.

1. The Business as Usual Scenario (BAU);
2. The Business as Usual Scenario with the Low Emission Vehicle policy adders;
3. The EMP Scenario;
4. The EMP Scenario with the Low Emission Vehicle policy adders.

[1] NESCAUM. <u>Northeast State GHG Emission Reduction Potential from Adoption of the California Motor Vehicle GHG Standards</u> (October 2005).

R/ECON™ Results

Based on a comparison of the EMP and the EMP with LEV model results in 2020, an LEV standard would have minimal impact on the economy before accounting for the economic benefits of lower environmental emissions. A few of the impacts include:

- New light duty truck and van registrations will decrease by 0.4%;
- Retail sales will decrease 1.6%;
- Gross State Product will decrease 0.3%;
- Vehicle miles traveled will decrease by 0.02%.

Table 1 provides further details of the model results.

Table 1: Macroeconomic Results from R/ECON™

	BAU	BAU with LEV	BAU LEV to BAU	EMP	EMP with LEV	EMP with LEV to EMP
	2020	*2020*	*%Difference*	*2020*	*2020*	*%Difference*
Non-ag. Employment (thousands)	4,392.1	4,390.0	-0.05%	4,410.7	4,408.6	-0.05%
Unemployment Rate (%)	4.8%	4.8%	0.1%	4.7%	4.7%	0.1%
Personal Income ($billions)	$791.0	$790.7	0.0%	$804.8	$804.5	0.0%
Real Personal Income ($billions, 2000)	$274.0	$273.9	0.0%	$278.5	$278.4	0.0%
Retail Sales ($billions)	$270.3	$266.0	-1.6%	$274.0	$269.7	-1.6%
Real Retail Sales ($billions, 2000)	$93.6	$92.1	-1.6%	$94.8	$93.3	-1.6%
New Vehicle Registrations (thousands)	658.8	657.7	-0.2%	659.0	657.9	-0.2%
New Car Registrations	397.9	397.9	0.0%	398.0	398.0	0.0%
New Light Trucks and Vans	260.9	259.8	-0.4%	261.0	260.0	-0.4%
Residential Building Permits	26,204	26,174	-0.1%	25,466	25,435	-0.1%
Contract Construction ($millions)	$14,818	$14,806	-0.1%	$15,156	$15,145	-0.1%
Consumer Price Index (1982=100)	288.6	288.7	0.0%	289.0	289.0	0.0%
Gross State Product ($2000 billions)	$507.0	$505.3	-0.3%	$507.4	$505.8	-0.3%
Total Tax Revenues ($billions)	$51.2	$51.0	-0.3%	$52.1	$52.0	-0.3%
Vehicle Miles Traveled (Millions)	90,764	90,750	-0.02%	90,766	90,751	-0.02%

Appendix 3

New Jersey Accomplishments and Ongoing Efforts with Respect to Greenhouse Gas Legislation, Regulations, Policies and Programs

Through enactment of Executive Order 54, the Global Warming Response Act (GWRA), and the Global Warming Solutions Fund Act (GWSF), the State has the direction and the vital tools necessary for addressing greenhouse gas (GHG) emissions in and from New Jersey. In addition to moving forward with its core 2020 recommendations (implementation of the Energy Master Plan (EMP), Regional Greenhouse Gas Initiative (RGGI) and the Low Emission Vehicle (LEV) program), the various State government agencies have made commitments and achievements to reduce New Jersey's impact on global warming, and are currently working to implement still more actions. This appendix highlights the State's GHG accomplishments to date, and gives the status of those in progress.

I. Establishing GHG Reduction Goals

The overarching GHG reduction goals for New Jersey were first established by Executive Order 54, and then expanded through the GWRA.

Executive Order 54

On February 13, 2007, Executive Order 54 was issued. The Executive Order, recognizing the devastating economic and environmental impact that global warming, if unchecked, could have on New Jersey, set ambitious goals for GHG reductions in New Jersey. Specifically, Executive Order 54 sets statewide limits to reduce GHG emissions designed to stabilize New Jersey's GHG emissions to 1990 levels by 2020 and reduce statewide GHG emissions 80 percent below 2006 levels by 2050. In addition to establishing statewide GHG reduction limits, Executive Order 54 directs the New Jersey Department of Environmental Protection (NJDEP) to develop a statewide inventory of GHG emissions and to evaluate policies to achieve the Statewide 2020 and 2050 emissions reduction limits.

Global Warming Response Act

On July 6, 2007, the GWRA put into law the statewide GHG limits established by Executive Order 54. In addition, the GWRA requires, among other things, that:

1. The NJDEP will establish an inventory of the current and 2006 Statewide GHG emissions, and an inventory of the 1990 level of Statewide GHG emissions. The NJDEP has completed this task. This initial inventory, as well as the updated inventory for 2005, 2006 and 2007, released November 9, 2009, can be found at http://www.nj.gov/globalwarming/index.shtml.

2. The NJDEP will adopt rules establishing a GHG emissions monitoring and reporting program for statewide GHG emissions. Specifically, these rules would require the identification of all significant sources of GHG emissions in the State (including but not limited to fossil fuel usage, electrical generation, and gas public utilities), and the monitoring and reporting of emissions from those sources and changes in emissions over time from those sources. These rules will allow the State to monitor its progress toward meeting the Statewide 2020 and 2050 GHG limits. See Section IV below for information on the status of this rulemaking.

3. The NJDEP, in consultation with the New Jersey Board of Public Utilities (NJBPU), the New Jersey Department of Agriculture (NJDA), the New Jersey Department of Transportation (NJDOT), and the New Jersey Department of Community Affairs (NJDCA), will prepare a report outlining specific recommendations for legislative and regulatory action needed to achieve the 2020 GHG limit. The State's final GWRA Recommendation Report satisfies this GWRA requirement. Subsequently, the NJDEP, in cooperation with any other affected State agencies, will prepare a second report outlining specific recommendations for legislative and regulatory action needed to achieve the 2050 GHG limit.

4. The EMP, required by N.J.S.A. 52:27F-14, will include a list of recommended policies and measures to reduce the GHG emissions from the production, processing, distribution, transmission, storage, or use of energy that will contribute to achieving the 2020 GHG limit. On October 22, 2008, the NJBPU released the final EMP, which can be found at http://nj.gov/emp/.

5. The NJDEP, by no later than January 1, 2009, and biennially thereafter, will prepare a report on the status of its GHG emissions monitoring and reporting program, the current level of GHG emissions in the State and the progress made toward compliance with the 2020 and 2050 GHG limits. The report will also include updated and comparative inventories of statewide GHG emissions. NJDEP has completed this task. The report, entitled "New Jersey Statewide Greenhouse Gas Emissions Inventory Update: 2005, 2006, and 2007 Estimates," can be found at http://www.nj.gov/globalwarming/.

6. The NJDEP, by no later than January 1, 2015, will evaluate the ecological, economic, and environmental factors and the technological capability affecting the attainment or maintenance of the 2020 and 2050 GHG limits.

7. The NJDEP will designate an independent research panel consisting of economists, business managers, nonprofit environmental organization representatives, public officials, and scientists from academia, industry and the government, to review its recommendations and evaluations. This research panel will complete its review within 12 months of the date of transmittal of the NJDEP's GWRA Recommendation Report to the Governor and State legislature, and will prepare and transmit its own report evaluating the ecological, economic and social impact of the proposed recommendations.

8. The NJBPU is authorized to develop an Emissions Portfolio Standard (EPS) to address pollution coming from out-of-state sources of electricity and an Energy Efficiency Portfolio Standard (EEPS) to specify energy efficiency requirements in existing building stock that utilities would have to achieve.

II. Global Warming Solutions Fund Act

On January 13, 2008, the Global Warming Solutions Fund Act (GWSF) was enacted. The GWSF legislation authorizes the auction of allowances under RGGI, a ten-state mandatory carbon dioxide (CO_2) cap and trade program for electric generating units above 25 megawatts. The legislation establishes, through the Department of the Treasury, a special, non-lapsing fund known as the Global Warming Solutions Fund. The GWSF dedicates to consumer benefit purposes up to 100 percent of the revenues derived from the auction or other sale of allowances pursuant to RGGI, and stipulates that these monies be delegated to State agencies as follows:

- Sixty percent of the proceeds to the New Jersey Economic Development Authority (NJEDA) to support end use energy efficiency, renewable energy, and combined heat and power (CHP) production and to develop innovative carbon abatement technologies to focus on reaching the 2020 GHG limit;
- Twenty percent of the proceeds to the NJBPU to fund programs to reduce electricity demand or cost to low and moderate income customers. The focus for these proceeds would be on urban areas, including an effort to address urban heat island effects;
- Twenty percent of the proceeds to NJDEP, with half of that allocation dedicated to support programs designed to promote local government efforts to reduce GHG emissions and the remaining half dedicated to investments in forestry and tidal marsh protection to maximize carbon sequestration.

The GWSF further directs the NJDEP, in consultation with the NJBPU and the NJEDA, to adopt guidelines and a priority ranking system for allocation of the funds, and sets forth evaluation criteria that need to be included in those guidelines and the priority ranking system. See Section IV below for information about the status of this rulemaking.

The GWSF also provides that all electric public utility and gas public utility investment in energy efficiency and conservations programs or Class 1 renewable energy programs[1] may be eligible for rate treatment approved by the NJBPU, including a return on equity, or other incentives or rate mechanism that decouple utility revenue from sales of electricity and gas.

Finally, the GWSF directs the NJBPU to undertake an EPS or other measure to mitigate the impact from "leakage" (increased imports from non-RGGI states) and authorizes the NJBPU to develop an Energy Efficiency Portfolio Standard. Electric and gas utilities have begun submitting plans for utility investment in energy efficiency and conservation programs, and Class 1 renewable energy programs to the Board of Public Utilities for approval. The NJBPU has convened a series of stakeholder meetings to discuss methods for mitigating potential "leakage" impacts related to RGGI implementation. The RGGI-participating states funded a study of leakage mitigation measures. The final report, issued in 2008, recommends an expansion of energy efficiency initiatives in the RGGI states as a primary means of addressing the impact of leakage. The report, "Potential Emissions Leakage and the Regional Greenhouse Gas Initiative (RGGI)," is available at http://www.rggi.org/docs/20080331leakage.pdf.

[1] "Class 1" renewable energy is defined as electricity derived from solar energy, wind energy, wave or tidal action, geothermal energy, landfill gas, anaerobic digestion, fuel cells using renewable fuels and, with written permission of the NJDEP, certain forms of sustainable biomass.

III. New Jersey Accomplishments

This section provides an overview of New Jersey's accomplishments to date to reduce greenhouse gas emissions.

Renewable Portfolio Standard

A Renewable Portfolio Standard (RPS) ensures that a minimum amount of renewable energy is included in the portfolio of electricity resources serving a state. By increasing that required amount over time, the RPS can put the electricity industry on a path toward increasing sustainability. In New Jersey, pursuant to the provisions of the Electric Discount and Energy Competition Act (P.L. 1999, c. 23), each electric power supplier or basic generation service provider serving retail customers in the State is required to include in its power portfolio electricity generated from renewable energy sources. The State's original RPS directive has been modified several times since 1999. Prior to the changes made in 2006, New Jersey's RPS required electricity suppliers to acquire 6.5 percent renewable energy.

In April 2006, the NJBPU adopted rules which expanded the State's RPS by extending the existing goals out to 2020 and increasing the required amount of renewable energy, with a separate requirement for solar energy. Specifically, under these regulations, 22.5 percent of New Jersey's electricity must come from renewable sources by 2020, with a requirement that 2.12 percent of the renewable sources requirement be from solar energy. This "solar set aside" is forecast to require between 1,400 and 1,500 megawatts (MW) of new solar generation capacity, the Nation's largest solar commitment relative to population and electricity use. These rules will increase the use of renewable resources, thereby providing greater fuel diversity for New Jersey while simultaneously reducing GHG emissions, diminishing price volatility, strengthening the economy, and improving public health and our environment.

CO_2 as a Pollutant

In November 2005, New Jersey adopted a regulation under the authority of New Jersey's Air Pollution Control Act to classify CO_2 as an air contaminant. The adoption was published in the New Jersey Register on November 21, 2005. This rule enabled the State to implement its responsibilities under RGGI and to enact additional rules to reduce CO_2 emissions from other sectors as necessary. Prior to this, in 2003 New Jersey added CO_2 and methane to its emission statement program reporting requirements. The emission statement program requires the annual reporting of emissions of 50 air contaminants from approximately 600 of the largest stationary sources of air pollution in New Jersey.

International Carbon Action Partnership

On October 29, 2007, New Jersey joined the other members of the RGGI, and the members of the Western Climate Initiative, as well as European Union member states, the European Commission, New Zealand and Norway (the latter two both joining on behalf of their own emissions trading programs) in forming the International Carbon Action Partnership (ICAP). ICAP is an international forum in which governments and public authorities adopting mandatory

GHG emission cap and trade systems, like RGGI, can share experiences and best practices on the design of these emissions trading schemes. This cooperation will ensure that the programs are compatible and are able to work together as the foundation for a global carbon market. Such a market will boost demand for low carbon products and services, promote innovation, and allow cost effective reductions, which ultimately will allow ambitious global reductions in global warming emissions.

New Jersey's Clean Energy Program

In 2003, the NJBPU established the Office of Clean Energy to administer New Jersey's Clean Energy Program (NJCEP). The NJCEP is a ratepayer-funded program which promotes increased energy efficiency and the use of clean, renewable sources of energy, including solar, wind, geothermal, and sustainable biomass, by offering financial incentives, and provides assistance services for residential, commercial, and municipal customers. Also in 2003, representatives from government, business, environmental, and public advocacy organizations helped the NJBPU establish a Clean Energy Council to engage stakeholders in the NJCEP's development and provide input to the NJBPU regarding the design, budgets, objectives, goals, administration, and evaluation of the NJCEP. Today, NJCEP is recognized as a national model for programs that spur market development and adoption of clean, renewable energy technologies; manage programs to encourage energy efficiency; and assist low-income consumers. The NJCEP offers the following programs that make clean energy technologies affordable and accessible to residential customers, businesses, schools and local governments:

- **Residential Energy Efficiency & Assistance Programs:** A suite of programs designed to assist homeowners to improve residential energy efficiency, including: energy audits and efficiency improvement recommendations; incentives for energy-efficient construction in Smart Growth Areas; consumer education about the federal ENERGY STAR® program; aid to income-eligible households; and rebates for energy efficient heating and cooling equipment.

- **Commercial Clean Energy Programs:** A series of programs to support businesses, schools and governments, including:
    - The New Jersey SmartStart Buildings Program, which enables energy efficiency upgrades for new and existing buildings;
    - Incentives to increase industrial energy efficiency by utilizing the waste heat generated by manufacturing processes; and,
    - Financing programs, including incentives and low-interest loans to small businesses, schools and local governments.

- **Renewable Energy Programs:** Several assistance and incentive programs designed to increase the use of renewable energy technologies in New Jersey, including:
    - a rebate program to reduce up-front purchase and installation costs for solar, small wind and sustainable biomass (e.g., plants-to-energy) systems;
    - support to owners and sellers of Solar Renewable Energy Certificates, a marketable commodity;

- o the CleanPower Choice Program, which enables voluntary purchases of green energy through local electric utilities;
- o renewable energy project grants and financing for larger projects as well as grants for commercializing new technologies in partnership with the NJEDA; and
- o technical and financial assistance for clean energy businesses.

The Table below summarizes the annual and projected lifetime emission reductions that result from the installation of energy efficiency and renewable energy measures installed in 2008, and projected cumulative emission reductions from measures installed from 2001 - 2008.

Emission Reductions from Energy Efficiency/Renewable Energy				
	CO_2 (metric tons)	**NO_x [a] (metric tons)**	**SO_2 [b] (metric tons)**	**Hg[c] (pounds)**
Annual Emission Reductions from Measures Installed in 2008	418,463	743	1678	20
Projected Lifetime Emission Reductions from Measures Installed in 2008	5,042,788	8,843	19,758	137
Cumulative Projected Lifetime Emission Reductions from Measures Installed from 2001-2008[d]	22,952,422	38,724	83,749	1,009

[a] NO_x is Nitrogen Oxides.
[b] SO_2 is Sulfur Dioxide.
[c] Hg is Mercury.
[d] Represents projected lifetime emission reductions for all energy efficiency and renewable energy installations since the inception of the New Jersey Clean Energy Program. From 2001 – 2002, the program was administered by the utilities. In 2003, the State government assumed administrative authority.

Other Energy Efficiency and Renewable Energy Programs:

- **NJDEP Regulations Supporting Renewable Energy and Energy Efficiency:** The NJDEP's rules require that major new sources of air pollution complete an evaluation of alternatives for non-attainment criteria pollutants, including oxides of nitrogen (NO_x) and fine particles emitted by fossil fuel fired plants and heaters. Pursuant to NJAC7:27-18.3(c)(2), alternative sizes, production processes (including pollution prevention measures) and environmental control techniques must be evaluated, demonstrating that the benefits of the project significantly outweigh the environmental and social costs imposed as result of the location and operation of such equipment. This is particularly relevant in the evaluation of new coal-fired power plants.

In 2007, New Jersey adopted NO_x rules to allocate NO_x allowances in response to the Ozone Transport Commission NO_x Memorandum of Understanding and subsequent federal NO_x State Implementation Plan Call to allow its emission trading program to promote energy efficiency. Specifically, these output-based allocations are based on energy produced, rather than being input-based allocations based on fuel burned. This program also has a set aside allocation for energy efficiency and renewable projects.

- **New Jersey Cool Cities Initiative:** As a result of research conducted by the NJDEP and the USEPA on urban heat island effects in Camden and Newark, New Jersey launched its Cool Cities Initiative in 2003. This program is designed to "green" New Jersey's larger cities by planting trees to create cooler, more comfortable urban environments, reduce air pollution, reduce the demand for electricity, and improve urban quality of life. The total Cool Cities funding from the NJCEP (including the NJBPU/NJDEP current 2009 Memorandum of Agreement funding commitment) to date is $16,850,000, resulting in the planting of over 36,000 trees. The program has or will work in 54 communities directly, and has worked with another 50 communities in 2006/2007 through the Statewide Cool Cities Grant program.

  The Cool Cites Initiative has provided the NJBPU with data concerning the conservation of energy through the tree planting effort. In addition, communities have provided positive feedback to the State regarding the Cool Cities partnerships. In fact, many communities have established a Community Forestry Management plan to not only manage the Cool Cities trees but the entire urban forest within their municipalities.

- **State Government Action to Promote Energy Efficiency:** On April 22, 2006 Executive Order #11 was enacted. This Executive Order was designed to promote energy efficiency, energy conservation, renewable energy, and the purchase by State government of recycled products, energy efficient products, renewable energy products, low toxicity products and alternatives to products that contain persistent bioaccumulative toxics. Executive Order #11 also created the post of Director of Energy Savings within the New Jersey Department of Treasury to oversee these new State government energy initiatives.

- **New Jersey Green Homes Office:** The NJDCA Green Homes Office works to increase the use of innovative green design and building technologies, raise building standards and create a consumer demand for efficient, healthy and environmentally responsible high-performance homes. This Office's primary focus is on energy efficiency.

IV. Status of GHG-Related Rulemakings

Reporting Rule

As discussed above, the GWRA requires the NJDEP to adopt GHG monitoring and reporting rules. The NJDEP held a stakeholder meeting on May 13, 2008 to outline approaches to this rulemaking and obtain stakeholder input. On January 20, 2009, the NJDEP proposed a rule[2] requiring: (1) reporting of releases by stationary sources of GHG other than CO_2 above a threshold of 2,500 tons per year; (2) reporting of fossil fuel use by manufacturers and distributors of fossil fuel, including prime suppliers, gas public utilities, and natural gas pipeline operators; and (3) reporting of storage quantities of GHG other than CO_2 and methane above threshold quantities. These proposed reporting requirements will be implemented through existing reporting mechanisms, with releases by stationary sources implemented through the Emission Statement program and reporting of fossil fuel use and quantities of GHG stored implemented through New Jersey's Worker and Community Right to Know program. A hearing on this rule proposal was held on March 3, 2009, and the comment period ended on March 21, 2009.

On April 10, 2009, the USEPA proposed rules establishing a federal mandatory GHG reporting program.[3] The NJDEP provided comments on the proposal urging the USEPA to coordinate with state GHG reporting requirements to improve the efficiency and effectiveness of future reporting. The final EPA rule appeared in the Federal Register on October 30, 2009.[4] NJDEP reviewed the final rule and has determined that it does not cover all of the requirements of the State monitoring and reporting program mandated by the GWRA. NJDEP is currently planning to adopt the State's rules to fill the gaps in reporting and to meet the State's requirements.

Priority Ranking Rule

As discussed above, the GWSF law requires the NJDEP, in consultation with the NJBPU and the NJEDA, to adopt guidelines and a priority ranking system to assist in annual allocation of funds to eligible projects or programs using GWSF monies, and sets forth evaluation criteria that must be included in those guidelines and the priority ranking system. Specifically, these guidelines and priority ranking system should include, but need not be limited to, an evaluation of each eligible project or program as to its predicted ability to:

- result in a net reduction in GHG emissions in the State or in GHG emissions from electricity produced out of the State but consumed in the State or net sequestration of carbon;
- result in significant reductions in GHGs relative to the cost of the project or program and the reduction of impacts on ratepayers attributable to the implementation of the GWSF, and the ability of the project or program to significantly contribute to achievement of the State's 2020 and 2050 GHG limits established pursuant to the GWRA, relative to the cost of the project or program;
- reduce energy use;

[2] 41 N.J.R. 337(a), January 20, 2009.
[3] Federal Register / Vol. 74, No. 68 p. 16448
[4] Federal Register / Vol. 74, No. 209 p. 56260

- provide co-benefits to the State, including but not limited to creating job opportunities, reducing other air pollutants, reducing costs to electricity and natural gas consumers, improving local electric system reliability, and contributing to regional initiatives to reduce emissions; and
- be directly responsive to the recommendations submitted by the NJDEP to the Legislature as part of this report.

On February 17, 2009, the NJDEP proposed rules[5] to meet this requirement. A public hearing on this rule proposal was held on March 23, 2009, and the public comment period closed on April 18, 2009. The rule is expected to be published in the New Jersey Register on December 21, 2009.

In addition to its leadership role in efforts to reduce GHG emissions regionally through RGGI, New Jersey continues to be very active in advocating for national and international efforts to reduce GHGs. For example, New Jersey has participated upon request in Congressional hearings and in national meetings regarding state and local perspectives on climate change.

In addition:

- On October 29, 2007, New Jersey became a founding member of the International Carbon Action Partnership (ICAP). For more information on ICAP, refer to Section III above; and
- New Jersey is a member of The Climate Registry (TCR), and sits on the organization's Board of Directors. TCR is a voluntary greenhouse gas reporting platform that allows organizations in North America to report their entity-wide greenhouse gas emissions. NJDEP participates in TCR's Protocol Committee, and played a leadership role in the development of the TCR General Reporting Protocol for organizational greenhouse gas reporting. More information is available at http://www.theclimateregistry.org.

[5] 41 N.J.R. 833 – 845, February 17, 2009.

Appendix 4

Activities in Other States

Given the enormity of the climate change problem, many states have recognized that each region within a country must do its part to reduce greenhouse gas (GHG) emissions if we are to avert the most devastating impacts from global warming, and have begun to take action.

State initiatives serve as models for subsequent federal action, similar to what has already happened with other environmental regulations, where a significant number of federal environmental laws and programs have been based on state models. State actions can have a significant impact on emissions, because many individual states emit relatively high levels of GHGs. Texas, for example, emits more GHGs than France, while California's emissions exceed those of Brazil. New Jersey accounts for approximately 0.5 percent of the global GHG emissions, and 2 percent of the U.S. GHG emissions.[1] State actions are also important because states have primary or substantial jurisdiction over many areas, such as agriculture, transportation, building codes and land use, which are critical to addressing climate change. By taking a proactive approach to climate change planning, states are finding that they can not only lower their GHG emissions, but they can also secure their energy supply and reliability while reducing energy costs, protecting their air quality and public health, stimulating economic development, and reducing traffic congestion.

State actions include:

1. Development of a baseline GHG inventory;
2. Development of projections that estimate future emissions based on expected population, economic growth and other factors;
3. Development of emission reporting and tracking systems to provide more accurate emissions data to enhance inventories and projections;
4. Identification of areas in which emissions could be reduced, and development of GHG emission reduction goals and targets;
5. Development of registries and brokering programs for tracking and exchanging emission offsets;
6. Development of GHG action plans;
7. Implementation of GHG reduction measures (e.g., cap-and-trade programs, programs to promote and require renewable energy and energy efficiency, low emission vehicle programs, etc.); and
8. Development of State Climate Adaptation Plan.

The USEPA has developed a website which shows those states that have completed, or are working on, a state climate action plan, as well as a searchable database of state policy recommendations by sector contained. These tools can be found at http://epa.gov/climatechange/wycd/stateandlocalgov/index.html.

In October of 2006, the Pew Center on Global Climate Change released a report entitled "Climate Change 101: State Action" An update to that report, "Learning From State Action on Climate Change" was released by the Pew Center in December 2007, highlighting state efforts as

---

[1] While New Jersey makes up about 3 percent of the U.S. population, it emits less GHG emissions per capita than the U.S. average, in part because of little heavy industry and a large contribution to its energy generation from nuclear power.

they responded to the challenges of implementing solutions to climate change. Both of the Pew Center's reports can be found at http://www.pewclimate.org/policy_center/policy_reports_and_analysis/state . The Pew Center also tracks state actions on climate change at http://www.pewclimate.org/states-regions.

A comprehensive list of state climate actions has been compiled by the National Association of Clean Air Agencies and is available at http://www.4cleanair.org/.

Finally, the New America Foundation has created the State Climate Policy Tracker, an online tool to allow state-by-state tracking of hundreds of carbon and energy saving measures now being implemented across the country. A seven-column matrix captures the climate actions taking place across six economic sectors, and reports on the progress of each measure, its cost or cost-saving potential, and the estimated reduction in carbon emissions expected on an annual basis. This tool can be found at http://www.newamerica.net/programs/climate.

Appendix 5

Center for Climate Strategies (CCS)
Analysis of Potential Greenhouse Gas Emission Reductions and Costs of Supporting Recommendations and Related Actions

Analysis of Potential Greenhouse Gas Emission Reductions and Costs of Supporting Recommendations and Related Actions for New Jersey

New Jersey Department of Environmental Protection
and the Center for Climate Strategies
November 2009

Table of Contents

List of Tables and Figures

Acronyms and Abbreviations

\$/kWh	dollars per kilowatt-hour
\$/MtCO_2e	dollars per million metric ton of carbon dioxide equivalent
\$/tCO_2e	dollars per metric ton of carbon dioxide equivalent
AASHTO	American Association of State Highway and Transportation Officials
AEO2008	Annual Energy Outlook 2008
ANL	Argonne National Laboratory
APTA	American Public Transportation Association
ARB	[California] Air Resources Board
BAU	business as usual
BBtu	billion British thermal units
Btu	British thermal unit
C	carbon
CA LEV	California Low Emission Vehicle Program
CAFE	corporate average fuel economy
CCS	Center for Climate Strategies
CESA	Clean Energy and Security Act of 2009
CH_4	methane
CNG	compressed natural gas
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
CWNS	Clean Watershed Needs Survey
DCA	New Jersey Division of Codes and Standards
EGU	Electricity Generating Unit
EIA	Energy Information Administration [US DOE]
EMP	New Jersey Energy Master Plan
EPA	[United States] Environmental Protection Agency
FTA	United States Federal Transit Administration
GB	Green Buildings
GB	Green Buildings
GHG	greenhouse gas
GREET	Greenhouse gases, Regulated Emissions and Energy use in Transportation [model]
GSPT	Garden State Preservation Trust

GWP	global warming potential
GWRA	New Jersey Global Warming Response Act
HDV	heavy-duty vehicle
HFC	hydrofluorocarbon
HOT	High Occupancy Toll
HOV	high-occupancy vehicle
HWA	Federal Highway Administration (US DOT)
ICC	International Code Council
IECC	International Energy Conservation Code
IGCC	integrated gasification combined cycle
IPM	Integrated Planning Model
km	kilometer
kWh	kilowatt-hour
LCFS	low-carbon fuel standard
LDAR	Leak Detection and Repair
LDV	light-duty vehicle
LEED	Leadership in Energy and Environmental Design [Green Building Rating
LFG	landfill gas
LPG	liquefied petroleum gas
metric ton	1,000 kilograms or 22,051 pounds
MG	million gallons
MGD	million gallons per day
MM	million
MMBtu	millions of British thermal units
MMT	million metric ton
$MMtCO_2e$	million metric tons of carbon dioxide equivalent
MRF	Materials recovery facility
MSW	municipal solid waste
$MtCO_2e$	metric tons of carbon dioxide equivalent
MW	megawatt [one thousand kilowatts]
MWh	megawatt-hour [one thousand kilowatt-hours]
NETL	National Energy Technology Laboratory [US DOE]
NG	natural gas
NGCC	natural gas combined cycle
NJDEP	New Jersey Department of Environmental Protection
NPV	net present value

NRC	National Research Council
NYSERDA	New York State Energy Research and Development Authority
NYSERDA	New York State Energy Research and Development Authority
ODS	ozone-depleting substance
POTWs	Publicly Owned Wastewater Treatment Works (Plants)
R/AC	refrigeration and air conditioning
RCA	Recycling Enhancement Act
RCI	Residential, Commercial, and Industrial [Technical Work Group]
RGGI	Regional Greenhouse Gas Initiative
RPS	renewable portfolio standard
SEM	structural equation modeling
SFMTA	San Francisco Municipal Transportation Agency
SI PHEV	spark ignition plug-in hybrid electric vehicles
SOCCR	First State of Carbon Cycle Report (2007)
SOTA	State of the Art
t	metric ton
T&D	transmission and distribution
tCe	tons of Carbon equivalent
tCO_2	metric tons of carbon dioxide
tCO_2e	metric tons of carbon dioxide equivalent
tCO_2e/MWh	metric tons of carbon dioxide equivalent per megawatt-hour
TCRB	Transit Cooperative Research Program
TDM	travel demand management
TLU	Transportation and Land Use [Technical Work Group]
TRB	Transportation Research Board
TRU	trailer refrigeration unit
TS	Terrestrial Carbon Sequestration
TSE	truck stop electrification
TSM	Transportation System Management
US DOE	United States Department of Energy
US EPA	United States Environmental Protection Agency
VISION	Voluntary Innovative Sector Initiatives: Opportunities Now Program [US DOE]
VMT	vehicle miles traveled
WARM	WAste Reduction Model [US EPA]
WWTP	wastewater treatment plant
yr	year

Acknowledgements

This report was prepared for the Memorandum of Understanding (MOU) between Center for Climate Strategies (CCS) and the New Jersey Department of Environmental Protection (NJDEP). CCS would like to thank the NJDEP for the opportunity to support the state in preparing this report to assess the potential greenhouse gas (GHG) emission reductions and costs or cost savings associated with supporting recommendations and related actions to enable the State to provide assurance that the State will achieve its 2020 GHG limit on its way to meeting its 2050 limit. In particular, we appreciate the opportunity to work with Mr. William Mates who served as NJDEP's project coordinator enabling the incorporation of NJ-specific data. Mr. Mates also provided valuable analytical and senior review assistance on the project. CCS also thanks Ms. Jeanne Herb and Dr. Marjorie Kaplan for their assistance in providing valuable guidance and insights during the development of the analytical approach for the supporting recommendations and related actions. In addition, we thank the following NJ agency staff who provided information and guidance for the quantification of these actions and recommendations: Michael Aucott, Steven Anderson, Joseph Carpenter, Kenneth Frank, John Gorgol, Serpil Guran, Robert Kettig, James Koroniades, William O'Sullivan, Marty Rosen, Athena Sarafides, Elizabeth Semple, Christopher Sherry, Andrew Sword, Guy Watson, and Pippa Woods.

Finally, CCS thanks the Rockefeller Brothers Fund who provided the funding for this project, and the following members of its team who worked with NJDEP and other NJ agency staff to incorporate NJ-specific data into the analysis for the supporting recommendations and related actions, prepared the analysis and documentation for this report, and revised the report to incorporate comments from NJDEP:

Randy Strait, Tom Peterson, and Jeff Wennberg, Center for Climate Strategies

Dr. Dan Wei and Dr. Adam Rose, University of Southern California

Steve Roe and Brad Strode, E. H. Pechan & Associates, Inc.

Dr. Lewison Lem, Michael Lawrence, Alex Lane, and Rami Chami, Jack Faucett Associates

Dr. Bill Dougherty, Stockholm Environmental Institute – US, Inc.

Chapter 1
Introduction and Overview

Introduction

New Jersey's Global Warming Response Act (GWRA) requires the state to reduce greenhouse gas (GHG) emissions to 1990 levels by 2020 (about a 24% reduction below estimated 2020 business-as-usual (BAU) emissions on a gross emissions, consumption basis). The Act also sets a long-term goal for New Jersey to further reduce statewide emissions to 80% below 2006 levels by 2050.[1] The State of New Jersey has adopted several core recommendations needed for the State to meet its 2020 statewide GHG emission limit. The State also has underway a number of additional "related actions" which together with the core recommendations will help ensure early emission reductions to set the state on a path toward achieving its long-term goal. However, the state recognizes the need to identify and adopt additional measures to provide further assurance that it will achieve its 2020 goal and to keep the state on course to meet its 2050 goal. Thus, New Jersey has identified several "supporting recommendations" that, if fully implemented, will provide assurance that the State will achieve its 2020 limit on its way to meeting its 2050 limit.

This report presents the results of an assessment of the GHG emission reductions and costs or cost savings associated with supporting recommendations and additional related actions identified by New Jersey on the basis of data availability. The supporting recommendations were analyzed incrementally to the core recommendations and related actions adopted by New Jersey for the following sectors:

- Residential and Commercial Energy Use (i.e., Green Buildings [GB]);
- Waste Management;
- Industrial Sector – Highly Global Warming Gases;
- Terrestrial Carbon Sequestration (TS) by Forestry and Agriculture;
- Transportation and Land Use (TLU); and
- Electricity generation.

For the electricity generation sector, the recommendation to establish a minimum carbon dioxide (CO_2) emissions performance standard was analyzed but not included in the overall results because it is considered a potential implementation mechanism for securing emission reductions under the Regional Greenhouse Gas Initiative (RGGI). The remainder of this chapter provides a summary of the analytical results for each of the supporting recommendations and related actions and describes the overall analytical framework for the analysis. Chapters 2 through 7 of this report provide details on the analytical design parameters, data sources, methods, assumptions, and results for the recommendations and actions analyzed for each sector; for completeness, actions with GHG reduction potential but without incremental costs were included in the detailed economic analyses as though they were being implemented solely to achieve GHG reductions;

---

[1] Taking initiative on a statewide level, Governor Jon S. Corzine signed the Global Warming Response Act (GWRA) (P.L. 2007, c.112) on July 6, 2007. This new law embodies the proactive and ambitious limits for the reduction of GHG emissions in New Jersey that were set forth previously in the Governor's Executive Order 54.

however, such actions are not included in the summary monetary figures presented in the current chapter.

The remainder of this introductory chapter provides a brief overview of the emission reductions associated with New Jersey's core recommendations followed by summaries of the results for the related actions and supporting recommendations analyzed and the overall methodology and guidelines applied to quantify the GHG emission reductions and costs or cost savings for the related actions and supporting recommendations.

Core Recommendations – Summary of Emission Reductions

The emission reductions associated with the core recommendations serve as the starting point for quantification of the related actions and supporting recommendations; therefore, the following provides a brief overview of the core recommendations. Table 1.1 lists the core recommendations that New Jersey has adopted for each sector. These core recommendations will enable New Jersey to meet its near-term statewide GHG reduction goal to reduce GHG emissions to 1990 levels by 2020. Several of these core recommendations also represent the most cost-effective methods for reducing GHG emissions in the state and will achieve significant savings through more efficient use of energy by residential, commercial, and industrial buildings and fuel by on-road vehicles.

Table 1.1. Core Recommendations – Net Annual GHG Emission Reductions in 2020

Core Recommendation	Sector	Net Annual GHG Reductions in 2020 ($MMtCO_2e$)*
Whole-building energy efficiency	Green buildings	11.7
California Low Emission Vehicle (CA LEV) Program	Transp./land use	10.0
Regional Greenhouse Gas Initiative (RGGI)	Electricity gen.	8.5
Wind power	Electricity gen.	5.9
Appliance standards	Green buildings	1.9
Imported electricity – Renewable Portfolio Standard (RPS)	Electricity gen.	1.9
HERS70 building code	Green buildings	1.6
Photovoltaics	Electricity gen.	1.3
2006 IECC building code upgrade	Green buildings	0.9
Biofuels combustion	Electricity gen.	-1.4
Combined heat and power (net)	Green buildings	-4.4
Total		**37.8**

* The negative values in the last column of this table represent net GHG emissions increases.

Additional Related Actions - Summary of Emissions Reductions

In additional to the core recommendations, New Jersey has underway a number of related actions that were not expressly designed for GHG reduction purposes but that are expected to produce such reductions as an added benefit. Table 1.2 summarizes the emissions reductions projected for these measures. Because the GHG reductions are not the express purpose of these measures, the marginal monetary costs or benefits of these measures are not included in our summary of the monetary impacts of the supporting recommendations.

Table 1.2. Related Actions – Net Annual GHG Emission Reductions in 2020

Additional Related Action	Sector	Net Annual GHG Reductions in 2020 ($MMtCO_2e$)*
Increase recycling rate to 70% from 50%	Waste management	5.00
Improve landfill gas management	Waste management	0.19
Increase recycling rate to 50%	Waste management	2.61
Preserve additional green infrastructure	Terrestrial sequestration	0.75
Adopt forest stewardship legislation	Terrestrial sequestration	0.03
Encourage low-carbon goods movement	Transportation & land use	1.40
Good state of road repair/maintenance	Transportation & land use	0.01
Double public transit ridership	Transportation & land use	0.65
Total		**10.64**

Because these actions were implemented for purposes other than GHG reduction, the marginal cost of such reductions is technically zero. However, they are expected to contribute to New Jersey's ability to surpass its 2020 GHG reduction goals on the way to meeting its 2050 goals.

Supporting Recommendations - Summary of Results

A total of 11 supporting recommendations were analyzed; 7 of the recommendations mitigate GHG emissions, 3 of the recommendations are designed to sequester carbon, and one recommendation represents a potential implementation mechanism under RGGI. The analytical results for each supporting recommendation reflect incremental GHG emission reductions and costs (or savings) relative to New Jersey's core recommendations and related actions. Each of the supporting recommendations was evaluated for potential overlap with other supporting recommendations within the same sector as well as with other sectors and adjusted to remove potential double-counting of emission reductions and costs (or cost savings). Table 1.3 provides a summary of the estimated GHG emission reductions and net costs (or savings) associated with the supporting recommendations analyzed for each sector after adjusting for overlaps. Table 1.4 shows the estimated GHG emission reductions and net costs (or savings) for each of the supporting recommendations and the adjustments for overlaps made for the TLU and electricity generation sectors.

Table 1.3. Supporting Recommendations - Estimated GHG Emission Reductions and Net Costs (or Cost Savings) by Sector (Adjusted for Overlaps)

Sector / No. Supporting Recommendations Analyzed[1]	Annual Results (2020)		Cumulative Results (2009-2020)		
	GHG Reductions ($MMtCO_2e$)	Costs (Million $)	GHG Reductions ($MMtCO_2e$)	Costs (NPV, Million $)	Cost-Effectiveness ($\$/tCO_2e$)
Green Buildings (Residential and Commercial) / 2 Recommendations	3.9	-$285	22	–$1,176	-$53
Highly Warming Gases (Commercial & Industrial) / 1 Recommendation	1.05	-$1.3	9.4	-$14	-$1.5
Waste / 1 Recommendation	0.4	-$89	2.0	-$483	-$238
Terrestrial Carbon Sequestration (Agriculture & Forestry) / 3 Recommendations	0.37	$38.2	2.03	$244	$120
Transportation and Land Use (TLU) / 3 Recommendations	10.14	$109	51.9	-$3,558	-$69
Totals	**15.85**	**-$228**	**87.3**	**-$4,987**	**-$57**

[1] The results for the one measure analyzed for the electricity sector are excluded from Table 1.3 because its emission reductions and costs would otherwise be double counted under RGGI. See Table 1.4 for the estimated impacts associated with this supporting recommendation.

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $\$/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent; NPV = net present value.

Costs are discounted to year 2009 in 2007 dollars using a 3% real discount rate. Negative values in the Cost and the Cost-Effectiveness columns represent net cost savings. The values shown in the Cost-Effectiveness column are calculated by dividing the value in the Cost column by value in the GHG Reduction column; these values represent the weighted average cost-effectiveness of the Supporting Recommendations within each sector after adjusting for overlaps between the measures and with recent actions (i.e., for the waste sector).

The order of the sectors presented in this table does not reflect or imply prioritization of the sectors based on the results presented in this table.

Table 1.4. Supporting Recommendations - Estimated GHG Emission Reductions and Net Costs (or Cost Savings) by Recommendation (Adjusted for Overlaps)

Sector / Supporting Recommendation	Annual Results (2020)		Cumulative Results (2009-2020)		
	GHG Reductions ($MMtCO_2e$)	Costs (Million $)	GHG Reductions ($MMtCO_2e$)	Costs (NPV, Million $)	Cost-Effectiveness ($\$/tCO_2e$)
Green Buildings (Residential and Commercial)					
GB-1 (new buildings)	1.7	-$68	9.8	-$299	-$30
GB-2 (existing buildings)	2.1	-$217	12.2	-$877	-$72
Highly Warming Gases (Commercial & Industrial Refrigeration and Air Conditioning)					
HWG-E (LDAR for refrigerants)	1.1	-$1.3	9.4	-$14	-$1.5
Waste Management					
W-1 (POTW anaerobic digesters)	0.4	-$89	2.0	-$483	-$238
Terrestrial Carbon Sequestration (Agriculture & Forestry)					
TS-3 (no net loss of forest land) *	0.004	$2	0.021	$11.1	$520.3
TS-4 (urban forest cover requirement) *	0.35	$36	1.9	$231	$121.6
TS-7 (sustainable agriculture)	0.019	$0.2	0.11	$1.88	$16.4
Transportation and Land Use					
TLU-1 (low- and zero-emission	4.52	$825	20.8	$2,861	$138
TLU-2 (low-carbon fuels)	4.53	$991	21.7	$3,728	$171
TLU-5 (reduce vehicle miles traveled)	3.41	-$1,445	20.5	-$9,598	-$469
Electricity Generation					
EGU-1 (performance standard for electricity generating units)	1.4	$75.6	4.7	$162	$35
Grand Total Before Adjusting for Overlaps	19.5	$109.5	103.1	-$4,276	-$42
Adjustments (Subtractions) for Overlaps	-$3.68	-$337.6	-15.8	-$711	NA
TLU overlaps with CA LEV	-2.32	-$262	-11.1	-$549	NA
EGU-1 overlaps with RGGI	-1.4	-$75.6	-4.7	-$162	NA
Grand Total After Adjusting for Overlaps	**15.85**	**-$228**	**87.3**	**-$4,987**	**-$57**

* Figures reflect costs and cost savings through 2020 only; actual costs and savings extend well beyond 2020.

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $\$/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent; NPV = net present value; POTW = Publicly Owned Treatment Works; LDAR = leak detection and repair; NA = Not applicable.

Costs are discounted to year 2009 in 2007 dollars using a 3% real discount rate. Negative values in the Cost and the Cost-Effectiveness columns represent net cost savings.

The numbering used to denote the above supporting recommendations is for reference purposes only; it does not reflect prioritization among these recommendations.

Figure 1.1 presents a graphical summary of the potential cumulative emission reductions associated with the core and supporting recommendations relative to the BAU reference case projections for New Jersey.

- The blue line shows actual (for 1990, 1995, 2000, and 2004) and projected (for 2010, 2015, and 2020) levels of New Jersey's gross GHG emissions on a BAU basis. This consumption-based approach accounts for emissions associated with the generation of electricity in New Jersey to meet the state's demand for electricity.
- The red line shows the projected emissions associated with the implementation of the core recommendations described in Table 1.1.
- The green line shows the projected emissions if all of the recommendations and related actions are implemented and the estimated reductions are fully achieved.
- Projected emissions associated with New Jersey's statewide GHG reduction targets are shown by the black line.

Figure 1.1. Annual GHG Emissions: Reference Case Projections and Core and Supporting Recommendations (consumption basis, gross emissions)

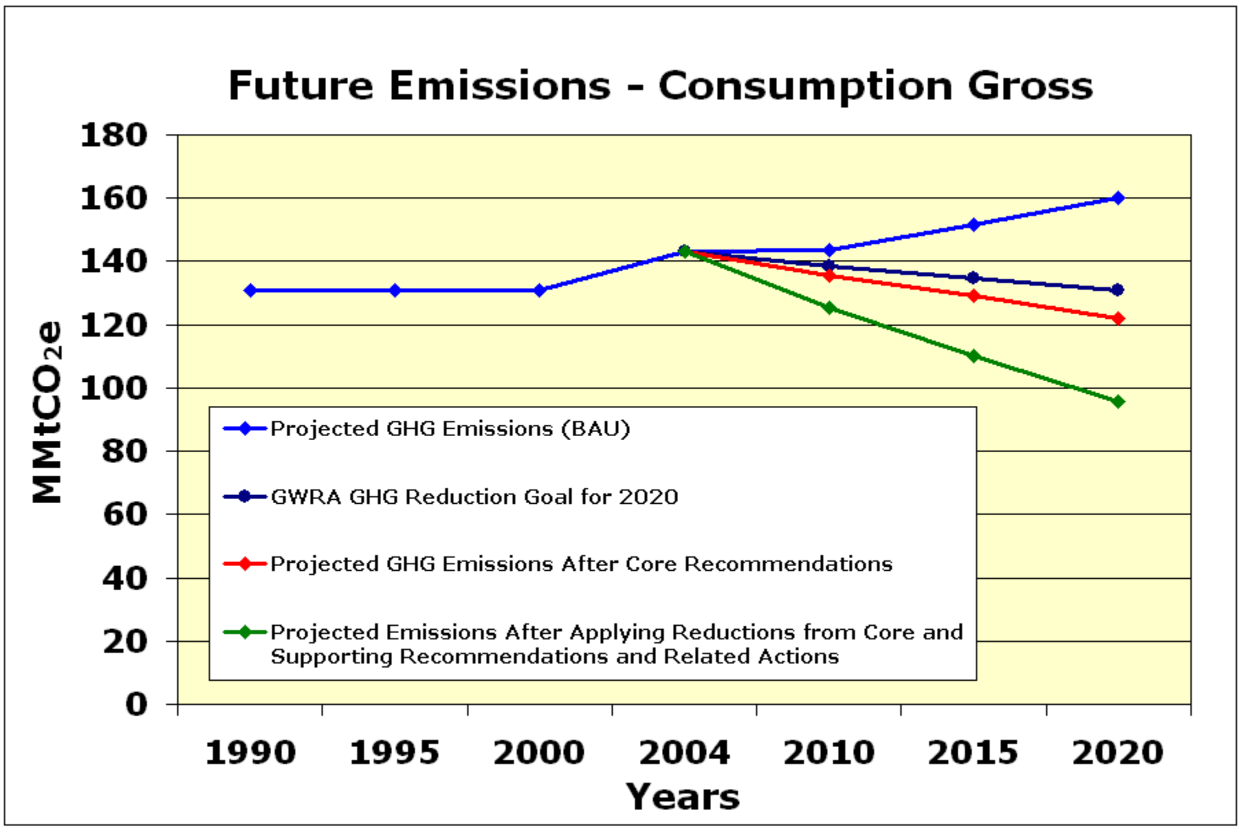


Table 1.5 provides the numeric estimates underlying Figure 1-1. In summary, if all of the core recommendations are fully implemented and achieve all of the GHG reductions projected, then New Jersey will be able to over-achieve its statewide GHG emissions reduction goal of 5% below 1990 levels by 8.7 $MMtCO_2e$ (6.6% below 1990 levels). Should the core measures not fully achieve their projected emission reduction levels, the related actions and supporting

recommendations will provide reductions by 2020 to ensure that New Jersey meets its 2020 goal. The related actions and supporting recommendations will also place the state well on its way toward achieving its long-term goal to further reduce statewide emissions to 80% below 2006 levels by 2050. Analysis of the related actions and supporting recommendations indicates that if fully implemented they have the potential to reduce GHG emissions by an additional 26.5 $MMtCO_2e$ in 2020. By 2020, emission reductions associated with both the core and supporting recommendations and the related actions would place New Jersey at 27% below 1990 levels and 33% below 2006 levels.

Table 1.5. Annual emissions: Reference Case Projections and Impact of Recommendations and Related Actions (consumption basis, gross emissions)

Consumption Basis - Gross Emissions	1990	1995	2000	2004	2010	2015	2020
Projected GHG Emissions (BAU)	130.8	130.8	130.8	143.3	143.4	151.6	159.9
Reductions from NJ's Core Recommendations							37.8
Projected GHG Emissions After Core Recommendations				143.3	135.5	129.0	122.1
GWRA GHG Reduction Goal for 2020				143.3	138.5	134.5	130.8
Total GHG Reductions from Supporting Recommendations and Related Actions							26.5
Projected Emissions After Applying Reductions from NJ's Recommendations and Related Actions				143.3	125.3	110.3	95.6
Percent below 1990 Levels							27%
Amount of Emissions Reduction Below GWRA Goal							35.1

It is important to note that, to yield these emission reductions from the core and supporting recommendations and the related actions, implementation must be timely, aggressive, and thorough. Evaluation of key factors such as cost-effectiveness, economic impacts, and harmonization with other New Jersey programs and policies will be critical to effective implementation of these recommendations and actions.

Overall, the supporting recommendations are projected to result in a net *benefit* of approximately $228 million *in 2020* (about $14/tCO_2e$ of emissions reduced, on average) after adjusting for overlaps and interactions between the supporting and core recommendations and related actions. Over the *entire* period of analysis (2009-2020), the supporting recommendations are projected to result in a net *cost* of about $1.57 billion or, on average, about $18/tCO_2e$ of emissions reduced.

As shown in Tables 1.3 and 1.4, net cost savings are attributed to improving the efficient use of (1) energy by existing and new residential and commercial buildings, (2) highly warming gases used in commercial and industrial refrigeration, (3) waste products in the waste sector, and (4) reduction in vehicle miles traveled in the transportation sector. Cumulative net costs are attributed to the supporting recommendations for managing forest and agricultural lands as carbon sinks and other transportation recommendations. For the recommendations designed to maintain and enhance carbon sequestration, some investment is required to acquire and manage lands while the emission reduction benefits are not significantly realized for several years past 2020. Thus, the constraint of the analysis period significantly understates the long-term benefits of these recommendations which are needed to keep New Jersey on its path toward meeting its long-term GHG reduction goal by 2050.

For the transportation sector, the costs associated with increasing the use of low- and zero-emission vehicles and low-carbon fuels in New Jersey are estimated incremental to the California low-emission vehicle (CA LEV) standards that New Jersey has adopted as a core recommendation. These standards include both tailpipe emission standards as well as requirements to improve the corporate average fuel economy (CAFE) of the on-road vehicle fleet. The net effect of these two supporting recommendations is that the net cost-effectiveness of electric vehicle and low-carbon fuels strategies is higher than the CAFE and state clean car tailpipe standards already adopted by New Jersey and also higher than potential additional incremental vehicle efficiency improvements.

Overall Methodology and Guidelines for Quantifying Supporting Recommendations

The following explains the overall methodology and guidelines applied to quantify the GHG emission reductions and costs / cost savings for the supporting recommendations. This overall methodology was then customized to incorporate specific design parameters and data sources for each supporting recommendation analyzed based on information provided by New Jersey Department of Environmental Protection (NJDEP) and other New Jersey State agencies. Due to time and resource constraints, it was not possible to incorporate all costs and benefits associated with the recommendations analyzed. To the extent possible, direct costs / cost savings were quantified. The sector-specific chapters included in this report provide details on how the following overall methodology was customized to quantify GHG emission reductions and costs / cost savings for each recommendation.

- Cost-Effectiveness: Because the monetized dollar value of GHG reduction benefits for New Jersey is not available, physical benefits are used instead, measured as dollars per $MMtCO_2e$ (cost per ton) or "cost-effectiveness" evaluation. Both positive costs and cost savings (negative costs) are estimated as a part of compliance cost.
- Focus of analysis: Net GHG reduction potential in physical units of million metric tons (MMt) of carbon dioxide equivalent (CO_2e) and net cost per metric ton reduced in units of dollars per metric ton of carbon dioxide equivalent ($\$/MtCO_2e$). Where possible, full life cycle analysis is used to evaluate the net energy performance of actions (taking into account all energy inputs and outputs to production). Net analysis of the effects of carbon sequestration is conducted where applicable.
- Geographic inclusion: Measure GHG impacts of activities that occur within New Jersey, regardless of the actual location of emissions reductions.
- Direct vs. Indirect Effects: Define "direct effects" as those borne by the entities implementing the recommendation. For example, direct costs are net of any benefits or savings to the entity. Define "indirect effects" as those borne by the entities other than those implementing the recommendation. For the quantification of the supporting recommendations, the following lists indirect cost and/or benefits that were not generally quantified due to time and resource constraints:
    - Re-spending effect on the economy

    - Net value of employment impacts
    - Net value of health benefits/impacts (except for TLU-5 and TLU-6)
    - Higher cost of electricity reverberating through the economy
    - Energy security
    - Health benefits of reduced air and water pollution
    - Ecosystem benefits of reduced air and water pollution
    - Value of quality-of-life improvements
    - Value of improved road safety (except for TLU-5 and TLU-6)
    - Value of net environmental benefits/impacts (value of damage by air pollutants to structures, crops, etc.)
    - Net savings on the embodied energy of materials used in buildings, appliances, equipment, relative to standard practice
    - Improved productivity as a result of an improved working environment, such as improved office productivity through improved lighting (though the inclusion of this as indirect rather than direct might be argued in some cases)

- Non-GHG (external) impacts and costs: Include in qualitative terms where deemed important. Quantify on a case-by-case basis as needed depending on need and where data are readily available.

- Discounted and "Levelized" Costs: Discount a multi-year stream of net costs (total costs net of any savings) to arrive at the "net present value cost" of a recommendation. Discount costs in constant 2007 dollars using a 3% annual real discount rate for the period 2009 through 2020. Capital investments are represented in terms of levelized or amortized costs through 2020. Create a "levelized" cost per ton by dividing the "present value cost" by the cumulative reduction in tons of GHG emissions. This is a widely used method to estimate the "dollars per ton" cost or cost savings of reducing GHG emission (all in CO_2e). A "levelized" cost is a "present value average" used in a variety of financial cost applications.

- Time period of analysis: Count the impacts of actions that occur during the project time period and, using levelized emissions reduction and cost analysis, report emissions reductions and costs for 2020. Where additional GHG reductions or costs occur beyond the project period as a direct result of actions taken during the project period, show these for comparison and potential inclusion.

- Aggregation of cumulative impacts of recommendations: In addition to "stand alone" results for each recommendation, estimate cumulative impacts of all recommendations combined. In this process avoid simple double counting of GHG reduction potential and cost when adding emission reductions and costs associated with all of the recommendations. Note and/or estimate interactive effects between recommendations using simple analytical methods where overlap is likely.

- Recommendation design specifications and other key assumptions: Include assumptions on timing, goal levels, implementing parties, types of implementation mechanism, and other key assumptions as determined by New Jersey.

- Transparency: Clearly identify recommendation design choices (above) as well as data sources, methods, key assumptions, and key uncertainties. Use data and comments provided by New Jersey to ensure best available data sources, methods, and key assumptions using their expertise and knowledge to address specific issues in New Jersey. Modifications will be made through decisions with New Jersey technical experts, as needed, to improve analysis.

All projections of future emissions, costs, and cost savings are subject to uncertainty, the key source of which is the uncertainty associated with the data inputs and assumptions. Due to constraints on time and resources, we elected to present point estimates of the future values of emissions, costs and cost savings, and other factors rather than attempt to do a formal uncertainty analysis. It should also be noted that our results are in the nature of projections rather than forecasts, the difference being that the former trace out the logical effects of given assumptions on the future, while the latter make explicit predictions about future states of affairs. New Jersey's future emissions reductions, costs, and cost savings will probably differ from those portrayed in this report, and the differences could be significant. Nonetheless, we believe that our results provide a reasonable basis for decision making, especially when taken as indicators of direction of change (increase or decrease), algebraic sign (positive or negative), and order of magnitude.

For additional reference see the economic analysis guidelines developed by the Science Advisory Board of the US EPA available at:
http://yosemite.epa.gov/ee/epa/eed.nsf/webpages/Guidelines.html.

Chapter 2
Green Buildings for the Residential and Commercial Sectors

Introduction

Two supporting recommendations for implementing “Green Building” initiatives to mitigate direct-energy use and GHG emissions by the residential and commercial sectors were analyzed for their emission reductions and costs / savings. The two recommendations are designed to be incremental to core recommendations included in New Jersey’s Energy Master Plan (EMP). The recommendations analyzed include:

- GB-1 - Develop and facilitate the use of a State Green Building Standard for all New Residential and Commercial Buildings through existing and emerging state programs; and
- GB-2 - Develop and facilitate State Green Building Remodeling, Operations and Maintenance Program for all Existing Residential and Commercial Buildings through existing and emerging state programs.

Table 2.1 summarizes the estimated GHG emission reductions and costs (savings) for each recommendation. The remainder of this chapter provides information on the parameters for analysis, methods, data sources, and assumptions used to prepare the analysis for each of the supporting recommendations.

Table 2.1. Estimated GHG Emission Reductions and Net Costs (or Cost Savings)

No.	Supporting Recommendation Name	Annual Results (2020)		Cumulative Results (2009-2020)		
		GHG Reductions ($MMtCO_2e$)	Costs (Million $)	GHG Reductions ($MMtCO_2e$)	Costs (NPV, Million $)	Cost-Effectiveness ($\$/tCO_2e$)
GB-1	Green Buildings – New	1.73	-$68	9.84	-$299	-$30.4
	Residential (Subtotal)	1.38	-$54	7.84	-$239	-$30.4
	Commercial (Subtotal)	0.35	-$14	2.00	-$61	-$30.4
GB-2	Green Buildings – Existing	2.14	-$217	12.17	-$877	-$72.0
	Residential (Subtotal)	1.72	-$176	9.77	-$711	-$72.8
	Commercial (Subtotal)	0.42	-$41	2.40	-$165	-$69.0
Sector Total (No adjustments for overlaps needed)		**3.87**	**-$285**	**22.0**	**-$1,176**	**-$53.4**

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $\$/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent; NPV = net present value.

Costs are discounted to year 2009 in 2007 dollars using a 3% real discount rate. Negative values in the Cost and the Cost-Effectiveness columns represent net cost savings.

The numbering used to denote the above recommendations is for reference purposes only; it does not reflect prioritization among the recommendations.

Design of Recommendations

For new buildings (GB-1), the goal is for the State of New Jersey to develop and facilitate the use of a State Green Building Standard for all New Residential and Commercial Buildings through existing and emerging state programs. In anticipation of the release of the New Jersey's Green Building Manual in the Summer of 2010, which will be used by State agencies to identify specific actions to incorporate into regulatory and / or incentive-based programs to facilitate new and existing green buildings, the next 18 months will be used to build capacity in the emerging green building industry in New Jersey.

For existing buildings (GB-2), the goal is for the State of New Jersey to develop and facilitate State Green Building Remodeling, Operation, and Maintenance Programs for all Existing Residential and Commercial Buildings through existing and emerging state programs. In anticipation of the release of the New Jersey's Green Building Manual in the Summer of 2010, which will be used by State agencies to identify specific actions to incorporate into regulatory and / or incentive-based programs to facilitate new and existing green buildings, the next 18 months will be used to build capacity in the emerging green building industry in New Jersey.

Analytical Approach and Data Sources

A spreadsheet model developed to analyze a similar policy for the state of Maryland was modified to incorporate New Jersey-specific data sources and assumptions to estimate GHG emission reductions, costs and cost savings, and the cost-effectiveness of the green building recommendations for New Jersey.[2] The modifications to the spreadsheet model include the following:

Emission Reductions:

- The timing and level of future building codes were determined.
- The compliance rate of new and renovated homes and buildings to the new building codes was assumed.
- Total energy savings from the new building codes were computed based on the number of participating buildings, average energy use per building, and energy saving rates resulted from the new building codes.
- The total energy savings were broken out by electricity and natural gas.
- The GHG emission reductions were calculated by using the emission factors of electricity and natural gas.

Savings:

- This is computed by multiplying energy savings of electricity and natural gas by the avoided delivered cost of electricity and natural gas, respectively, and then adding them together.

[2] The spreadsheet model is based on the model developed to analyze the impacts associated with RCI-1 (Improved Building and Trade Codes and Beyond-Code Building Design and Construction in the Private Sector) adopted by the Maryland Climate Change Commission and included in the Maryland Climate Action Plan, see Appendix D-3 for details, August 2008, http://www.mde.state.md.us/assets/document/Air/ClimateChange/Appendix_D_Mitigation.pdf.

Costs:

- Average construction cost of a New Jersey home or commercial building was calculated.
- The incremental costs for new and renovated buildings from future building code improvements as percentages of the average construction cost were assumed.
- The total incremental costs were computed by multiplying the costs for an individual building by the total number of participating buildings.

The analyses of the "Green Building" recommendations are designed to be incremental to the building codes policy in the New Jersey's EMP. Table 2.1 shows the energy efficiency goals of the improved building codes in the EMP and the incremental goals included in the analysis of GB-1/GB-2.

Table 2.1. Energy Efficiency Goals of Improved Building Codes in New Jersey Energy Master Plan and in GB-1/GB-2

	New Jersey 's Energy Master Plan	GB-1/GB-2	LEED
New (vs. Code)	30%	10-20% (incremental to EMP)	40-50%
Existing (vs. actual)	20%	10-20% (incremental to EMP)	30-40%

Table 2.2 presents the key assumptions used to compute the emission reductions and associated savings. Table 2.3 presents the key assumptions used to compute the costs.

Table 2.2. Key Assumptions for the Calculation of Emission Reductions and Associated Savings

Assumption	Residential Sector	Commercial Sector	Notes
Number or total square feet of new homes/buildings	314,109 (2009-2020 cumulative)	158,334,633 (2009-2020 cumulative)	Residential buildings: the total "housing units authorized by building permits for new construction" in 2007 from the New Jersey Division of Codes and Standards (DCA) website (http://www.state.nj.us/dca/codes/) is used as the base year value. The numbers of new residential buildings in the forecast years are projected based on the population growth rate of New Jersey. Commercial buildings: the total square feet of new office space and retail space authorized by building permits in 2007 from the New Jersey DCA website is used as the base year value. The total square feet of new commercial buildings in the forecast years are projected based on the population growth rate of New Jersey.
Ratio of new vs. renovated homes/buildings	1.00	1.00	Assumption used in Maryland;
Building code compliance rate	100%	100%	Assumption provided by New Jersey DCA
Number or total square feet of new homes/buildings participating in building code updates	314,109 (2009-2020 cumulative)	158,334,633 (2009-2020 cumulative)	Calculated by multiplying the number or total square feet of new homes/buildings by the building code compliance rate.
Number of renovated homes/buildings participating in building code updates	314,109 (2009-2020 cumulative)	158,334,633 (2009-2020 cumulative)	Calculated by multiplying the number or total square feet of renovated homes/buildings by the building code compliance rate.
Average square footage per new/renovated building	2,438	18,339	Residential: 2008 national average square footage. Commercial: calculation of projected square footage of buildings divided by the projected number of buildings for the Middle Atlantic Region.
Average energy use for a new/renovated home/building under current building code	106,645 Btu/sq. ft./year	131,875 Btu/sq. ft./year	Residential: average residential energy use per household (from EMP) divided by average square footage per home. Commercial: average level between 2009 and 2020 (from EMP).
Percentage difference between the energy use in the new homes/buildings constructed under the current code and the average energy use in all the existing building stock.	20%	16%	Adopted the data used in the Maryland Climate Action Plan which are calculated using Gulf Coast studies on building codes.

Assumption	Residential Sector	Commercial Sector	Notes
Energy savings goals for improved building code	2010: 10% energy savings incremental to EMP 30% (new) and 20% (existing) goal 2015: 20% energy savings incremental to EMP 30% (new) and 20% (existing) goal	2010: 10% energy savings incremental to EMP 30% (new) and 20% (existing) goal 2015: 20% energy savings incremental to EMP 30% (new) and 20% (existing) goal	Assumptions provided by New Jersey Department of Environmental Protection (NJDEP).
Proportion of energy savings by fuel type	37.5% Electricity 62.5% Natural gas	37.5% Electricity 62.5% Natural gas	The percentages are computed based on the data provided by NJDEP.
Emissions factors	Electricity average (2008–2020): 0.569 tCO_2e/MWh, or the equivalent in (tCO_2/BBtu), Natural Gas: 54 tCO_2e/Bbtu		Electricity: provided by NJDEP. Natural Gas: EPA 2003 U.S. GHG inventory, Appendix A
Transmission and distribution (T&D) electricity loss	7%		Assumption for New Jersey provided by NJDEP.
Avoided energy costs (utility avoided costs)	Electricity: $28,375/BBtu (2007$) Natural Gas: $7,514/BBtu (2007$)	Electricity: $26,766/BBtu (2007$) Natural Gas: $7,744/BBtu (2007$)	The data used in the Maryland Climate Action Plan are adjusted by the ratio of delivered electricity and NG prices in Maryland and New Jersey.

Table 2.3. Key Assumptions for the Calculation of Costs

Assumption	Residential Sector	Commercial Sector	Notes
Real Discount Rate	3%		Assumption provided by NJDEP.
Capital Recovery Factor for Levelization	4.95% Interest rate: 3% Period: 30 years	4.95% Interest rate: 3% Period: 30 years	Calculated based on assumed interest rate and levelization period. The Capital Recovery Factor is used to generate equal annual capital costs.
Average Construction Cost of Home/Building	$319,698/home	$155.5/sq. ft.	Average cost per Sq. Ft. is based on national estimates from ICC and adjusted by the ratio of New Jersey to national average weekly wage in the construction sector. Average construction cost of a home is computed by multiplying the average cost per Sq. Ft. by the average square footage per home.
Incremental Costs from Building Code Improvements (as percentage of the construction cost of a Home/Building)	Existing: 2010: 2% (corresponding to 10% incremental energy savings to EMP 20% goal) 2015: 2% (corresponding to 20% incremental energy savings to EMP 20% goal) New: 2010: 2% (corresponding to 10% incremental energy savings to EMP 30% goal) 2015: 4% (corresponding to 20% incremental energy savings to EMP 30% goal)	Existing: 2010: 2% (corresponding to 10% incremental energy savings to EMP 20% goal) 2015: 2% (corresponding to 20% incremental energy savings to EMP 20% goal) New: 2010: 2% (corresponding to 10% incremental energy savings to EMP 30% goal) 2015: 4% (corresponding to 20% incremental energy savings to EMP 30% goal)	Adopted the data used in the Maryland Climate Action Plan, which are based on the incremental costs of LEED levels with equivalent energy savings.

ICC = International Code Council; LEED = Leadership in Energy and Environmental Design Green Building Rating System™.

Chapter 3
Waste Management Sector

Introduction

One supporting recommendation and two related actions for the waste sector were analyzed for their emission reductions and costs / savings. These include:

- W-1 - Improved Efficiency at Publicly Owned Wastewater Treatment Plants (POTWs);
- W-2 - Increase Municipal Solid Waste (MSW) Diversion Rate; and
- W-3 - State of the Art Guidelines for Landfill Gas (LFG) Control.

Table 3.1 summarizes the estimated GHG emission reductions and costs (savings) for each of the three supporting recommendations/related actions. The remainder of this chapter provides information on the parameters for analysis, methods, data sources, and assumptions used to prepare the analysis for each of the supporting recommendations/related actions.

Table 3.1. Total Estimated GHG Emission Reductions and Net Costs and Cost Savings for All Recommendations and Actions for the Waste Management Sector

No.	Name of Supporting Recommendation or Related Action	Annual Results (2020)		Cumulative Results (2009-2020)		
		GHG Reductions ($MMtCO_2e$)	Costs (Million $)	GHG Reductions ($MMtCO_2e$)	Costs (NPV, Million $)	Cost-Effectiveness ($\$/tCO_2e$)
W-1	Improved Efficiency at Publicly Owned Wastewater Treatment Plants (POTWs)	0.39	-$88.9	2	-$483	-$238
W-2	Increase Municipal Solid Waste (MSW) Diversion Rate	4.98	-$44.0	27.4	-$242	-$8.8
W-3	State of the Art Guidelines for Landfill Gas (LFG) Control	0.19	$0.23	1.5	$2.3	$1.5
Sector Total (No adjustments for overlaps needed)		5.56	-$133	31	-$723	-$23
Reductions From Recent Actions (i.e., 50% MSW Recycling Statutory Mandate)		2.61	-$23.1	14.4	-$127	-$8.8
Sector Total Plus Recent Actions		8.2	-$156	45.3	-$850	-$19

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $\$/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent; NPV = net present value.

Costs are discounted to year 2009 in 2007 dollars using a 3% real discount rate. Negative values in the Cost and the Cost-Effectiveness columns represent net cost savings.

The numbering used to denote the above recommendations is for reference purposes only; it does not reflect prioritization among the recommendations.

Improved Efficiency at Publicly Owned Wastewater Treatment Plants (POTWs) (W-1)

Design of Recommendation

The goal of this supporting recommendation is to provide favorable financing from the New Jersey Environmental Infrastructure Financing Program to local government units (such as municipal utilities authorities) to install energy efficiency and/or greenhouse gas (GHG) reduction measures at Publicly Owned Treatment Works (POTWs) and public water supply systems. Two states for which CCS has provided facilitation and technical support, South Carolina and Vermont, have set efficiency targets to reduce the amount of electricity at POTWs by 25%. Therefore, the goal proposed by CCS is a 25% reduction in the amount of electricity used at POTWs by 2020. A linear ramp-up between 2010 and 2020 is assumed.

POTWs will be encouraged to undertake energy audits to identify processes/equipment that can be changed or upgraded to reduce energy use and/or greenhouse gas emissions. As part of the survey discussed below, information will be provided to the POTWs regarding the local government energy audit program administered by the New Jersey Board of Public Utilities.

The Department intends to increase the practice of using anaerobic digester gases generated at POTWs for energy generation. As a first step, the Department will be conducting a survey of approximately 100 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 under what operating conditions. The Department plans to partner with selected POTWs to develop and refine case studies documenting energy savings, costs and cost savings, as well as greenhouse gas reductions for different operating scenarios. These studies will be used to demonstrate how the practice can be effectively applied across a range of POTW sizes and designs. The Department will use the energy audit data and the case study data to encourage the use of anaerobic digestion at suitable POTWs.

The Department will develop an education and outreach program to inform POTWs across the state about the effectiveness and benefits of digester gas energy recovery. The Department will also take steps to partner with groups representing the wastewater treatment sector, along with the New Jersey Board of Public Utilities in these activities.

To facilitate implementation of beneficial equipment and process changes identified in the energy audits and the case study results, the New Jersey Environmental Infrastructure Financing Program will develop a protocol to provide additional priority points for projects that incorporate measures to reduce energy usage and/or greenhouse gases at POTWs. In addition, the loan program will place 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.

Public water supply systems will be encouraged to conduct energy audits and to replace inefficient energy-consuming equipment. The New Jersey Environmental Infrastructure

Financing Program will develop protocols for providing additional priority points for projects that incorporate measures to reduce energy usage.

Analytical Approach and Data Sources

This analysis relied on data from EPA's Clean Watershed Needs Survey (CWNS).[3] The existing municipal flow for the year 2004 (1,045 MGD)[4] was used as the baseline flow rate for POTWs in New Jersey. The energy use per million gallons is determined from the median of a survey of 12 Wastewater Treatment Plants (WWTPs) (2,286 kWh/MG).[5] The annual BAU WWTP electricity consumption is estimated by taking the product of the annual municipal flow and the electricity use (in kWh/MG treated). The goal of 25% electricity use reduction is applied to the BAU WWTP electricity consumption to yield the amount of electricity avoided in 2020. The carbon intensity of New Jersey electricity production is multiplied by the electricity avoided to calculate GHG emission reductions.

The cost-effectiveness estimate is based on the aforementioned analyses completed for similar GHG mitigation recommendations in South Carolina and Vermont. The basis for the cost estimates are several case studies of various efficiency improvements at POTWs in Vermont. These case studies were updated to include 3% interest and discount rates. The energy-saving technologies considered include variable frequency drives for pumping and aeration motors, high efficiency aeration motors, improved lighting at buildings, rotary solids dewatering (as opposed to centrifugal), and implementation of anaerobic digestion for combined heat and power (where feasible). CCS extracted the per-kWh (avoided) cost of such upgrades at POTWs, as they were utilized to meet the goals set in South Carolina and Vermont. The average upgrade cost between the two states is applied to the avoided electricity in New Jersey to calculate the upgrade cost. The cost savings from avoided electricity is calculated by multiplying the energy avoided by the projected electricity prices in New Jersey (provided by NJDEP). It is assumed that there is a one year lag between the incurrence of upgrade cost and the realization of GHG emission reductions.

These key data inputs, including the assumed New Jersey electricity carbon intensity and electricity prices, are presented in Table 3.2. The electricity carbon intensity is incorporated from the Electricity Sector Appendix of the New Jersey GHG Inventory and Forecast.

Results

Table 3.3 presents the projected GHG emission reductions due to improved energy efficiency at POTWs in New Jersey. The cumulative emission reductions (2010-2020) are 2.03 $MMtCO_2e$ and the annual emission reductions in 2020 are 0.39 $MMtCO_2e$. The GHG emission reductions are estimated by multiplying the kWh avoided through increased energy efficiency at POTWs by the New Jersey electricity production carbon intensity for each year.

---

[3] U.S. EPA. Clean Watersheds Needs Survey. "Select CWNS 2004 Data of Interest: Ask WATERS Simple Query Tool." Available at: http://www.epa.gov/cwns/2004data.htm.
[4] MGD – Million Gallons per Day.
[5] SBW Consulting, Inc. *Energy Benchmarking Secondary Wastewater Treatment and Ultraviolet Disinfection Processes at Various Municipal Wastewater Treatment Facilities*. San Francisco, CA: Pacific Gas and Electric Company, February 28, 2002. Available at: http://www.cee1.org/ind/mot-sys/ww/pge2.pdf.

Table 3.2. Key Data Inputs and Assumptions

Year	Electricity usage reduced through increased efficiency (kWh)	Electricity Generation Carbon Intensity (tCO_2e/MWh)	Upgrade Cost per kWh Saved (South Carolina)	Upgrade Cost per kWh Saved (Vermont)	Electricity Price ($/kWh)
2010	-	0.42	$0.00033	$0.00072	$0.13
2011	65,402,638	0.47	$0.00024	$0.00057	$0.14
2012	130,805,276	0.43	$0.00043	$0.00096	$0.14
2013	196,207,914	0.46	$0.00040	$0.00097	$0.15
2014	261,610,552	0.50	$0.00037	$0.00098	$0.15
2015	327,013,190	0.54	$0.00035	$0.00099	$0.16
2016	392,415,828	0.56	$0.00021	$0.00100	$0.16
2017	457,818,466	0.58	$0.00019	$0.00101	$0.17
2018	523,221,104	0.61	$0.00017	$0.00102	$0.17
2019	588,623,742	0.60	$0.00015	$0.00103	$0.18
2020	654,026,380	0.59	$0.00014	$0.00103	$0.19

Table 3.3. GHG Emission Reductions Associated with Improving the Energy Efficiency at POTWs

Year	GHG Emission Reductions from Avoided Electricity ($MMtCO_2e$)
2010	-
2011	0.03
2012	0.06
2013	0.09
2014	0.13
2015	0.18
2016	0.22
2017	0.27
2018	0.32
2019	0.35
2020	0.39
Total	**2.03**

The cost-effectiveness is estimated by applying the factors in Table 3.2 to the GHG emission reduction estimates in Table 3.3. Table 3.4 presents the levelized (discounted) cost results assuming a 3% discount rate. The upgrade costs are calculated by adding the levelized upgrade cost from the previous year (assumed to be zero for 2010) by the product of the average upgrade cost from the South Carolina and Vermont analyses and the kWh saved in the previous year. This is done to implement the assumption that there is a one year lag between the incurrence of upgrade costs and the accrual of GHG emission reductions from that expenditure.

Table 3.4. Levelized (Discounted) Cost of Improved Energy Efficiency at POTWs

Year	GHG Emission Reductions ($MMtCO_2e$)	Upgrade Cost ($MM)	Electricity Cost Savings ($MM)	Net Program Cost ($MM)	Discounted Net Cost ($2007MM)
2010	-	$0.03	$0.00	$0.0	$0.0
2011	0.03	$0.09	$8.97	-$8.9	-$8.6
2012	0.06	$0.22	$18.56	-$18.3	-$17.3
2013	0.09	$0.40	$28.80	-$28.4	-$26.0
2014	0.13	$0.62	$39.72	-$39.1	-$34.7
2015	0.18	$0.89	$51.36	-$50.5	-$43.5
2016	0.22	$1.16	$63.75	-$62.6	-$52.4
2017	0.27	$1.48	$76.94	-$75.5	-$61.4
2018	0.32	$1.83	$90.95	-$89.1	-$70.4
2019	0.35	$2.21	$105.84	-$103.6	-$79.4
2020	0.39	$2.21	$121.65	-$119.4	-$88.9
Total	**2.03**	**$11.12**	**$607**	**-$595**	**-$483**
				Cost-Effectiveness ($/tCO₂e)	**-$238**
				2020 Cost-Effectiveness ($/tCO₂e)	**-$229**

Increase Municipal Solid Waste (MSW) Diversion Rate (W-2)

Design of Action

This related action is designed to achieve the statutorily required 50% MSW diversion goal and exceed the goal to achieve a 70% MSW recycling rate by 2020,[6] with an ultimate goal of zero waste production by 2050. According to the most recent county-level recycling statistics documented on the NJDEP website, the 2006 MSW diversion rate was about 36%, not including bulky waste (i.e., Class B recyclables, C&D waste). CCS utilized the estimates in the material-specific recycling statistics document to develop a waste characterization profile for New Jersey. This step was necessary to generate inputs for the EPA Waste Reduction Model (WARM), which was used to estimate GHG emission reductions.

The 50% diversion target is statutorily required, but was not included in the business-as-usual scenario. The quantification of this related action will therefore assess the GHG emission reduction and cost-effectiveness implications of the 50% BAU target, as compared to the baseline recycling rate. Additionally, this assessment will estimate the GHG emission reductions and cost-effectiveness of the 70% target diversion rate, as compared to both the baseline diversion rate and the 50% BAU target. The goal of zero waste by 2050 is not quantified.

The achievement of the aforementioned diversion targets is dependent on the implementation of several policy, funding, and outreach mechanisms, many of which have already been identified and implemented by NJDEP. For example, the New Jersey Solid Waste Management Act (NJSA 13:1E-1 et. seq.), and New Jersey Statewide Mandatory Source Separation and Recycling Act (NJSA 13:1E-99.11 et. seq.) establish a regulatory system of statewide oversight of county-level plans to manage solid waste and recycling programs. Substantial funding will also be necessary for the construction and operation of additional materials recovery facilities (MRF) and additional recyclable and compostable waste collection efforts. The Recycling Enhancement Act (REA) provides approximately $20 million annually to counties and municipalities for recycling assistance. The NJDEP will utilize recycling research or demonstration, education and professional training money contained in the REA fund to focus on those activities that will maximize the GHG emissions 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.

[6] "Diversion" is equal to the sum of MSW recycled plus MSW composted. New Jersey DEP considers composting to be a form of recycling. Therefore, recycling and composting will not be considered separately in this analysis. Source reduction, also a method of waste diversion, is not considered in this analysis.

Analytical Approach and Data Sources

The key source of data for the New Jersey baseline waste management scenario was the "New Jersey Generation, Disposal and Recycling Statistics" webpage.[7] The "Generation, Disposal and Recycling Rates by County" 2006 data file was used to determine both the baseline diversion rate and the breakdown of waste diverted and disposed. The total amount of waste generated was multiplied by 0.50 and 0.70 to determine the tonnage of waste diverted under the two scenarios, respectively.

The 2006 baseline breakdown of waste generated and diverted, by material (from the "Material Specific Recycling Rates" data set),[8] was applied to the tonnages under the BAU and policy scenarios. The resulting material-specific MSW characterization was entered into EPA's Waste Reduction Model (WARM) in order to determine the GHG emission reductions above the baseline (2006) waste management scenario.[9] A linear ramp-up is assumed from zero incremental diversion in 2010 through full implementation of each scenario in 2020.
The cost-effectiveness estimate is based on the average cost-effectiveness of waste diversion GHG mitigation recommendations from several other states assisted by CCS. In each of the selected reference state-level analyses, similar cost and revenue variables were considered in the quantitative assessment of the recommendations. These analyses have been updated to reflect a 3% discount rate for costs and savings and a 3% real interest rate for capital costs. The cost variables include capital and operation cost for additional MRF or composting capacity and additional curbside collection cost. The revenue variables include avoided landfill tipping fees and revenue from recycled or composted materials. It is known that some costs may be borne in 2010 in order to yield emission reductions beginning in 2011. However, the approach of applying cost-effectiveness estimates from other states does not allow for costs to be counted for years in which zero GHG reductions accrue.

Table 3.5 shows the total levelized net cost ($2007 NPV) of GHG mitigation recommendations in the reference analyses using a 3% discount rate. As the data in this table show, waste diversion measures in other states assisted by CCS have presented a net cost savings. The average cost-effectiveness ($2007/t$CO_2$e) of these states is applied to the GHG emission reduction estimate to yield the estimated cost-effectiveness of the New Jersey related action.

---

[7] New Jersey Department of Environmental Protection. "New Jersey Generation, Disposal, and Recycling Statistics: 2006 Generation, Disposal and Recycling Rates by County." Available at: http://www.state.nj.us/dep/dshw/recycle/stats.htm.

[8] New Jersey Department of Environmental Protection. "New Jersey Generation, Disposal, and Recycling Statistics: 2006 Material Specific Recycling Rates." Available at: http://www.state.nj.us/dep/dshw/recycle/ stats.htm.

[9] U.S. Environmental Protection Agency. WAste Reduction Model (WARM)." Version 8, May 2006. Available at: http://www.epa.gov/climatechange//wycd/waste/calculators/WARM_home.html. EPA created WARM to help solid waste planners and organizations track and voluntarily report GHG emission reductions from several different waste management practices. WARM is available as a web-based calculator and as a Microsoft Excel spreadsheet. WARM calculates and totals GHG emissions of baseline and alternative waste management practices—source reduction, recycling, combustion, composting, and landfilling. The model calculates emissions in tCe, tCO_2e, and energy units (MMBtu) across a wide range of material types commonly found in MSW. For an explanation of the methodology, see the EPA report *Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks*, EPA530-R-02-006, May 2002. Available at: http://epa.gov/climatechange/wycd/waste/SWMGHGreport.html.

The cumulative emission reductions and cost-effectiveness values in Table 3.5 are based on the projected life-cycle emission reductions of the recycling GHG mitigation recommendations in each state. In Michigan, the Climate Action Council chose to report only in-state emissions in the final summary table (e.g., direct emissions from landfills and waste combustion), which is why the results in that report differ from those reported in Table 3.5.[10] The nature of recycling as a mitigation strategy is such that most of the GHG emission reductions are indirect (i.e., emissions avoided due to reduced extraction of raw materials and energy consumption during manufacturing of the products and packaging that are not needed due to recycling). These indirect GHG emission reductions may or may not take place within a given state's borders, as it is very difficult to model the entire manufacturing supply chain for all materials recycled in a given state). Therefore, the only emissions that are known to be reduced in-state through recycling are the direct emissions from MSW landfills. Based on the WARM outputs, the MSW landfill emission reductions are much smaller than the indirect emission reductions. The total cost of recycling is the same regardless of the estimated emission reductions. Therefore, the absolute value of the cost-effectiveness estimate will be much higher when only in-state emission reductions are counted.

Table 3.5. Reference Case Analytical Results of State GHG Mitigation Recommendations

State	Cumulative Emission Reductions ($MMtCO_2e$)	Analysis Period (years)	Avg. Annual GHG Emission Reduction ($MMtCO_2e/yr$)	NPV (3% Discount Rate) ($MM)	Cost-Effectiveness (3% Discount Rate) ($/$tCO_2e$)
Arkansas	35.8	15	2.4	-$360	-$10.0
Iowa	26.5	10	2.6	-$264	-$10.0
Maryland	183.7	10	18.4	-$1,309	-$7.1
Michigan	313.8	15	20.9	-$4,090	-$13.0
Pennsylvania	65.06	15	4.3	-$615	-$9.5
South Carolina	20.1	10	2.0	-$68	-$3.4
				Average Cost-Effectiveness	**-$8.8**

Results

Table 3.6 presents the projected GHG emission reductions due to an increase above the baseline waste diversion practices in New Jersey. The cumulative emission reductions (2010-2020) of the 50% (BAU) scenario are 14.4 $MMtCO_2e$ and the annual emission reductions in 2020 are 2.61 $MMtCO_2e$. The cumulative emission reductions of the 70% (policy) scenario are 41.8 $MMtCO_2e$ and the annual emission reductions in 2020 are 7.60 $MMtCO_2e$. The difference between the BAU and policy scenario (identified as GHG Emission Reductions Incremental to BAU) represents the potential GHG emission reduction due to achieving the 70% goal, as compared to the statutorily required 50% diversion rate goal.

[10] Michigan Climate Action Council, Michigan Climate Action Plan, MCAC Final Report - March 2009, see Appendix J for Agriculture, Forestry, and Waste Management Policy Recommendations, http://www.miclimatechange.us/stakeholder.cfm.

Table 3.6. GHG Emission Reduction from Additional Waste Diversion

Year	Incremental GHG Emission Reductions - 50% Diversion Rate ($MMtCO_2e$)	Incremental GHG Emission Reductions - 70% Diversion Rate ($MMtCO_2e$)	GHG Emission Reductions Incremental to Recent Action (50% Diversion Rate) ($MMtCO_2e$)
2010	-	-	-
2011	0.26	0.76	0.50
2012	0.52	1.52	1.00
2013	0.78	2.28	1.50
2014	1.04	3.04	1.99
2015	1.31	3.80	2.49
2016	1.57	4.56	2.99
2017	1.83	5.32	3.49
2018	2.09	6.08	3.99
2019	2.35	6.84	4.49
2020	2.61	7.60	4.98
Total	**14.4**	**41.8**	**27.4**

The cost-effectiveness of waste diversion under the two New Jersey scenarios is estimated by applying the average cost-effectiveness from the reference analysis in Table 3.5 to the GHG emission reduction estimates in Table 3.6. Table 3.7 presents the levelized (discounted) cost results assuming a 3% discount rate.

Table 3.7. Levelized (Discounted) Cost of Additional Waste Diversion

Year	Levelized Annual Cost - 50% Diversion Rate (million $2007)	Levelized Annual Cost - 70% Diversion Rate (million $2007)	Levelized Annual Cost - Incremental to Recent Action (million $2007)
2010	$0.0	$0.0	$0.0
2011	-$2.3	-$6.7	-$4.4
2012	-$4.6	-$13.4	-$8.8
2013	-$6.9	-$20.1	-$13.2
2014	-$9.2	-$26.8	-$17.6
2015	-$11.5	-$33.6	-$22.0
2016	-$13.8	-$40.3	-$26.4
2017	-$16.2	-$47.0	-$30.8
2018	-$18.5	-$53.7	-$35.2
2019	-$20.8	-$60.4	-$39.6
2020	-$23.1	-$67.1	-$44.0
Total ($2007 NPV)	**-$127**	**-$369**	**-$242**

State of the Art Guidelines for Landfill Gas (LFG) Control (W-3)

Design of Action

The Department will propose State of the Art (SOTA) guidelines for LFG control pursuant to N.J.A.C 7:27C 8.12 and 22.35., and is also planning to propose amendments to the design standards and construction requirements for sanitary landfills gas collection and venting systems. This analysis addresses the control of methane at landfill sites that currently are not required to collect and control LFG and are currently venting methane.

Analytical Approach and Data Sources

Data were provided by NJDEP on current LFG control and utilization in the state.[11] These data included whether the site currently collected and utilized its LFG for energy purposes, collected and controlled via flaring, vented LFG with passive vents, or was currently not controlled nor vented. This analysis focused on the sites with passive vents (19 sites). For each site, NJDEP provided information on the waste in place, year opened, year closed, estimated methane (CH_4) generated, and estimated CH_4 emitted.

Of the 19 sites, 10 sites that were closed after 1980 were selected for analysis, since the older sites could be getting toward the end of their life in terms of methane generation. It was assumed that 50% of the methane emitted from each site could be collected by the vents and would be combusted via the use of solar flares attached to each vent. This might appear to be a conservatively low assumption; however, the US EPA considers the default collection efficiency for active LFG collection at non-state of the art sites to be 75%.[12] Passive vents are likely to be less efficient at gas collection than an active gas collection system. Solar flares consist of a stand-alone unit at each vent of a small open flare that is assisted by spark ignition powered by a battery and solar panel. In addition to this equipment, it was assumed that a thermocouple and data logger would be needed for each flare (for monitoring purposes to assure that the flare is always operational).

For each site, the surface area of the landfill was obtained from NJDEP's website.[13] For one of the 10 sites assessed, the area had to be estimated using the average area per cubic yard of waste in place. Typical LFG design of passive vents suggests a minimum of 1 vent per acre of landfill surface. Information on the cost of solar flares was taken from the list sheet for Solar Spark Vent Flares™ sold by Landfill Service Incorporated (www.landfill.com). The cost of each solar flare, data logger and thermocouple is estimated to be $4,050. Installation and maintenance costs were not readily available but are estimated at $300 each for installation and $15,600 per landfill site

[11] B. Kettig, NJDEP, personal communication with S. Roe, CCS, June 2009.
[12] US EPA, AP-42 Section 2.4, http://www.epa.gov/ttn/chief/ap42/ch02/draft/d02s04.pdf.
[13] http://www.state.nj.us/dep/dshw/lrm/landfill.htm.

annually for maintenance.[14] Estimates of equipment life were not available but were assumed to be 15 years.

Results

Table 3.8 provides an overall summary of the reductions and costs for this recommendation. The cost-effectiveness was estimate to be less than $2/t$CO_2$e. The recommendation is estimated to achieve 0.19 MMtCO_2e of GHG reductions annually by 2020.

Table 3.8. Landfill Gas Mitigation from Passively Vented Sites

Year	GHG Reductions (tCO_2e)	Capital Costs ($)	Maintenance Costs ($)	Annualized Capital Costs ($)	Total Annual Costs ($)	Discounted Costs (2007$)
2010	-	$419,411	$31,200	$35,133	$66,333	$60,704
2011	37,750	$419,411	$62,400	$70,265	$132,665	$117,871
2012	75,500	$419,411	$93,600	$105,398	$198,998	$171,657
2013	113,249	$419,411	$124,800	$140,531	$265,331	$222,210
2014	150,999	$419,411	$156,000	$175,663	$331,663	$269,672
2015	188,749	$0	$156,000	$175,663	$331,663	$261,818
2016	188,749	$0	$156,000	$175,663	$331,663	$254,192
2017	188,749	$0	$156,000	$175,663	$331,663	$246,789
2018	188,749	$0	$156,000	$175,663	$331,663	$239,601
2019	188,749	$0	$156,000	$175,663	$331,663	$232,622
2020	188,749	$0	$156,000	$175,663	$331,663	$225,846
2021	188,749	$0	$156,000	$175,663	$331,663	$219,268
2022	188,749	$0	$156,000	$175,663	$331,663	$212,882
2023	188,749	$0	$156,000	$175,663	$331,663	$206,682
2024	188,749	$0	$156,000	$175,663	$331,663	$200,662
2025	188,749	$0	$156,000	$175,663	$331,663	$194,817
2026	188,749	$0	$124,800	$140,531	$265,331	$151,314
2027	188,749	$0	$93,600	$105,398	$198,998	$110,180
2028	188,749	$0	$62,400	$70,265	$132,665	$71,314
2029	188,749	$0	$31,200	$35,133	$66,333	$34,619
2030	188,749	$0	$0	$0	$0	$0
Total (2010-2030)	**3,397,481**					**$3,704,720**
Total (2010-2020)	**1,509,992**					**$2,302,983**
2020 CE =	**$1.53**	**$2007/t$CO_2$e**	**3% Discount Rate**			

Note: assumes that 50% of the methane emitted is available for collection; also assumes one vent per acre based on an estimate of the average surface area per cubic yard of waste.

[14] Installation costs assume 4 man-hours each @ $75/hr. Maintenance costs assume 8 hours per site for each bi-monthly visit to assure proper operation and $75/hr.

Chapter 4
Control of Highly Warming Gases from Commercial and Industrial Refrigeration and Air Conditioning

Introduction

This supporting recommendation involves developing a state regulation establishing a Leak Detection and Repair (LDAR) program for highly warming gases used in commercial and industrial refrigeration equipment that exceed a threshold size.

Table 4.1 summarizes the estimated GHG emission reductions and costs for this recommendation. The remainder of this chapter provides information on the parameters for analysis, methods, data sources, and assumptions used to prepare the analysis for this supporting recommendation.

Table 4.1. Estimated GHG Emission Reductions and Net Cost Savings

No.	Supporting Recommendation Name	Annual Results (2020)		Cumulative Results (2009-2020)		
		GHG Reductions ($MMtCO_2e$)	Costs (Million $)	GHG Reductions ($MMtCO_2e$)	Costs (NPV, Million $)	Cost-Effectiveness ($\$/tCO_2e$)
HWG-1	Reducing HWG emissions from commercial and industrial refrigeration and air conditioning equipment	1.05	-$1.3	9.4	-$14	-$1.5
Sector Total (No adjustments for overlaps needed)		1.05	-$1.3	9.4	-$14	-$1.5

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $\$/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent; NPV = net present value.

Costs are discounted to year 2008 in 2007 dollars using a 3% real discount rate. Negative values in the Cost and the Cost-Effectiveness columns represent net savings.

Design of Recommendation

This recommendation would essentially extend many of the current federal requirements for Ozone Depleting Substances (ODSs) under Title VI of the federal Clean Air Act to cover hydrofluorocarbons (HFCs), which are used as replacements for ODSs but are currently not regulated under Title VI. The commercial and industrial refrigeration sector in New Jersey is projected to release 2.09 $MMtCO_2e$ in 2020, which will account for 1.35% of total Statewide releases of greenhouse gases (GHGs) in that year (based on 2020 BAU without projected reductions).

Analytical Approach and Data Sources

The analysis for this action is based on a similar analysis undertaken by staff of the California Air Resources Board (ARB).[15] The ARB analysis drew on data from a survey of 26,000 California businesses with HFC-emitting refrigeration systems; cost data from the survey are summarized in Table 4.2.[16] ARB staff divided survey respondents into three categories based on the size of their refrigeration systems; larger facilities tended to have fewer but larger systems than small or medium facilities.

Most of the costs shown in Table 4.2 vary with the number of systems for which HFC leaks are to be detected and repaired; a few costs depend solely on the size of the facility. The bulk of the facilities surveyed were small or medium-sized. Overall, the average facility had an annual cost (including amortization of capital costs) of just under $1,700 before savings on refrigerant and net savings of just under $500 net of refrigerant savings.

The total annual cost for the HFC-only facilities came to about $44 million. That cost would be offset in part by the savings on HFC refrigerant compounds due to earlier leak detection and repair, estimated by ARB staff at $56.8 million annually, leaving a net savings of $12.8 million.

ARB staff estimated that the 26,000 HFC-emitting facilities emit a total of about 14.3 $MMtCO_2e$ annually, and that about half of that or 7.2 $MMtCO_2e$ could be avoided through the proposed LDAR program. Based on a net savings statewide of $12.8 million, the savings per metric ton comes to about $1.79. That figure will vary as the price of HFC refrigerants fluctuates on the world market.

As noted above, it is projected that by 2020 under a BAU scenario, New Jersey's HFC-emitting facilities will emit some 2.09 million $MtCO_2e$, or about 15% of California's statewide emissions. Assuming that half of New Jersey's HCF emissions can be avoided through an LDAR program comparable to that proposed by ARB, about 1.045 million $MtCO_2e$ could be avoided. At $1.79 per Mt, the total net savings of a New Jersey LDAR program for HFCs would come to about $1.87 million.

The annual projected emissions from the New Jersey HFC-emitting facilities between 2009 and 2020 are computed by interpolating between the emission level in 2004 (0.58 million $MtCO_2e$) and the 2020 projected emission level before reductions of 2.09 million $MtCO_2e$. It is assumed that half of the annual emissions can be avoided through the program at the savings of $1.79 per metric ton. All costs were discounted to 2008 using an annual discount rate of 3%.

[15] California Air Resources Board , High-GWP Refrigerant Management Program for Stationary Sources, Refrigerant Management Program, Presentation at Technical Workgroup Meeting, Sacramento, July 7, 2009.
[16] Other facilities had ODS-emitting refrigeration systems already covered under Title VI.

Table 4.2. CA HWG Leak Detection and Repair Program and Extrapolation to NJ (HFC-Emitting Refrigeration Systems Only)

Annual CA LDAR Costs	HFC only
Periodic inspections or audits	$19,700,000
Leak repair (incl. refrigerant recharge)	10,200,000
Annual reporting/recordkeeping costs	6,400,000
Equipment (amortized) & maintenance	5,700,000
Annual implementation fees	2,000,000
Total gross cost/yr	**44,000,000**
Annual savings on refrigerant (net)	56,800,000
Total net cost/year	**-12,800,000**
Total CA facilities subject to rule	26,000
Gross cost (savings)/facility/yr	$1,692
Net cost (savings)/facility/yr	-$492
Projected 2020 BAU $MtCO_2e$ (HFCs)	14,300,000
Pct. of 2020 $MtCO_2e$ avoided	50.0%
2020 $MtCO_2e$ avoided	7,150,000
Total net cost/$MTCO_2e$ avoided	**-$1.79**
Extrapolation to NJ	**HFC only**
NJ 2020 BAU $MtCO_2e$ (HFCs)	2,090,000
Pct. 2020 $MtCO_2e$ avoided	50.0%
2020 $MtCO_2e$ avoided (HFCs)	1,045,000
Total net cost/$MtCO_2e$ avoided	-$1.79
Total NJ cost (savings)	**-$1,870,769**

Chapter 5
Terrestrial Sequestration of Carbon by the Forestry and Agriculture Sectors

Introduction

Three supporting recommendations and two related actions for sequestering carbon by forest and agricultural management practices were analyzed for their emission reductions and costs. These include:

- TS-1 - Expansion of Green Infrastructure/Garden State Preservation Trust (GSPT)
- TS-2 - Forest Stewardship;
- TS-3 - No Net Loss of Forest Reforestation;
- TS-4 - Forest Canopy/Cover Requirement; and
- TS-7 - Sustainable Agriculture.

Table 5.1 summarizes the estimated GHG emission reductions and costs for each of the five recommendations or actions. The remainder of this chapter provides information on the parameters for analysis, methods, data sources, and assumptions used to prepare the analysis for each of the supporting recommendations and related actions.

Table 5.1. Total Estimated GHG Emission Reductions and Net Costs for Supporting Recommendations and Related Actions for Terrestrial Sequestration

No.	Name of Supporting Recommendation or Related Action	Annual Results (2020)		Cumulative Results (2009-2020)		
		GHG Reductions ($MMtCO_2e$)	Costs (Million $)	GHG Reductions ($MMtCO_2e$)	Costs NPV, Million $)	Cost-Effectiveness ($\$/tCO_2e$)
TS-1	Green Infrastructure	0.75	$50	4.5	$463	$103
TS-2	Forest Stewardship	0.032	$0.37	0.18	$2.9	$17
TS-3	No Net Loss of Forest Reforestation	0.004	$1.6	0.021	$11	$520
TS-4	Forest Canopy/Cover Requirement	0.35	$36	1.94	$231	$119
TS-7	Sustainable Agriculture[1]	0.019	$0.15	0.11	$1.9	$16
Sector Total (No adjustments for overlaps needed)		1.16	$88	6.7	$710	$106

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $\$/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent; NPV = net present value.

Costs are discounted to year 2009 in 2007 dollars using a 3% real discount rate.

[1] Covers just the terrestrial carbon storage (no-till cultivation) component of this plan.

The numbering used above to denote the supporting recommendations and related actions is for reference purposes only; it does not reflect prioritization among these recommendations.

Design of Recommendations and Actions

The overall purpose of these supporting recommendations and related actions is to enhance terrestrial carbon sequestration via a set of five supporting recommendations and related actions for interventions in forest and agricultural land uses, and the state's green infrastructure as a whole. In forestry, the recommendation is for expansion of the forest stewardship program to cover 4,000 acres/yr. Forest stewardship plans would be developed to identify, among others, the best mechanisms for enhancing carbon sinks in forests which currently have less-than-optimal carbon stocks (e.g., via forest stand improvement or other forest management approaches). The other forestry options are: 1) a “no net loss” reforestation program that would require all state-funded projects to replace all trees lost in areas impacted by project development; and 2) forest canopy/cover goals for development areas across the state. In agriculture, a sustainable agriculture program would expand the use of “no till” practices or other approaches to enhance levels of soil carbon, thereby indirectly sequestering carbon dioxide from the atmosphere. Finally, the continued preservation of the state's land assets would be pursued and expanded with support from the Garden State Preservation Trust (GSPT). The main component of this recommendation is the Green Acres program, which covers acquisition of conservation lands comprising the green infrastructure of forests, watersheds and wildlife habitats, freshwater wetlands, tidal marshes, and agricultural landscapes of environmental significance. A total of 10,000 acres is assumed to be acquired annually and preserved for posterity.

Analytical Approach and Data Sources

Forest Stewardship (TS-2)

The GHG emission reductions for this recommendation were estimated by assessing the carbon accumulation that would occur over a 45-yr period as forested areas with less than optimal stocking are improved by one “stocking level” as defined by the U.S. Forest Service. The targeted acreage is 4,000 acres/yr over 10 years. An estimate of the 45-yr carbon accumulation achieved by treatment of less than optimally stocked areas was taken from a recent CCS analysis for New York State Energy Research and Development Authority (NYSERDA) (0.80 tCO_2/acre-yr).

Costs assume that the emission reductions would be achieved by development of stewardship plans with oversight by New Jersey Department of Environmental Protection (NJDEP) or other state staff and that the treatment would include plantings with disease resistant species appropriate for each area. The average cost of plantings ($137/acre) was also taken from the recent work conducted for NYSERDA. The estimated GHG reductions (carbon sequestration) and cost estimates are provided in Attachment 1.

No Net Loss Program (TS-3)

The recommendation calls for achieving no net loss of forested land (e.g., at the urban fringe and along transportation corridors). The GHG emission reductions were estimated by using an

NJDEP estimate of 5.8 tCO_2e/acre-yr of net GHG emission reductions provided by urban forests. This includes both the GHG emission reductions associated with carbon sequestration as well as the energy savings provided by urban trees via shading and wind protection. The recommendation calls for trees to be either retained or an equivalent number replanted in a nearby location. Under the recommendation, an estimated 67 acres/yr would be covered. NJDEP estimated that there is an average of 204 trees/acre. The number of trees retained or planted was used along with the net GHG emission reduction estimate above to estimate GHG reductions in each year.

The length of the No Net Loss program was assumed to be through 2020; however, the emission reductions continue to accrue over the life of the urban trees covered by the program (assumed at 30 years on average). To estimate the costs of the program, CCS assumed that all of the trees would need to be replanted. Of the trees that would need to be replanted, CCS assumed that one-third would be strategically located to provide energy savings to buildings. NJDEP provided an estimate of tree replacement cost of $300 per tree. To estimate the value of energy savings, an average per-tree estimate of emissions reduction from energy savings was taken from the CCS analysis for NYSERDA (0.0034 tCO_2/yr). Most of this would be associated with shading effects which would reduce electricity consumption. Using the per-tree emission reduction estimate and the carbon content of NJ electricity (0.569 tCO_2e/MWh), an estimated energy savings of 5.98 kWh/tree-yr was derived. NJDEP provided estimates of average electricity prices (ranging from $0.112/kWh in 2005 to $0.186/kWh in 2020). Total costs in each year were the sum of the annualized tree planting and administrative costs, offset in part by the energy savings. The estimated GHG reductions and costs are provided in Attachment 2.

Forest Canopy/Cover Requirement (TS-4)

Here the program goals are to retain urban tree canopy coverage and rural forest cover in all developable areas of the state including those that are not environmentally sensitive. The targeted area for enhancing canopy cover is much larger at 30,000 acres/yr (estimate provided by NJDEP) with a goal of retaining 50% of all forest canopy/cover. As the program will cover both rural and urban areas, the same net emission reduction estimate for carbon sequestration was used here (5.8 tCO_2e/acre-yr) for the both the rural forest cover and urban forest canopy components. Key assumptions used in the analysis are that under BAU all of the trees on developed acres would be removed (NJDEP estimates an average statewide forest cover of 40% covering both rural and urban areas). GHG reductions in both the rural and urban areas were estimated using a value of 5.8 tCO_2/acre-yr provided by NJDEP as a statewide average estimate of carbon sequestration. In the urban areas, it was assumed that the replacement trees would be strategically planted to reduce energy use, resulting in energy savings (from shading and wind protection for buildings). The avoided CO_2 due to these energy savings was taken from the CCS analysis for NY (0.0034 tCO_2/tree-yr).

Costs were estimated separately for rural and urban development. The break-out of lands to be developed through 2020 was assumed to be 60% urban and 40% rural. For rural costs, an estimated reforestation cost of $550/acre was used, which is the average cost estimated in the CCS analysis for NY state. For urban costs, a similar approach to that described above for the No Net Loss Program was used, except that it was assumed that all replanted trees in urban areas would be strategically placed to achieve energy savings. Based on data from 4 NJ cities, the average number of mature urban trees per acre is 45.[17] The same replanting costs as the No Net Loss Program ($300/tree) were applied. Costs for the incremental urban tree maintenance were also included, since there would be an increase in the number of trees above baseline ($8.50/tree taken from the CCS analysis for NYSERDA). The annual GHG reductions and costs are shown in Attachment 3.

Sustainable Agriculture (TS-7)

This analysis focused on achieving soil carbon gains (indirectly sequestering carbon dioxide from the atmosphere) through no till farming (the recommendation also addresses other sustainable agricultural practices that can achieve GHG emission reductions). The incremental annual cultivated area brought into continuous no-till farming targeted by NJDEP is assumed to be 3,500 acres, and the program is assumed to last for 10 years. From a similar analysis conducted by CCS for NYSERDA, it is estimated that continuous no-till practices can sequester 0.454 tCO_2/acre annually. Also, from the same analysis, there are additional GHG reductions via lower diesel fuel consumption of 0.043 tCO_2/acre-yr.

Under the program, farmers would receive an incentive of $10/acre-yr. Fuel cost savings of 3.5 gallons/acre are estimated at a current cost of $2.46/gallon (fuel costs are estimated to increase by 2.4%/yr based on data from the U.S. Department of Energy's Energy Information Administration). Total annual costs are the cost of no-till practices net of payments to farmers, fuel savings, and administrative costs. The annual GHG reductions and costs are shown in Attachment 4.

Green Infrastructure (TS-1)

This program is primarily concerned with acquisition and conservation management of priority protected landscapes and open spaces throughout the state. Sequestering these lands maintains and enhances their ecosystem functions and services, which include carbon uptake and accumulation in vegetation and soils. The GHG emission reductions (associated with carbon sequestration of lands to be conserved) were estimated following a two-step process. <u>First</u>, the typology of lands acquired under the Green Acres program was determined and the percentage share of each type was applied to the to the total target area of lands assumed to be purchased annually (10,000 acres). The percentage composition as determined from Green Acres and GSPT program reports is as follows: 55% forestlands, 30% wetlands including tidal wetlands, 5% farmlands, and 7% others (open space, urban, barren lands). Open waters comprise 3%, but these are assumed to have no significant sequestration. <u>Second</u>, carbon removal coefficients appropriate for each land type were used to estimate the carbon sequestration to be expected from land preservation.[18] The amount of sequestration is cumulative as acreage is added every

[17] Average of 4 NJ cities (Woodbridge, Moorestown, Freehold, and Jersey City) from Nowak et al, "A Ground-Based Method of Assessing Urban Forest Structure and Ecosystem Services", Arboriculture & Urban Forestry, 34(6): November 2008.

[18] All coefficients, except for wetlands, are from Northeast Carbon Feasibility Project ("Terrestrial Carbon Sequestration in the Northeast: Quantities and Costs". 2007, The Nature Conservancy, The Sampson Group, and Winrock International). Wetland coefficient calculated from data of the First State of Carbon Cycle Report

year through 2020. The lands continue sequestering carbon through time, at least until individual trees die (for simplicity this has been ignored since the projection only goes out to 2020).

The cost of land acquisition is assumed to average $15,000 per acre based on Green Acres data. It should be noted that the program is contingent on the re-authorization of Garden State Preservation Trust funding. Legislation is currently pending gubernatorial approval for a voter referendum on the bond issue this year, and approval of the legislation by the Governor and voters is assumed for analytic purposes. The bill proposes funding for Green Acres at the level of $218 million. At the specified cost of acquisition, the proposed funding would be exhausted in less than two years' time. Historically, however such referenda have been held every 3 to 4 years, and the 2007 bond issue will be exhausted in 2010. The current legislation does not indicate which years the bond issue covers, so the estimates assume constant annual funding will be available for 2010 to 2020 at the level of $150 million annually, i.e., 10,000 acres times $15,000 per acre.

Based on the foregoing assumptions, the NJDEP estimates that a total of about 4.5 million metric tons of CO_2 equivalents would be sequestered from 2010 through 2020 (see Tables 5.2 and 5.3). The annual cost of $150 million is discounted to 2009 using an annual discount rate of 3%; this treatment is in keeping with that used for the other recommendations considered in this report, and it results in a present value cost (in real 2007 dollars) of about $1.3 billion. The direct cost of this related action is therefore $308 per $MtCO_2e$. The relatively high direct cost is attributable to the cost of the land being preserved. This estimated cost does ***not*** reflect the value of the ecosystem services preserved through the program.

The true economic cost of preserved land is less than the annual cost used here when the avoided cost of community infrastructure and other services (sewer, waste, water, schools, etc.) is taken into account. Certain studies indicate that preserved land requires, on a per dollar basis, from 35 to 37 cents of these services as against $1 to $1.19 for residential development[19] (Compton, 2007; American Farm Trust). This translates to a 1:3 ratio. When the avoided cost of community infrastructure services is accounted for, the actual cost of preserved land is reduced accordingly. Based on the 1:3 ratio, the actual cost is $5,000 annually. Taking this approach reduces the direct cost of this related action to $103 per $MtCO_2e$ (see Table 5.3). As in the original analysis, this cost does not reflect the value of the ecosystem services preserved through the program.

(SOCCR) The North American Carbon Budget and Implications for the Global Carbon Cycle. 2007. U.S. Climate Change Science Program.

[19] It is estimated that open space requires only 35 cents in services and that open space reduces the cost of services and Taxes (Crompton, J.L., 2004. The proximate principle: the impact of parks, open space and water features on residential property values and the property tax base). Other studies show that residential development required an average of $1.19 in municipal services vs. farmland that required only 37 cents in services (American Farmland Trust http://www.farmlandinfo.org/documents/27757/COCS_09-2007.pdf).

Table 5.2. Garden State Preservation Trust - Estimated CO_2 Storage and Sequestration (Green Acres Component Only)

			2010		2011 - 2020	Cumulative Total		
Land Type	**Share**	**Area (acres)**	**Storage (tonnes)**	**Seq (tonnes/yr**	**Same as 2010**	**Area (acres)**	**Storage (tonnes)**	**Seq (tonnes/yr**
Forest	55%	5,500	1,251,250	64,350		60,500	13,763,750	707,850
Wetland*	30%	3,000	885,000	2,100		33,000	9,735,000	23,100
Farmland	5%	500	39,500	1,650		5,500	434,500	18,150
Other	7%	700	51,100	280		7,700	562,100	3,080
Open water	3%	300	0	0		3,300	0	0
Total	**100%**	**10,000**	**2,226,850**	**68,380**		**110,000**	**24,495,350**	**752,180**
*includes tidal wetlands								
Carbon Removal Factors	**CO_2 storage**	**CO_2 seq'n**						
Land Type	*MT/acre*	*MT/acre/yr*						
Forest	227.5	11.7						
Wetland	295.0	0.7						
Farmland	79.0	3.3						
Other	73.0	0.4						
Open water	0.0	0.0						

Notes: Funding proposed for Green Acres under GSPT Bill (A3901) is $218 million. For analytic purposes, approval by Governor and voters is assumed. Historically, referenda have been held every 3 to 4 years. Since A3901 is silent on which years the bond issue covers, the above calculations assume constant annual funding will be available for 2010 - 2020.

Table 5.3. Garden State Preservation Trust - Estimated Costs (Green Acres Component Only)

Year	Assumed Expenditure*	PV Factor	PV at 3.00%	Acres Acquired	Cumulative Acreage	$MtCO_2e$ Sequestered	6.838 MT/acre/yr
2009		**1.0000**					
2010	$50,000,000	0.9709	$48,543,689	10,000	10,000	68,380	
2011	$50,000,000	0.9426	$47,129,795	10,000	20,000	136,760	
2012	$50,000,000	0.9151	$45,757,083	10,000	30,000	205,140	
2013	$50,000,000	0.8885	$44,424,352	10,000	40,000	273,520	
2014	$50,000,000	0.8626	$43,130,439	10,000	50,000	341,900	
2015	$50,000,000	0.8375	$41,874,213	10,000	60,000	410,280	
2016	$50,000,000	0.8131	$40,654,576	10,000	70,000	478,660	
2017	$50,000,000	0.7894	$39,470,462	10,000	80,000	547,040	
2018	$50,000,000	0.7664	$38,320,837	10,000	90,000	615,420	
2019	$50,000,000	0.7441	$37,204,696	10,000	100,000	683,800	
2020	$50,000,000	0.7224	$36,121,064	10,000	110,000	752,180	
	$550,000,000		**$462,631,206**	**110,000**		**4,513,080**	
			4,513,080				
			$103	**per $MtCO_2e$**			

* Net of $100 million/yr in avoided costs of development.

Results

Table 5.4 provides an overall summary of the GHG reductions and costs for the five components of the terrestrial carbon sequestration sector. Combined, these five recommendations and actions are estimated to achieve 1.16 $MMtCO_2e$ of GHG reductions annually by 2020. The overall cost-effectiveness is $106/metric ton in 2007 dollars.

Table 5.4. Annual GHG Emission Reductions and Net Costs Associated with Supporting Recommendations and Related Actions for Terrestrial Sequestration

	Forest Stewardship		No Net Loss Program		Forest Canopy/Cover Requirement		Sustainable Agriculture	
Year	Reductions	Discounted Costs	Reductions	Discounted Costs	Reductions	Discounted Costs	Reductions	Discounted Costs
2010	-	$134,458	-	$288,979	-	$2,623,603	1,740	$196,632
2011	3,200	$166,393	389	$459,863	35,351	$7,020,959	3,479	$188,266
2012	6,400	$196,353	777	$623,407	70,702	$11,144,171	5,219	$183,600
2013	9,600	$224,427	1,166	$776,807	106,052	$15,028,892	6,958	$179,046
2014	12,800	$250,698	1,554	$920,510	141,403	$18,677,864	8,698	$174,601
2015	16,000	$275,249	1,943	$1,054,945	176,754	$22,101,525	10,437	$170,263
2016	19,200	$298,158	2,332	$1,180,527	212,105	$25,309,904	12,177	$166,031
2017	22,400	$319,498	2,720	$1,297,652	247,456	$28,312,638	13,916	$161,900
2018	25,600	$339,342	3,109	$1,406,701	282,806	$31,118,984	15,656	$157,869
2019	28,800	$357,759	3,497	$1,508,041	318,157	$33,737,835	17,395	$153,935
2020	32,000	$374,815	3,886	$1,602,024	353,508	$36,177,732	19,135	$150,097
Totals	**176,000**	**$2,937,150**	**21,373**	**$11,119,457**	**19,442,944**	**$231,254,107**	**114,807**	**$1,882,238**
	TS-2 CE=	**$17**	**TS-3 CE=**	**$520**	**TS-4 CE=**	**$119**	**TS-7 CE=**	**$16**
Total 2020 Reductions =			**1,160,709**					
Cumulative GHG Reductions =			**6,769,554**					
Cumulative Discounted Costs =			**$709,824,158**					
Cost-Effectiveness =			**$106**					

Green Infrastructure (GSPT)		
	Reductions	Discounted Costs
2010	68,380	48,543,689
2011	136,760	47,129,795
2012	205,140	45,757,083
2013	273,520	44,424,352
2014	341,900	43,130,439
2015	410,280	41,874,213
2016	478,660	40,654,576
2017	547,040	39,470,462
2018	615,420	38,320,837
2019	683,800	37,204,696
2020	752,180	36,121,064
Total	**4,513,080**	**462,631,206**
	TS-1 CE=	**103**

Sensitivity Analysis

The results shown for Forest Stewardship, the No Net Loss Program, and the Forest Canopy/Cover Requirement are based on total emissions and total net present value costs through 2020. That year was chosen to make the results of these analyses comparable to those for the other supporting recommendations and related actions considered in this report. However, barring such events as disease, fire, land clearing, etc., trees are inherently long-lived assets, and therefore choosing such a relatively short time horizon understates both the emissions reductions and the costs. Because most of the implementation costs for these three programs are incurred in the early years, the net result is to overstate the cost per $MtCO_2e$ for shorter versus longer time horizons. The effect of time horizon on the cost-effectiveness of the supporting recommendations and related actions is presented in Table 5.5. As Table 5.5 shows, the cost per $MtCO_2e$ is cut roughly in half when the longer time horizon is used. While the results from the 2020 analysis are presented in Chapter 1, it is important to keep in mind the very different results that use of a longer time horizon would produce.

Table 5.5. Effect of Time Horizon on Cost-Effectiveness of Cost-Effectiveness of Supporting Recommendations and Related Actions for Terrestrial Sequestration

	Forest Stewardship	No Net Loss	Forest Canopy/Cover
2020 GHG reduction ($MtCO_2e$)	176,000	21,373	1,944,294
2020 NPV cost	$2,937,150	$11,119,457	$231,254,106
2020 $/MtCO2e	**$17**	**$520**	**$119**
Adjusted time horizon	**2065**	**2050**	**2050**
GHG reduction ($MtCO_2e$)	1,616,000	137,953	12,549,534
NPV cost	$6,753,264	$36.340,900	$860,548,793
$/MtCO₂e	**$4**	**$263**	**$69**

Attachment 1. Forest Stewardship

Year	GHG Reductions (tCO_2e)	Acres in Program	Plan Costs ($)	Admin Costs ($)	Enhanced Stocking Capital Costs ($)	Annualized Capital Costs ($)	Total Annual Costs ($)	Discounted Costs (2007$)
2010	-	4,000	$ 18,000	$ 106,576	$ 548,000	$ 22,350	$ 146,926	$ 134,458
2011	3,200	8,000	$ 36,000	$ 106,576	$ 548,000	$ 44,701	$ 187,277	$ 166,393
2012	6,400	12,000	$ 54,000	$ 106,576	$ 548,000	$ 67,051	$ 227,627	$ 196,353
2013	9,600	16,000	$ 72,000	$ 106,576	$ 548,000	$ 89,401	$ 267,977	$ 224,427
2014	12,800	20,000	$ 90,000	$ 106,576	$ 548,000	$ 111,751	$ 308,327	$ 250,698
2015	16,000	24,000	$ 108,000	$ 106,576	$ 548,000	$ 134,102	$ 348,678	$ 275,249
2016	19,200	28,000	$ 126,000	$ 106,576	$ 548,000	$ 156,452	$ 389,028	$ 298,158
2017	22,400	32,000	$ 144,000	$ 106,576	$ 548,000	$ 178,802	$ 429,378	$ 319,498
2018	25,600	36,000	$ 162,000	$ 106,576	$ 548,000	$ 201,152	$ 469,728	$ 339,342
2019	28,800	40,000	$ 180,000	$ 106,576	$ 548,000	$ 223,503	$ 510,079	$ 357,759
2020	32,000	44,000	$ 198,000	$ 106,576	$ 548,000	$ 245,853	$ 550,429	$ 374,815
2021	32,000	44,000	$ -	$ -	$ -	$ 245,853	$ 245,853	$ 162,538
2022	32,000	44,000	$ -	$ -	$ -	$ 245,853	$ 245,853	$ 157,804
2023	32,000	44,000	$ -	$ -	$ -	$ 245,853	$ 245,853	$ 153,207
2024	32,000	44,000	$ -	$ -	$ -	$ 245,853	$ 245,853	$ 148,745
2025	32,000	44,000	$ -	$ -	$ -	$ 245,853	$ 245,853	$ 144,413
2026	32,000	44,000	$ -	$ -	$ -	$ 245,853	$ 245,853	$ 140,207
2027	32,000	44,000	$ -	$ -	$ -	$ 245,853	$ 245,853	$ 136,123
2028	32,000	44,000	$ -	$ -	$ -	$ 245,853	$ 245,853	$ 132,158
2029	32,000	44,000	$ -	$ -	$ -	$ 245,853	$ 245,853	$ 128,309
2030	32,000	44,000	$ -	$ -	$ -	$ 245,853	$ 245,853	$ 124,572
2031	32,000	44,000	$ -	$ -	$ -	$ 245,853	$ 245,853	$ 120,943
2032	32,000	44,000	$ -	$ -	$ -	$ 245,853	$ 245,853	$ 117,421
2033	32,000	44,000	$ -	$ -	$ -	$ 245,853	$ 245,853	$ 114,001
2034	32,000	44,000	$ -	$ -	$ -	$ 245,853	$ 245,853	$ 110,680
2035	32,000	44,000	$ -	$ -	$ -	$ 245,853	$ 245,853	$ 107,457
2036	32,000	44,000	$ -	$ -	$ -	$ 245,853	$ 245,853	$ 104,327
2037	32,000	44,000	$ -	$ -	$ -	$ 245,853	$ 245,853	$ 101,288
2038	32,000	44,000	$ -	$ -	$ -	$ 245,853	$ 245,853	$ 98,338
2039	32,000	44,000	$ -	$ -	$ -	$ 245,853	$ 245,853	$ 95,474
2040	32,000	44,000	$ -	$ -	$ -	$ 245,853	$ 245,853	$ 92,693
2041	32,000	44,000	$ -	$ -	$ -	$ 245,853	$ 245,853	$ 89,993
2042	32,000	44,000	$ -	$ -	$ -	$ 245,853	$ 245,853	$ 87,372
2043	32,000	44,000	$ -	$ -	$ -	$ 245,853	$ 245,853	$ 84,827
2044	32,000	44,000	$ -	$ -	$ -	$ 245,853	$ 245,853	$ 82,357
2045	32,000	44,000	$ -	$ -	$ -	$ 245,853	$ 245,853	$ 79,958
2046	32,000	44,000	$ -	$ -	$ -	$ 245,853	$ 245,853	$ 77,629
2047	32,000	44,000	$ -	$ -	$ -	$ 245,853	$ 245,853	$ 75,368
2048	32,000	44,000	$ -	$ -	$ -	$ 245,853	$ 245,853	$ 73,173
2049	32,000	44,000	$ -	$ -	$ -	$ 245,853	$ 245,853	$ 71,042
2050	32,000	44,000	$ -	$ -	$ -	$ 245,853	$ 245,853	$ 68,972
2051	32,000	44,000	$ -	$ -	$ -	$ 245,853	$ 245,853	$ 66,963
2052	32,000	44,000	$ -	$ -	$ -	$ 245,853	$ 245,853	$ 65,013
2053	32,000	44,000	$ -	$ -	$ -	$ 245,853	$ 245,853	$ 63,119
2054	32,000	44,000	$ -	$ -	$ -	$ 245,853	$ 245,853	$ 61,281
2055	32,000	44,000	$ -	$ -	$ -	$ 245,853	$ 245,853	$ 59,496
2056	32,000	44,000	$ -	$ -	$ -	$ 201,152	$ 201,152	$ 47,261
2057	32,000	44,000	$ -	$ -	$ -	$ 178,802	$ 178,802	$ 40,786
2058	32,000	44,000	$ -	$ -	$ -	$ 156,452	$ 156,452	$ 34,648
2059	32,000	44,000	$ -	$ -	$ -	$ 134,102	$ 134,102	$ 28,834
2060	32,000	44,000	$ -	$ -	$ -	$ 111,751	$ 111,751	$ 23,328
2061	32,000	44,000	$ -	$ -	$ -	$ 89,401	$ 89,401	$ 18,119
2062	32,000	44,000	$ -	$ -	$ -	$ 67,051	$ 67,051	$ 13,193
2063	32,000	44,000	$ -	$ -	$ -	$ 44,701	$ 44,701	$ 8,539
2064	32,000	44,000	$ -	$ -	$ -	$ 22,350	$ 22,350	$ 4,145
2065	32,000	44,000	$ -	$ -	$ -	$ -	$ -	$ -
Total	1,616,000							**$ 6,753,264**
2020 Total	**176,000**							**$ 2,937,150**
2020 CE =	$ **17**	$2007/tCO2e	3% Discount Rate					

Attachment 2. No Net Loss Program

Year	GHG Reductions (tCO_2e)	Tree Planting Costs ($)	Annualized Capital Costs ($)	Trees in Place for Energy Savings	Electricity Saved per Year (kWh)	Energy Savings ($)	Admin Costs ($)	Total Annual Costs ($)	Discounted Costs (2007$)
2010	-	4,100,400	$ 209,199	4,510	0	0	$ 106,576	$ 315,775	$ 288,979
2011	389	4,100,400	$ 418,399	9,021	$ 53,903	$ 7,395	$ 106,576	$ 517,580	$ 459,863
2012	777	4,100,400	$ 627,598	13,531	$ 80,855	$ 11,474	$ 106,576	$ 722,700	$ 623,407
2013	1,166	4,100,400	$ 836,797	18,042	$ 107,807	$ 15,825	$ 106,576	$ 927,548	$ 776,807
2014	1,554	4,100,400	$ 1,045,997	22,552	$ 134,758	$ 20,462	$ 106,576	$ 1,132,111	$ 920,510
2015	1,943	4,100,400	$ 1,255,196	27,063	$ 161,710	$ 25,399	$ 106,576	$ 1,336,373	$ 1,054,945
2016	2,332	4,100,400	$ 1,464,396	31,573	$ 188,662	$ 30,651	$ 106,576	$ 1,540,320	$ 1,180,527
2017	2,720	4,100,400	$ 1,673,595	36,084	$ 215,613	$ 36,235	$ 106,576	$ 1,743,936	$ 1,297,652
2018	3,109	4,100,400	$ 1,882,794	40,594	$ 242,565	$ 42,167	$ 106,576	$ 1,947,204	$ 1,406,701
2019	3,497	4,100,400	$ 2,091,994	45,104	$ 269,517	$ 48,463	$ 106,576	$ 2,150,106	$ 1,508,041
2020	3,886	4,100,400	$ 2,301,193	49,615	$ 296,468	$ 55,143	$ 106,576	$ 2,352,626	$ 1,602,024
2021	3,886	-	$ 2,301,193	49,615	$ 296,468	$ 57,040	$ -	$ 2,244,153	$ 1,483,650
2022	3,886	-	$ 2,301,193	49,615	$ 296,468	$ 59,002	$ -	$ 2,242,191	$ 1,439,177
2023	3,886	-	$ 2,301,193	49,615	$ 296,468	$ 61,031	$ -	$ 2,240,162	$ 1,395,995
2024	3,886	-	$ 2,301,193	49,615	$ 296,468	$ 63,130	$ -	$ 2,238,063	$ 1,354,065
2025	3,886	-	$ 2,301,193	49,615	$ 296,468	$ 65,301	$ -	$ 2,235,892	$ 1,313,351
2026	3,886	-	$ 2,301,193	49,615	$ 296,468	$ 67,547	$ -	$ 2,233,646	$ 1,273,817
2027	3,886	-	$ 2,301,193	49,615	$ 296,468	$ 69,871	$ -	$ 2,231,322	$ 1,235,429
2028	3,886	-	$ 2,301,193	49,615	$ 296,468	$ 72,274	$ -	$ 2,228,919	$ 1,198,154
2029	3,886	-	$ 2,301,193	49,615	$ 296,468	$ 74,760	$ -	$ 2,226,433	$ 1,161,959
2030	3,886	-	$ 2,301,193	49,615	$ 296,468	$ 77,331	$ -	$ 2,223,862	$ 1,126,812
2031	3,886	-	$ 2,301,193	49,615	$ 296,468	$ 79,991	$ -	$ 2,221,202	$ 1,092,684
2032	3,886	-	$ 2,301,193	49,615	$ 296,468	$ 82,742	$ -	$ 2,218,451	$ 1,059,544
2033	3,886	-	$ 2,301,193	49,615	$ 296,468	$ 85,588	$ -	$ 2,215,605	$ 1,027,364
2034	3,886	-	$ 2,301,193	49,615	$ 296,468	$ 88,532	$ -	$ 2,212,661	$ 996,116
2035	3,886	-	$ 2,301,193	49,615	$ 296,468	$ 91,577	$ -	$ 2,209,616	$ 965,772
2036	3,886	-	$ 2,301,193	49,615	$ 296,468	$ 94,727	$ -	$ 2,206,466	$ 936,306
2037	3,886	-	$ 2,301,193	49,615	$ 296,468	$ 97,985	$ -	$ 2,203,208	$ 907,693
2038	3,886	-	$ 2,301,193	49,615	$ 296,468	$ 101,355	$ -	$ 2,199,838	$ 879,907
2039	3,886	-	$ 2,301,193	49,615	$ 296,468	$ 104,841	$ -	$ 2,196,352	$ 852,925
2040	3,886	-	$ 2,091,994	49,615	$ 296,468	$ 108,447	$ -	$ 1,983,547	$ 747,849
2041	3,886	-	$ 1,882,794	49,615	$ 296,468	$ 112,177	$ -	$ 1,770,617	$ 648,125
2042	3,886	-	$ 1,673,595	49,615	$ 296,468	$ 116,035	$ -	$ 1,557,560	$ 553,531
2043	3,886	-	$ 1,464,396	49,615	$ 296,468	$ 120,026	$ -	$ 1,344,369	$ 463,851
2044	3,886	-	$ 1,255,196	49,615	$ 296,468	$ 124,155	$ -	$ 1,131,042	$ 378,880
2045	3,886	-	$ 1,045,997	49,615	$ 296,468	$ 128,425	$ -	$ 917,572	$ 298,418
2046	3,886	-	$ 836,797	49,615	$ 296,468	$ 132,842	$ -	$ 703,955	$ 222,276
2047	3,886	-	$ 627,598	49,615	$ 296,468	$ 137,411	$ -	$ 490,187	$ 150,270
2048	3,886	-	$ 418,399	49,615	$ 296,468	$ 142,137	$ -	$ 276,261	$ 82,223
2049	3,886	-	$ 209,199	49,615	$ 296,468	$ 147,026	$ -	$ 62,173	$ 17,966
2050	3,886	-	$ -	49,615	$ 296,468	$ 152,083	$ -	$ (152,083)	$ (42,666)
Total	137,953								$ **36,340,900**
2020 Total	**21,373**								$ **11,119,457**
2020 CE =	$ **520**	$2007/tCO2e	3% Discount Rate						

Attachment 3. Forest Canopy/Cover Requirement								
Year	**GHG Reductions (tCO_2e)**	**Tree Replacement Cap Costs ($)**	**Annualized Cap Costs ($)**	**Energy Savings ($)**	**Urban Tree Maintenance ($)**	**Admin Costs**	**Total Annual Costs ($)**	**Discounted Costs (2007$)**
2010	-	$49,920,000	$2,546,881	$0	$0	$320,000	$2,866,881	$2,623,603
2011	35,351	$49,920,000	$5,093,763	$265,612	$2,754,000	$320,000	$7,902,151	$7,020,959
2012	70,702	$49,920,000	$7,640,644	$549,495	$5,508,000	$320,000	$12,919,149	$11,144,171
2013	106,052	$49,920,000	$10,187,526	$824,243	$8,262,000	$320,000	$17,945,283	$15,028,892
2014	141,403	$49,920,000	$12,734,407	$1,098,991	$11,016,000	$320,000	$22,971,417	$18,677,864
2015	176,754	$49,920,000	$15,281,289	$1,373,738	$13,770,000	$320,000	$27,997,550	$22,101,525
2016	212,105	$49,920,000	$17,828,170	$1,648,486	$16,524,000	$320,000	$33,023,684	$25,309,904
2017	247,456	$49,920,000	$20,375,051	$1,923,234	$19,278,000	$320,000	$38,049,818	$28,312,638
2018	282,806	$49,920,000	$22,921,933	$2,197,981	$22,032,000	$320,000	$43,075,952	$31,118,984
2019	318,157	$49,920,000	$25,468,814	$2,472,729	$24,786,000	$320,000	$48,102,085	$33,737,835
2020	353,508	$49,920,000	$28,015,696	$2,747,476	$27,540,000	$320,000	$53,128,219	$36,177,732
2021	353,508	$0	$28,015,696	$2,841,975	$27,540,000	$0	$52,713,720	$34,849,979
2022	353,508	$0	$28,015,696	$2,939,725	$27,540,000	$0	$52,615,971	$33,772,190
2023	353,508	$0	$28,015,696	$3,040,836	$27,540,000	$0	$52,514,860	$32,725,525
2024	353,508	$0	$28,015,696	$3,145,425	$27,540,000	$0	$52,410,271	$31,709,076
2025	353,508	$0	$28,015,696	$3,253,611	$27,540,000	$0	$52,302,085	$30,721,963
2026	353,508	$0	$28,015,696	$3,365,518	$27,540,000	$0	$52,190,177	$29,763,329
2027	353,508	$0	$28,015,696	$3,481,275	$27,540,000	$0	$52,074,421	$28,832,344
2028	353,508	$0	$28,015,696	$3,601,012	$27,540,000	$0	$51,954,683	$27,928,202
2029	353,508	$0	$28,015,696	$3,724,868	$27,540,000	$0	$51,830,827	$27,050,120
2030	353,508	$0	$28,015,696	$3,852,984	$27,540,000	$0	$51,702,711	$26,197,337
2031	353,508	$0	$28,015,696	$3,985,507	$27,540,000	$0	$51,570,189	$25,369,116
2032	353,508	$0	$28,015,696	$4,122,588	$27,540,000	$0	$51,433,108	$24,564,739
2033	353,508	$0	$28,015,696	$4,264,383	$27,540,000	$0	$51,291,312	$23,783,511
2034	353,508	$0	$28,015,696	$4,411,056	$27,540,000	$0	$51,144,640	$23,024,757
2035	353,508	$0	$28,015,696	$4,562,773	$27,540,000	$0	$50,992,922	$22,287,821
2036	353,508	$0	$28,015,696	$4,719,709	$27,540,000	$0	$50,835,987	$21,572,066
2037	353,508	$0	$28,015,696	$4,882,043	$27,540,000	$0	$50,673,653	$20,876,874
2038	353,508	$0	$28,015,696	$5,049,959	$27,540,000	$0	$50,505,736	$20,201,645
2039	353,508	$0	$28,015,696	$5,223,652	$27,540,000	$0	$50,332,044	$19,545,797
2040	353,508	$0	$25,468,814	$5,403,318	$27,540,000	$0	$47,605,496	$17,948,522
2041	353,508	$0	$22,921,933	$5,589,164	$27,540,000	$0	$44,872,769	$16,425,448
2042	353,508	$0	$20,375,051	$5,781,402	$27,540,000	$0	$42,133,649	$14,973,599
2043	353,508	$0	$17,828,170	$5,980,253	$27,540,000	$0	$39,387,917	$13,590,109
2044	353,508	$0	$15,281,289	$6,185,942	$27,540,000	$0	$36,635,346	$12,272,216
2045	353,508	$0	$12,734,407	$6,398,706	$27,540,000	$0	$33,875,701	$11,017,264
2046	353,508	$0	$10,187,526	$6,618,789	$27,540,000	$0	$31,108,737	$9,822,694
2047	353,508	$0	$7,640,644	$6,846,441	$27,540,000	$0	$28,334,204	$8,686,044
2048	353,508	$0	$5,093,763	$7,081,922	$27,540,000	$0	$25,551,840	$7,604,943
2049	353,508	$0	$2,546,881	$7,325,504	$27,540,000	$0	$22,761,378	$6,577,110
2050	353,508	$0	$0	$7,577,463	$27,540,000	$0	$19,962,537	$5,600,349
Totals	**12,549,534**							**$860,548,793**
			2020 CE =	**$119**	**$2007/$tCO_2e$**	**3% Discount Rate**		

Attachment 4. Sustainable Agriculture							
Year	GHG Reductions (tCO_2e)	Program Acres	Payments ($)	Admin. Costs ($)	Fuel Savings ($)	Annualized Costs ($)	Discounted Costs (2007$)
2010	1,740	3,500	$ 35,000	$ 210,000	$ 30,135	$ 214,865	$ 196,632
2011	3,479	7,000	$ 70,000	$ 210,000	$ 68,105	$ 211,895	$ 188,266
2012	5,219	10,500	$ 105,000	$ 210,000	$ 102,158	$ 212,842	$ 183,600
2013	6,958	14,000	$ 140,000	$ 210,000	$ 136,210	$ 213,790	$ 179,046
2014	8,698	17,500	$ 175,000	$ 210,000	$ 170,263	$ 214,737	$ 174,601
2015	10,437	21,000	$ 210,000	$ 210,000	$ 204,315	$ 215,685	$ 170,263
2016	12,177	24,500	$ 245,000	$ 210,000	$ 238,368	$ 216,632	$ 166,031
2017	13,916	28,000	$ 280,000	$ 210,000	$ 272,420	$ 217,580	$ 161,900
2018	15,656	31,500	$ 315,000	$ 210,000	$ 306,473	$ 218,527	$ 157,869
2019	17,395	35,000	$ 350,000	$ 210,000	$ 340,526	$ 219,475	$ 153,935
2020	19,135	38,500	$ 385,000	$ 210,000	$ 374,578	$ 220,422	$ 150,097
Total	**114,807**	**38,500**					**$ 1,882,238**
2020 CE =	**$ 16.39**	$2007/tCO2e	3% Discount Rate				

Chapter 6
Transportation and Land Use

Introduction

Six supporting recommendations or related actions for mitigating carbon by transportation and land use measures were analyzed for their emission reductions and/or costs. These include:

- TLU-1 - Facilitate Widespread use of Low-Emission and Zero-Emission Vehicles
- TLU-2 - Require Low-Carbon Fuels;
- TLU-3 - Transition to Low-Carbon Methods of Goods Movement;
- TLU-4 - Maintain Good State-of-Repair in Roads Infrastructure and Operation while mitigating greenhouse gas (GHG) Impacts;
- TLU-5 - Reduce vehicle-miles traveled (VMT); and
- TLU-6 - Double Transit Ridership and Enhance Greenhouse Commuting Programs.

Table 6.1 summarizes the estimated GHG emission reductions and costs for each of the six recommendations or actions. The remainder of this chapter provides information on the parameters for analysis, methods, data sources, and assumptions used to prepare the analysis for each of the supporting recommendations or related actions.

Overview of Analytical Approach

Analysis of transportation and land use issues is inherently complex, given the inter-relationships among transportation systems, land use, and other important aspects of societal well-being. Several issues arise in any assessment of the GHG emissions impacts associated with changes to the transportation system. The variables and assumptions used have a significant impact on the outcome. Key variables include but are not limited to (1) future growth rates for VMT, (2) average fuel prices, and (3) discount rates. Evaluation of the baseline scenario is also as important as is an evaluation of the validity of changes to the baseline.

For any specific analysis of changes to the transportation system, a number of analytical questions arise. Some of these questions include:

(1) What is the affected population?

(2) What portion of the population is affected?

(3) What is the market penetration rate for any changes to business as usual?

(4) How quickly is the population affected (i.e., is the pattern linear, exponential, or asymptotic)?

The analytic methods and the results they produce are often dependent upon professional judgments by stakeholders and the timing and sequencing of programs and projects:

(1) When do the programs start?

(2) How long is the ramp-up period?

(3) What is the shape of ramp-up period to the horizon year?

(4) What horizon year is used?

(5) Is peer group comparison data used? (e.g., data related to the size of urbanized areas, patterns of baseline development, and stages in pathway upon technology curves).

Table 6.1. Total Estimated GHG Emission Reductions and Net Costs and Cost Savings for All TLU Supporting Recommendations and Related Actions

		Annual Results (2020)		Cumulative Results (2009-2020)			
No.	**Name of Supporting Recommendation or Related Action**	**GHG Reductions ($MMtCO_2e$)**	**Costs (Million $)**	**GHG Reductions ($MMtCO_2e$)**	**Costs (NPV, Million $)**	**Cost-Effectiveness ($\$/tCO_2e$)**	**Fuel Savings (million gallons)**
1	Facilitate widespread use of low and zero emissions vehicles	4.52	$825	20.77	$2,861	$138	1,459
2	Require low carbon fuels	4.53	$991	21.74	$3,728	$171	1,727
3	Transition to low carbon methods of goods movement	1.40	-$54	8.13	-$417	-$51	686
4	Maintain good state of repair in roads infrastructure and operation while mitigating GHG impacts	0.006	-$6	0.07	-$58	-$831	8
5	Reduce vehicle-miles traveled (VMT)	3.41	-$1,445	20.48	-$9,598	-$469	1,925
6	Double transit ridership and enhance greenhouse commuting programs	0.65	n/a	3.92	n/a	n/a	337
Sector Total Before Adjusting for Overlaps		14.52	$311	75.11	-$3,484	-$46	6,142
Sector Total After Adjusting for Overlaps		12.24	$49	64.00	-$4,033	-$63	5,281

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $\$/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent; NPV = net present value; TBD = to be determined; NA = Not available.

Costs are discounted to year 2009 in 2007 dollars using a 3% real discount rate. Negative values in the Cost and the Cost-Effectiveness columns represent net cost savings.

The numbering used to denote the above supporting recommendations and related actions is for reference purposes only; it does not reflect prioritization among these recommendations.

To ensure consistent results across recommendations, common factors and assumptions are used for the following items:

- ***Independent and integrated analyses*—**Each recommendation is first analyzed individually and then addressed as part of an overall integrated analysis.
- ***Fuel costs and projected escalation*—**Fuel cost estimates are based on common sources wherever possible. For example, fossil fuel price escalation is indexed to the U.S. Department of Energy (U.S. DOE), Energy Information Administration (EIA) projections as indicated in their most recent Annual Energy Outlook 2008 (AEO2008).[20]
- ***Consumption-based approach*—**The analysis uses a consumption-based approach where emissions are calculated on the basis of the consumption of transportation fuels (regardless of where produced) to provide energy to consumers, as opposed to a production-based approach, which considers the emissions from in-state production of transportation fuels (regardless of where the fuels are consumed).
- ***Life-cycle GHG approach*—**Life-cycle GHG emissions are considered to the extent feasible. The use of the U.S. DOE life-cycle emissions analysis tools (i.e., GREET and VISION) facilitates these analyses of the life-cycle GHG emissions of Transportation and Land Use sector activities.

In addition to estimating the impacts of each individual policy recommendation, the combined impacts of the TLU policy recommendations are estimated, assuming that all policies are implemented together. This "overlap analysis" involves adjusting gross totals for the TLU sector to avoid double-counting of impacts. In addition, overlaps between policy recommendations in the TLU sector and policies in other sectors were identified. The following section identifies where these overlaps occur and summarizes the methods used to adjust the impacts analysis to avoid double-counting of impacts. Potential synergies between TLU policies may not be fully accounted for, and so the results are best interpreted as *conservative* estimates of GHG reductions.

Method for Analyzing the Potentially Overlapping Impacts of Combined TLU Policies

It is widely accepted that there are three general categories of factors that impact the emission of GHGs from the transportation sector. These three general categories are often described as "the three-legged stool." The three categories (or three legs of the stool) are vehicle characteristics, fuels, and travel activity or travel demand.

These three factors interact in a complex fashion to affect on GHG emission levels. The following formula summarizes this interaction in a simplified fashion:

(1) Vehicle miles traveled per year divided by

(2) Miles per gallon multiplied by

(3) Million metric tons of carbon equivalent ($MMtCO_2e$) per gallon yields

(4) $MMtCO_2e$ per year.

[20] U.S. Department of Energy (U.S. DOE), Energy Information Administration (EIA), Annual Energy Outlook 2008, http://www.eia.doe.gov/oiaf/archive/aeo08/index.html.

Thus, the GHG emissions reductions resulting from individual stand-alone policies are not simply additive. For example, a policy that reduces VMT will *reduce* the GHG benefits of a policy that improves fuel economy or one that reduces fuel carbon intensity and vice versa.

The cumulative GHG emissions reduction that would result if all TLU policies described below were implemented as a package was estimated by identifying the potential for overlap between the policies as follows:

- TLU Categories 1 and 2 and the New Jersey LEV program affect both the light-duty vehicle (LDV) and heavy-duty vehicle (HDV) fleets, while TLU-3 affects the HDV fleet. Overlaps between TLU-3 and the other measures were not assessed because TLU-3 relates to the operation and use of HDVs and does not relate to the vehicle technologies themselves.
- TLU Category 1 and the New Jersey LEV program affect vehicle fuel economy. TLU-2 and TLU-3 affect the carbon intensity of fuels. TLU-4 affects traffic flow and operations in urban areas, which primarily impact vehicle fuel economy. TLU Categories 5 and 6 affect primarily LDV VMT. The overlap within each of these three groups was first determined.
- As a final step, the overlap between each of the three categories of the three-legged stool was estimated and applied. The use of the VISION model was a critical tool in this step in the overlap analysis. Consecutive and alternative VISION model runs provided an estimate of the overlap between Categories 1, 2, and NJ LEV. In addition, alternative VMT inputs into VISION with subsequent runs of the model provided an estimate of the overlap between the VMT categories and other categories.

Facilitating Widespread Use of Low and Zero Emissions Vehicles (TLU-1)

To quantify the GHG emission reductions and cost-effectiveness of low and zero emissions vehicles, a target of 10% reduction in carbon intensity over predicted levels in 2020 was assumed. This target is based on New Jersey's stated commitment to developing an approach to implementing a low-carbon fuel standard (LCFS) that would reduce carbon intensity by 10% by 2020. There are many approaches and combinations of approaches to achieving this goal, and analysis of all of the approaches is beyond the scope of this study. Therefore a single well-defined scenario was selected for investigation.

In this analysis, new electric vehicles powered by zero-emission energy sources are assumed to displace new gasoline internal combustion engine LDVs so that the target is met. The analysis was performed with the VISION spreadsheet modeling tool.[21] VISION provides estimates of the potential energy use, oil use and carbon emission impacts through 2100 of advanced LDV and HDV vehicle technologies and alternative fuels. The VISION model reflects data from EIA's AEO2008 report and includes vehicle fleet characteristics for the entire United States. To generate emission estimates, the VISION model uses full fuel-cycle carbon emissions rates from Argonne National Laboratory's GREET model.

The VISION model default values used in the present study reflect the characteristics of the U.S. vehicle fleet and fuel prices. These characteristics were not altered, with the exception of the proportions of electricity derived from various sources, which were based on the New Jersey energy profile for February 2009.[22] On-road fuel consumption in New Jersey was derived from VMT estimates and the U.S. fleet fuel efficiency characteristics. Forecasted State fuel consumption as a percentage of the U.S. was used as a scaling factor to scale the VISION U.S. results to New Jersey. Vehicle costs were scaled using the share of vehicle registrations in New Jersey to the U.S. total.[23]

Other Assumptions

- 100% of the electricity necessary to power new electric vehicles was assumed to be derived from wind, solar and geothermal. Many other blends of energy sources are possible, but this one was selected for analysis because it is assumed that additional electrical power for electric vehicles would be fully powered by renewable energy sources.
- The new electric LDV market share of new car sales was assumed to increase linearly from 2010 to 2020 when it reaches 22.55% and attains a 10% reduction in carbon equivalent emissions against forecasted emissions.
- New electric vehicles were assumed to displace gasoline internal combustion engine market share.

[21] ANL, http://www.transportation.anl.gov/modeling_simulation/VISION/index.html.
[22] EIA, http://tonto.eia.doe.gov/state/state_energy_profiles.cfm?sid=NJ.
[23] HWA, Policy Information, http://www.fhwa.dot.gov/policy/ohpi/hss/index.cfm.

- Annual percentage reductions in carbon equivalent emissions were applied to a baseline forecast of GHG emissions for New Jersey to determine the reduction in carbon dioxide equivalent (CO_2e) emissions.

Savings

- Avoided gasoline and ethanol sales were based on forecasted U.S. fuel prices and multiplied by a scaling factor for New Jersey.

Costs

- Vehicle costs were calculated by multiplying the cost of an electric vehicle over the cost of a conventional gasoline vehicle by the number of vehicles sold, scaled to New Jersey.
- To calculate fuel costs, an average of U.S. renewable electricity prices for solar, geothermal, and wind was multiplied by the electricity consumption necessary to power the New Jersey fleet of electric vehicles. [24]

Table 6.2 provides a summary of the emission reductions and net discounted costs estimated for this supporting recommendation.

Table 6.2. Estimated GHG Emission Reductions and Net Cost Savings for TLU-1

Year	Additional Vehicle Cost (millions)	Additional Electricity Cost (millions)	Gasoline & Ethanol Cost (millions)	Total Cost (millions)	GHG Reduction ($MMtCO_2e$)	Cost-Effectiveness (mil. $\$/MMtCO_2e$)	Gasoline Reduction (million gallons)
2009	$0.00	$0.00	$0.00	$0.00	0.00	$0.00	0.00
2010	$14.99	$10.09	-$14.29	$10.79	0.07	$148.03	5.22
2011	$46.56	$31.40	-$43.34	$34.61	0.23	$150.93	16.22
2012	$95.31	$63.91	-$86.47	$72.75	0.47	$154.45	33.15
2013	$160.63	$106.16	-$139.79	$127.00	0.79	$160.46	55.21
2014	$241.35	$157.29	-$204.86	$193.79	1.18	$164.85	81.77
2015	$338.10	$217.11	-$272.71	$282.51	1.62	$174.48	112.60
2016	$451.07	$285.78	-$348.81	$388.04	2.12	$183.17	147.78
2017	$578.63	$361.78	-$440.06	$500.36	2.66	$187.95	186.27
2018	$720.62	$445.62	-$545.21	$621.03	3.25	$191.28	228.14
2019	$862.47	$536.08	-$675.27	$723.27	3.87	$186.95	273.07
2020	$1,002.45	$631.59	-$808.93	$825.11	4.52	$182.65	319.97
Total				**$2,861.18**	**20.77**	**$137.73**	**1,459.40**

[24] Smith, Rebecca. "The New Math of Alternative Energy." Wall Street Journal. February 12, 2007.

Requiring Low-Carbon Fuels in the Transportation Sector (TLU-2)

To quantify the GHG emission reductions and cost-effectiveness of a LCFS, a target of 10% reduction in carbon intensity over predicted levels in 2020 was assumed. This target is based on New Jersey's stated commitment to developing an approach to implementing a low-carbon fuel standard that would reduce carbon intensity by 10% by 2020. The standard is assumed to be met by fuel providers: refiners, importers, and blenders of on-road vehicle fuels. The LCFS is assumed not to specify a particular mix of fuel types—the fuel formulations are left to fuel providers, who decide how to meet the standard. The possible fuels that could be used to meet the standard are assumed to include ethanol, biodiesel, compressed natural gas (CNG), liquefied petroleum gas (LPG), hydrogen, and electricity.

As with TLU-1, many approaches could lead to achievement of the 10% goal, and a single one was selected for investigation. The analysis here was performed by examining the impact of increased sales of spark ignition plug-in hybrid electric vehicles (SI PHEV). (Note: according to AEO 2008 forecasts of greenhouse gas emissions, biofuels were not sufficiently low in emissions to achieve the 10% goal.) Previous analyses have been conducted using the methods described below for several other states, including Washington, Montana, South Carolina, Iowa, and Arkansas.

The analysis was performed with the VISION spreadsheet modeling tool (see TLU-1 for a description). The VISION model default values used here reflect the characteristics of the U.S. vehicle fleet and fuel prices. These characteristics were not altered, with the exception of the proportions of electricity derived from various sources, which were based on the New Jersey energy profile for February 2009.[25] On-road fuel consumption in New Jersey was derived from VMT estimates and the U.S. fleet fuel efficiency characteristics. The forecasted State fuel consumption as a percentage of the U.S. fuel consumption was used as a scaling factor to scale the VISION U.S. results to New Jersey. Vehicle costs were scaled to New Jersey using the ratio of vehicle registrations in New Jersey to the U.S. total.[26]

<u>Other Assumptions</u>

- According to default carbon coefficients in the VISION model, New Jersey electricity produces 24.64 $MMtCO_2e$ per quadrillion British thermal unit (Btu), and gasoline produces 26.87. The majority of the decrease in emissions in the present study is thus from the increased mileage per gallon of the vehicles rather than from fuel switching.
- To reach the goal of a 10% decrease in carbon intensity by 2020, sales of new gasoline internal combustion engine vehicles were assumed to be phased out entirely by 2018 in favor of SI PHEVs. (In the individual analyses for TLU-1 and TLU-2, CCS assumed that the new vehicle technologies (ZEV and SI PHEV) replaced the most fuel inefficient technology, which was gasoline, and the model was able to increase new sales penetration to meet the 10% reduction goals by subtracting the corresponding new sales market penetration from the gasoline-only vehicle sales percentage forecast. However, when the two technologies were

[25] EIA, http://tonto.eia.doe.gov/state/state_energy_profiles.cfm?sid=NJ.
[26] HWA, Policy Information, http://www.fhwa.dot.gov/policy/ohpi/hss/index.cfm.

combined for the overlap analysis, the combined new sales percentage of ZEVs and SI PHEVs went beyond the forecasted new sales percentage of gasoline-only vehicles in 2017.)

- Annual percentage reductions in carbon-equivalent emissions were applied to a baseline forecast of GHG emissions for New Jersey to determine the forecasted reduction in CO_2e emissions.

Savings

- Avoided gasoline and ethanol sales were based on forecasted U.S. fuel prices and multiplied by a scaling factor for New Jersey.

Costs

- Vehicle costs were calculated by multiplying the cost of SI PHEV over the cost of a conventional gasoline vehicle by the number of vehicles sold, scaled to New Jersey.
- Increased electricity consumption was multiplied by the forecasted U.S. price of electricity and scaled to New Jersey.

Table 6.3 provides a summary of the emission reductions and net discounted costs estimated for this supporting recommendation.

Table 6.3. Estimated GHG Emission Reductions and Net Costs for TLU-2

Year	Additional Vehicle Cost (millions)	Additional Electricity Cost (millions)	Gasoline & Ethanol Cost (millions)	Total Cost (millions)	GHG Reduction ($MMtCO_2e$)	Cost-Effectiveness (mil. $/MMtCO_2e$)	Gasoline Reduction (million gallons)
2009	$0.00	$0.00	$0.00	$0.00	0.00	$0.00	0.00
2010	$32.71	$1.53	-$18.05	$16.19	0.08	$193.60	6.59
2011	$98.50	$4.56	-$53.00	$50.06	0.26	$196.26	19.83
2012	$197.62	$9.42	-$104.39	$102.66	0.52	$199.06	40.02
2013	$327.78	$16.16	-$167.61	$176.33	0.86	$205.71	66.20
2014	$485.79	$24.16	-$243.38	$266.57	1.26	$211.84	97.14
2015	$671.81	$34.89	-$324.29	$382.41	1.73	$221.66	133.88
2016	$885.23	$47.70	-$414.43	$518.50	2.24	$231.03	175.54
2017	$1,122.28	$63.26	-$523.01	$662.54	2.80	$236.22	221.33
2018	$1,394.51	$82.61	-$656.42	$820.70	3.44	$238.40	274.63
2019	$1,622.75	$101.76	-$802.05	$922.46	4.03	$229.18	324.27
2020	$1,802.47	$118.90	-$930.24	$991.13	4.53	$218.83	367.88
Total				**$3,727.90**	**21.74**	**$171.47**	**1,727.31**

Transition to Low-Carbon Methods of Goods Movement (TLU-3)

To quantify the GHG emission reductions and net costs of a transition to low-carbon methods of goods movement, the following three approaches were examined:

- Encouraging truck stop electrification;
- Promoting the use of plug-in trailer refrigeration units; and
- Encouraging increased use of shuttle rail to move goods.

The effects of encouraging truck stop electrification (TSE) were calculated by estimating the number of expected TSE units during the policy analysis period (i.e., 2009 to 2020), the GHG reductions attributed to a TSE unit relative to traditional engine idling, and the cost of expanding TSE units on a per unit basis. The 2009 count of TSE units in New Jersey was estimated using information from the U.S. DOE.[27] The number of truck stops in New Jersey is assumed to increase at the same growth rate as TSE units in New York, as estimated in a recently completed NYSERDA study. GHG emissions relative to traditional idling practices and TSE unit costs were obtained from a 2004 TRB study.[28]

There is a lack of readily available data on the number of trailer refrigeration units (TRUs) in New Jersey. Accordingly, the number of TRUs in New Jersey was estimated by scaling the number of TRUs in New York, according to a recently completed NYSERDA study, by the population ratio for the two states. Plug-in TRU GHG emissions relative to traditional idling practices and TRU unit costs were obtained from a 2004 TRB study.[29] The analysis utilizes a perpetual inventory of TRUs that enter and exit the TRU population as old units are phased out and new units are purchased over time.

The effects of encouraging increased use of freight rail diversion were estimated from a national level estimate of the impacts of freight rail diversion. New Jersey's share of the estimated GHG reduction and cost estimates were scaled using New Jersey's current share of national rail freight movement, which is estimated to be 1.3% of all national rail-transported freight and available rail lines.[30]

Other Assumptions

- The annual percentage reductions in carbon-equivalent emissions were applied to a baseline forecast of GHG emissions for New Jersey to determine the reductions in CO_2e emissions.

Savings

- Avoided gasoline and ethanol sales were obtained by multiplying a scaling factor for New Jersey by forecasted U.S. fuel prices.

---

[27] Department of Energy, http://www.afdc.energy.gov/afdc/locator/tse/state.

[28] TBR. 2004. "Long-Haul Tractor Idling Alternative." Table 1. http://epa.gov/smartway/documents/dewitt-study.pdf.

[29] TBR. 2004. "Long-Haul Tractor Idling Alternative." Table 1. http://epa.gov/smartway/documents/dewitt-study.pdf.

[30] New Jersey State Rail Plan. 2009. http://www.state.nj.us/transportation/freight/rail/pdf/railplan.pdf.

Costs

- TRU and TSE program costs are calculated by multiplying the cost of a TRU or TSE unit by the number of TRUs and TSEs expected to be sold in New Jersey over time minus the fuel savings expected from introducing the new technology. The number of TSEs sold is based on a growth rate assigned to the number of TSEs currently in New Jersey. The number of TRUs is scaled down from the number of TRUs in New York based on the population ratio for the two states.

- Rail freight diversion costs were estimated by scaling down the national-level costs of rail freight diversion based on the current share of rail freight that is transported through New Jersey according to the Association of American Railroads.[31] To calculate the costs and levels of rail diversion that might be realized, a credible source is AASHTO's Bottom Line report for rail.[32]

Table 6.4 provides a summary of the emission reductions and net costs and cost savings estimated for this related action.

Table 6.4. Estimated GHG Emission Reductions and Net Costs and Savings for TLU-3

	Annual Results (2020)		Cumulative Results (2009-2020)			
	GHG Reductions ($MMtCO_2e$)	Costs (Million $)	GHG Reductions ($MMtCO_2e$)	Costs (NPV, Million $)	Cost-Effectiveness ($/t$CO_2e$)	Fuel Savings (million gallons)
Trailer Refrigeration Units (TRU)	0.38	-$68.64	2.63	-$382.00	-$145.16	231.07
Truck Stop Electrification (TSE)	0.52	$15.03	1.45	$30.91	$21.35	126.53
TRU + TSE (Anti-idling)	0.90	-$53.61	4.08	-$351.09	-$86.06	357.60
Rail Diversion	0.49	-$0.01	4.05	-$66.18	-$16.36	328.06
Total (TRU + TSE + Rail)	**1.40**	**-$53.62**	**8.13**	**-$417.27**	**-$51.35**	**685.66**

[31] "State Rankings: 2007" Association of American Railroads. http://www.aar.org/~/media/AAR/2007_RailroadsAndStates/State%20Rankings%202007.ashx
[32] "Transportation Invest in America Freight-Rail Bottom Line Report," American Association of State Highway and Transportation Officials (AASHTO).

Maintaining a Good State of Repair in Roads Infrastructure and Operation while Mitigating Greenhouse Gas Impacts (TLU-4)

Transportation System Management (TSM), the key concept here, means managing and operating the transportation system to help transportation networks meet demand in an effective and efficient manner. Effective system management may utilize a variety of strategies based on advanced technologies, market-based incentives, regulations, and design standards. Each strategy provides a relatively small benefit in terms of GHG reduction, but when applied in concert, significant gains can be achieved.

Technological improvements include traffic signal coordination, lane management, traveler information displays, and other "intelligent" transportation system applications. Incentives can include policies that financially favor desired behavior or that allow users to gain a time advantage and include value pricing and smart parking strategies. System design is also important since infrastructure and technology can be adapted to encourage less driving; system design includes access management applications and intersection improvements. Finally, users can be barred from performing certain actions that would negatively impact the efficiency of the transportation system. TSM policies can be instituted at every level of government; some can have a virtually instant effect, while others require many decades to reap the full benefits.

For this related action, the emission reductions and costs associated with expansion of emergency service patrols and of signal synchronization were estimated using data that was provided by various New Jersey state and local agencies. Analysis of the cumulative impacts was conducted using simple spreadsheet analysis techniques; given the relatively small size of the projects involved, no ramp-up was assumed within the eleven-year period from 2009 to 2020. Cost estimates were based on information provided by New Jersey Department of Environmental Protection (NJDEP). Table 6.5 provides a summary of the emission reductions and net cost savings estimated for this related action.

Table 6.5. Estimated GHG Emission Reductions and Net Cost Savings for TLU-4

	Annual Results (2020)		Cumulative Results (2009-2020)			
	GHG Reductions ($MMtCO_2e$)	Costs (Million $)	GHG Reductions ($MMtCO_2e$)	Costs (NPV, Million $)	Cost-Effectiveness ($/t$CO_2e$)	Fuel Savings (million gallons)
Emergency service patrols	0.001	-$0.5	0.014	-$4.7	-$338	1.6
Signal Synchronization	0.005	-$-5.8	0.056	-$53.6	-$954	6.4
Total	0.006	-$6.3	0.070	-$58.3	-$831	8.0

Reducing Vehicle Miles of Travel (TLU-5)

The most common approach for reducing travel activity is to reduce VMT; therefore, for this supporting recommendation, methods for reducing VMT were analyzed. The baseline forecast of VMT in the absence of new technologies and institution of certain "best practices" is based on VMT data provided by the New Jersey Department of Transportation (NJDOT). Based on historical trends, VMT are increasing at an annual rate of 1.7% over the 2005 baseline value of 64.2 billion VMT and at that rate would reach 82.6 billion VMT in 2020. If instead VMT increases were held to 1%/year, the level would reach 74.5 billion VMT in 2020, or about 8.1 billion VMT/year less. GHG emissions associated with vehicle travel would decline accordingly. This comparison raises the following questions:

1. Is a reduction of 8.1 billion VMT/year by 2020 realistic?
2. What policy measures would be needed to achieve that reduction?
3. What would be the net costs or benefits of those measures?

A variety of state, regional, and municipal land use planning and development practices and expansion of travel mode options can affect the number and length of vehicle trips. There is no one program or approach that can achieve New Jersey's VMT and GHG reduction goals, but over the long term, a suite of approaches can substantially reduce the state's GHG emissions by reducing the growth in VMT. It should be noted that within any group of approaches, the strength of implementation is a key variable.

- Estimating the impact of all of the many potential VMT-reducing mechanisms is beyond the scope of this study. The analysis presented in this section and the next simplifies by dividing the potential mechanisms into those producing *primary or direct* VMT reductions due to (e.g., expanding public transit) and those resulting in *secondary or indirect* reductions (e.g., stemming from a shift towards more compact development patterns).[33] The terminology is widely used in the field and does not imply relative importance.

- The analysis of the potential for VMT reduction relies upon a well-established body of research and policy analysis that incorporates the concept of 'transit leverage'. Statistical studies of cities around the world have shown that those with significant transit investments show a more energy-efficient use of the transportation system that is not fully accounted for simply by 'mode shift' from private automobiles to bus and rail transit. There has been increasing understanding that transit networks also allow for more trip chaining (see below), shorter driving trips, and more walking trips. As a result, researchers have recognized in the last decade that some cities have been able to "leverage" transit investments in a manner that augments their impact.

Newman describes the operation of transit leverage as follows: "The phenomenon of 'transit leverage' is where people who switch from a car to transit actually save more than just one

[33] More compact development can reduce truck trip lengths, but the vast majority of the literature examines light-duty vehicle (LDV) VMT only. This study therefore considers potential GHG reductions from reductions in VMT for personal (non-commercial) travel.

passenger km [kilometer] for one passenger km as an engineer would calculate. For a start trains go straighter than cars and hence even for the same destination there will be extra passenger km saved. Then passengers tend to do 'trip chaining' where several functions are combined like shopping, collecting dry cleaning, picking up children, when they take a transit trip which means even more passenger km are saved. Then as is often the case with quality transit, households save on (i.e., eliminate) one car and hence even more trips are saved. Finally, transit tends to attract land use around it and hence even fewer passenger km are generated."[34]

The American Public Transportation Association (APTA) and the United States Federal Transit Administration (FTA) have both recognized the role and contribution of transit leverage and have provided information to assist transit agencies and policy analysts to consider the effects of transit leverage. As Johnston states, "[t]he most effective policy sets combine land use policies, such as compact growth, with strong transit provision and not expanding highway capacity. The addition of auto pricing policies, such as fuel taxes, work trip parking charges, or all-day tolls increases the effectiveness of land use and transit policies." In reviewing one study of U.S. scenario exercises, Johnston found that "[t]hese studies generally evaluated modest growth management policies and did not employ the pricing of parking or fuels or roadways. So, these results may be viewed as lower bounds on what VMT reductions could occur in scenario exercises."[35]

The concept of "transit leverage" (or the "land use multiplier" as it is sometimes called) is backed by significant scientific evidence based on international comparisons of cities. For example, a Canadian study suggested that "capital investment in expanded transit systems appears to have relatively little impact on GHG reductions on its own unless accompanied by highly integrated and effective travel demand management (TDM) measures. Effective TDM may also require the gradual introduction of road pricing. In other words, achieving transit ridership goals and associated emissions reductions requires appropriate TDM policies (probably eventually including road pricing) and real land use initiatives. At the same time, if appropriate TDM policies are implemented, considerable capital investment in expanded transit services will be required to accommodate the anticipated modal shifts."[36]

Strength of the "Transit Leverage" Effect

A large body of literature now documents the effects of compact, transit-oriented land-use patterns on reducing vehicle trips and vehicle travel (for a recent synthesis, see Ewing, Bartholomew et al. 2008). Appendix A describes some of the more noteworthy studies. Evidence for the transit leverage or land-use multiplier is considerably strengthened by the fact that the studies generate results that are at least the same order of magnitude. This is

---

[34] Peter Newman, "Saving Transport Greenhouse—Some basic principles and data", unpublished paper, Curtin University.

[35] Johnston, Robert A., Department of Environmental Science & Policy, University of California – Davis, "Review of U.S. and European Regional Modeling Studies of Policies Intended to Reduce Transportation Greenhouse Gas Emissions," July 30, 2007, for presentation at the Transportation Research Board (TRB) Annual Meeting, Washington, D.C., January, 2008.

[36] "The Impact of Transit Improvements on GHG Emissions: A National Perspective: Final Report," (March 2005) Prepared for Transport Canada, prepared by Cansult and TSi Consultants, p. 29.

despite significant differences in methodologies, geographic context and the method of computing the multiplier (some studies report it as the reduction in vehicle travel per transit passenger mile, while others report it as a multiple of the primary mode shift effect).[37]

The research shows an overall consensus on the general range of the transit leverage effect, namely somewhere between 2 and 7 times for North American urban areas. This means that for every mile reduction in VMT due to increased transit options and mode shift, between 2 and 7 *additional* miles are reduced due to indirect or secondary effects. It is plausible that the international comparisons show a higher range of values because cities and countries in other parts of the world have been able to successfully 'leverage' transit to a higher degree than most American cities have to date. Some results are based on U.S. transit, including bus-based systems, while other studies use data are from global cities with higher densities and a higher proportion of rail systems; given this, it is not surprising that the multiplier effects reported in the latter are sometimes stronger.

The transit leverage research and other related regional modeling research provide the basis for the following general method of quantifying and allocating the indirect effects of transit on VMT:

(1) An urban growth boundary can provide an impact roughly equal to the direct transit effect (i.e., it has a leverage of 1.0 “units” or 1.0 times the direct effect).

(2) A low level of travel demand management (TDM) programs can produce an effect roughly half as large as direct transit investment or 0.5x the direct effect.

(3) A high level of TDM programs can produce an additional 1.0 unit effect, for a total potential of 1.5x the direct effect from TDM programs.

(4) A program of significant auto use pricing (some combination of fuel taxes, tolls and other facility charges, parking charges, etc) can have an effect equal to the overall TDM effect.

(5) Congestion reduction associated with transit has an estimated effect that is 0.2x the direct transit effect.

(6) The remaining indirect effects may be considered to be mainly related to land use, including overall residential and job density, as well as transit-oriented development and other aspects of 'smart growth'.

Strategies that seek to result in avoided travel and trips are usually referred to “travel demand management” or TDM. Some TDM strategies being considered by New Jersey for implementation do not yet have sufficient data to provide an estimate of GHG emission and energy savings. For example, a regional network of High Occupancy Toll (HOT) lanes involves converting existing High Occupancy Vehicle (HOV) lanes to HOT and using the revenue generated to finance completion of the HOV/HOT system as well as other improvements within the HOT corridors. HOT lanes could provide for reduced congestion and emissions and provide faster and more predictable travel times for carpools and buses. Funds from HOT lanes could allow the region to complete its HOV network without having to rely on outside funds. Such a program could have a significant impact on VMT, but its extent and cost have not been developed in sufficient detail to include in the present analysis.

---

[37] Recommended Practice for Quantifying Greenhouse Gas Emissions from Transit, APTA Climate Change Standards Working Group, Prepared for APTA Climate Change Standards Working Group (April 2008).

Application to New Jersey

In applying the transit leverage analysis to the state of New Jersey, several factors were considered:

(1) Are there urban limit lines (growth boundaries) that are in place or being considered?

(2) Does New Jersey as a state have a 'low TDM' or a 'high TDM' program level?

(3) Is a system of auto use pricing (including HOT lanes and New Jersey Transit parking charges) being considered for the horizon year of 2020?

Based on information provided by various state and local agencies about programs and policies in place and being considered, the indirect effects were assessed qualitatively as follows:

1. Urban growth boundaries were judged not to be in effect, but a program of growth management exists in terms of infrastructure investment and channeling of development toward locations where infrastructure is already available.
2. The level of TDM was judged to be high in suburban areas and medium in urban areas; the latter is lower because there tend to be more transit options in urban areas and where such options are available, people tend to use them without special TDM measures. The state as a whole can be characterized as medium to high in terms of TDM level.
3. Auto use pricing approaches, including parking taxes, pay-as-you-drive insurance, and other mechanisms, are being analyzed as possible ways of reducing auto use. Whether and when such measures might be adopted cannot be predicted with certainty at this time.

Based on these assumptions, the transit leverage effect for New Jersey and its components were estimated using the assumptions provided in Table 6.6. The land use factor of just under 4x and the overall factor of about 5.2x are in line with the range of results for North American cities (see above), especially given the highly urbanized nature of the northeastern New Jersey/New York transit service area, as summarized in Table 6.7. This analysis implies that holding the rate of VMT increase to 1%/year is a realistic goal for New Jersey. Table 6.8 shows the calculation of fuel savings (based on an assumed mileage of 23.31 mpg from 2009 through 2020) and $MMtCO_2e$ (based on 0.0005 Mt per VMT) saved per year.

Costs and Benefits of the Indirect Effects

The literature on the cost per ton associated with reducing GHG emissions through the use of pricing measures and travel demand management is somewhat uncertain. Growth management and land use change are obviously very complex policies with many components and therefore very more complicated cost structures. The cost for TLU-5 is, therefore, a rough estimate that considers selected study results for the cost of regional pricing, TDM, and land use/growth management measures.

Two studies of regional pricing measures include cost-effectiveness estimates:

(1) An unpublished study for the NYC metro area conducted for NYSERDA that CCS completed using the U.S. DOT's TRUCE model for the tri-state metro region.

(2) San Francisco Bay Area Metropolitan Transportation Commission results from Regional Transportation Plan documents.

Table 6.6. Transit Land Use Leverage Analysis Showing Estimated Direct and Indirect VMT Reduction Impacts

Savings in 2020 VMT from reducing VMT growth to 1.0%/yr from 1.7%/yr over 2005		8,133,370,190	100%
Transit leverage estimates:			
-direct transit effect*		1,307,700,774	16%
-total indirect transit effect		6,825,669,416	84%
Transit leverage factor		5.22	
Allocation of indirect effects	**Leverage factor**		
Urban growth boundaries with significant 'leakage'	0.25	326,925,194	4%
Medium (assumed) TDM programs	0.50	653,850,387	8%
Low (assumed) auto use pricing programs (including assumed New Jersey Transit parking tax)	0.50	653,850,387	8%
Land use leverage factor	3.97	5,191,043,449	64%
Total of non-transit VMT allocations	5.22	6,825,669,416	84%

* New Jersey Transit estimate pro-rated to 2020 based on New Jersey Transit capital expenditure data.

Table 6.7. Data on New Jersey Transit Service Area and Urban Area

Year	Service Area Population	Service Area Population Density	Urban Area Population	Population Density	Percent of Residents in Transit-Supportive Areas
2006	17,799,861	5,308.64	18,213,825	5,432	19%

Source: National Transit Database" of the U.S. Department of Transportation, Federal Transit Administration, http://204.68.195.57/ntdprogram/.

Table 6.8. Fuel Savings Calculated for TLU-5

Component of VMT Reduction	2020 Value (Billion VMT)	2020 Million Gallons Gasoline	$MMtCO_2e$ Saved (2020)
Savings in 2020 VMT from reducing VMT growth	8.1	349	4.07
Transit leverage estimates:			
-direct transit effect*	1.3	56	0.65
-total indirect transit effect	6.8	293	3.41
Allocation of indirect effects:			
Urban growth boundaries	0.3	14	0.16
Medium (assumed) TDM programs	0.7	28	0.33
Low (assumed) auto use pricing programs (including assumed New Jersey Transit parking tax)	0.7	28	0.33
Land use leverage	**5.2**	**223**	**2.60**
Total of non-transit VMT allocations	**6.8**	**293**	**3.41**

Based on these two studies, the cost of reducing VMT using auto use pricing mechanisms could be estimated at about $300/ton. However the federal Congestion Management and Air Quality (CMAQ) program reports an average for two categories of pricing measures of $399/ton (converted from 2005 dollars by CCS), without considering benefits. The average of these two estimates is $350/ton. CMAQ also reports a cost of $311/ton for regional TDM measures.

The cost of policies such as urban growth boundaries and other land use measures is harder to estimate. Some previous analyses have used a qualitative "less than zero" determination in other state climate action plans based upon extended stakeholder discussions of the issues in qualitative terms. There are several studies (most commonly, TRB TCRP "Cost of Sprawl" study by several authors at Rutgers University) to give basis for this qualitative judgment. In quite a few states, the stakeholders are comfortable with this assessment which translates numerically into a 'conservative' estimate of $0/ton.

The recent Moving Cooler report estimates a 'positive cost' associated with local planning efforts related to rezoning. A "zero" or even negative (cost savings) conclusion could be based upon an operating assumption that all measures undertaken are 'deregulatory' and relate to release existing market demand for development that is currently restricted by zoning. Two examples of deregulatory zoning would be (1) relaxation of height limits on development and (2) changes from single use zoning to zoning where mixed use development would be allowed occur. A positive cost, zero cost, and net cost savings are not necessarily inconsistent. The value used in any given situation would depend on whether or not and to what degree there is a belief that 'upzoning' or removal of a 'single use zoning' district or some other deregulatory zoning would have the effect of releasing pre-existing market demand for development. Of course results also depend upon the market conditions for specific locations in question

The staff of the California Air Resources Board has estimated this cost at a “conservative” $100 per MTCO2e, while other studies argue that the cost of such measures is nil. Rather than a cost of $100 (which we believe is high) or $0 per ton, we elect to use the midpoint of this range or $50 per ton, recognizing that this is a subject of active research and controversy and that new findings are likely to appear regularly.

Using the leverage factors from Table 6.6, the average cost per ton of the indirect transit leverage effects can be estimated as shown in Table 6.9.

Table 6.9. Weighted Average Cost per Ton for TLU-5 Indirect Transit Leverage Effects

Indirect effect	Leverage factor	Share of total	Cost/ton	Weight
Urban growth boundaries and land use measures	4.00 (approx.)	80%	$50	$40
TDM programs	0.50	10%	$311	$31
Auto use pricing programs	0.50	10%	$350	$35
Total or average	**5.00**	**100%**		**$106**

Using the weighted average of about $106/ton, we can then estimate the total cost of the TLU-5 measures, from which we need to subtract the indirect effects’ share of the benefits described below in the discussion of TLU-6 (see Table 6.12).

Combining the costs and the benefits produces the results shown in Table 6.10. The estimated net cost savings of $484/tCO_2e$ is conservative; Moving Cooler, for example, shows net cost savings for land use measures of $728/tCO_2e$.

Table 6.10. Estimated GHG Emission Reductions and Net Cost Savings for TLU-5

	Annual Results (2020)		Cumulative Results (2009-2020)			
	GHG Reductions ($MMtCO_2e$)	Costs (Million $)	GHG Reductions ($MMtCO_2e$)	Costs (NPV, Million $)	Cost-Effectiveness ($/$tCO_2e$)	Fuel Savings (million gallons)
Total	3.41	-$1,445	20.48	-$9,598	-$469	1,925

Doubling transit ridership and enhancing greenhouse commuting programs (TLU-6)

Improvement and expansion of existing transit service and implementation of new, innovative transit services can shift passenger transportation from single-occupant vehicles to public transit, thereby reducing VMT, fuel consumed, and emissions. Public transportation improvements are also critical to support Smart Growth initiatives, which as discussed above accounts for even greater reductions in VMT, fuel consumption, and emissions. This mitigation policy involves action by all levels of government. Table 6.11 summarizes New Jersey Transit's service levels for 2006.

Table 6.11. New Jersey Transit Data on Passenger Miles, Passenger Trips, and Revenue Miles for 2006

Mode	Passenger Miles	Passenger Trips	Revenue Miles
Commuter Rail – Directly Operated	2,116,307,617	75,067,220	58,787,082
Commuter Rail – Privately Operated	12,298,425	327,475	218,022
Demand Responsive – Publically Operated	9,789,981	1,264,368	9,752,353
Light Rail – Directly Operated	13,427,835	5,537,710	584,128
Light Rail – Privately Operated	59,471,684	10,229,366	2,808,158
Motor Bus – Directly Operated	915,684,027	149,587,799	68,014,358
Motor Bus – Privately Operated	50,305,881	12,678,685	8,946,086
Van Pool - Total	24,381,685	601,655	3,383,309

In recent years, several states in the United States have established an official policy goal of doubling transit ridership. This goal of doubling ridership has been included in the official state climate and energy action plans for Florida[38], Iowa[39], and in the draft state climate and energy plan for the State of New Jersey[40]. The next section examines the feasibility of this goal.

Feasibility of Doubling Transit Ridership

The goal of doubling transit ridership in certain parts of the United States is more than a rhetorical goal. Increasing concern with petroleum dependence, the growth of GHG emissions, and associated global climate change have motivated the official adoption of this goal. The goal of doubling transit ridership may be traced to an influential special report of the National Research Council's (NRC) Transportation Research Board (TRB). The report "Making Transit

38 (http://www.flclimatechange.us/documents.cfm).
39 (http://www.iaclimatechange.us/capag.cfm).
40 (http://www.state.nj.us/globalwarming/home/documents/pdf/final_report20081215.pdf).

Work: Insight from Western Europe, Canada, and the United States," was published by the National Academy Press as Special Report 257. [41]

TRB Special Report 257 included a comparison of public transportation systems in cities in the United States, Canada, and Western Europe. The report finds that "Ridership levels in Canadian cities are roughly double those of American cities."[42] Since the report was released in 2001, transportation professionals are increasingly recognizing that some of best practices and results from Canadian cities seem within reach for American cities.

The goal of 'doubling transit ridership' can be interpreted in two ways – either as an absolute ridership goal, or a standardized ridership goal. An example of doubling absolute transit ridership would be moving from 100,000 to 200,000 total transit trips in a year. Such a goal would include a 'natural' increase in absolute ridership that might be associated with population growth. An example of doubling standardized transit ridership would be moving from 25 annual rides per capita to 50 rides per capita. Such a standardized goal would look for ridership increases over and above those natural increases that might occur from population growth alone.

Neither the 'absolute' nor the 'standardized' formulation of the doubling goal takes into account the economic cycle. Commuter traffic increases as a result of higher employment, and to the extent that the economic cycle results in different levels of employment, both absolute and standardized ridership would change to some extent as a result. These 'cyclical' increases in transit ridership may be viewed as differing from increases due to structural changes in the urban environment, although some are influenced by the changing price associated with the cost of travel.

Based upon a review of standardized transit system ridership data during the 1990s, the TRB special report found that most Canadian cities have annual transit ridership of between 50 and 100 rides per capita. In contrast, most United States cities have annual transit ridership of between 0 and 50 rides per capita. This difference in the experience of the two countries suggests that if some United States cities were to follow a more 'Canadian' path, they could double their standardized transit ridership and have travel patterns more like their counterparts north of the border.

Six major urban areas in the United States already meet or exceed the Canadian patterns of public transit usage. The greater New York City region averages 140 transit rides per year per capita. Five other urban areas in the U.S. – Boston, Chicago, San Francisco, Philadelphia, and Washington, DC – have transit ridership greater than 75 rides per capita annually. These five relatively transit-intensive American cities seem more comparable to Canadian cities, while the New York City region seems more comparable to the largest urban regions in Canada—Montreal and Toronto-- and to major western European cities reviewed in the TRB special report, almost all of which have per capita transit usage levels greater than 100 rides per capita.

---

[41] Making Transit Work: Insight From Western Europe, Canada, and the United States—Special Report 257. Transportation Research Board: Washington, DC, 2001.

[42] Ibid, page 31.

As examples of the standardized transit ridership levels of some other cities and urban regions, the southeast Florida region has about 30 annual transit trips per capita, comparable with the Atlanta region and southern California. The Orlando area has 15 annual trips per capita, and the Jacksonville and Tampa-St. Petersburg regions have about 10 annual trips per capita. This data suggests that there is significant room to grow per capita transit ridership in Florida cities.[43]

Just as some U.S. cities and states are envisioning the possibility of following a more “Canadian” path when it comes to travel patterns, the most transit-intensive American cities may set a goal of become more like Western European cities in their levels of public transit use, just as New York City has already done.

For example the greater San Francisco Bay Area metropolitan region shows transit ridership greater than 75 rides per capita annually, and the City of San Francisco, the most ‘transit-rich’ portion of the metropolitan region, demonstrated transit usage levels of 272 rides per capita in 2005, according to the San Francisco Municipal Transportation Agency (SFMTA). The SFMTA’s recent Climate Action Plan includes a summary of a plan to increase ridership by up to 32% in ten years, assuming the availability of additional funding to increase service hours by 25% over 2005 levels. If successful, this increased ridership would result in a per capita ridership of 334 rides annually. The SFMTA climate plan compares its increased ridership plan to the example of Zurich, Switzerland, which has a per capita annual ridership of 560. The Zurich level of per capita transit ridership is roughly two times San Francisco’s 2005 level of 272.

In summary, it appears that the policy goal of ‘doubling transit ridership’ has a resonance and usefulness for consideration by more cities, urban regions, and states in the U.S. The goal is flexible in that it takes into account the ‘starting point’ of transit ridership for a given city or urban region and attempts to build on this starting point. In addition, it implicitly recognizes the need for expansion of transit service, since it is rarely if ever possible to double ridership with the existing supply of transit capacity and service.

For this related action, doubling transit ridership by 2020 was analyzed based on data provided by various New Jersey state and local agencies; the 2020 annual estimates of GHG savings were also obtained from New Jersey agency reports. Analysis of the cumulative impacts was conducted using simple spreadsheet techniques with a linear annual ramp-up assumed for the eleven-year period from 2009 to 2020. Table 6.12 shows the emission reductions estimated for TLU-6. As noted in Chapter 1, New Jersey Transit’s capital program is being undertaken for many reasons in addition to GHG reduction, and there is no easy way to allocate that budget among the various purposes. Since it would be misleading to attribute the entire capital budget to GHG reduction, no analysis of the costs and benefits of TLU-6 was performed.

[43] APTA Transit Ridership Report, as cited in “South Florida Economic Trends” (2006) http://www.edri-research.org/clientuploads/EDRI_Study_files/SEFLWeb.pdf.

Table 6.12. Estimated GHG Emission Reductions for TLU-6

	Annual Results (2020)		Cumulative Results (2009-2020)			
	GHG Reductions ($MMtCO_2e$)	Costs (Million $)	GHG Reductions ($MMtCO_2e$)	Costs (NPV, Million $)	Cost-Effectiveness ($\$/tCO_2e$)	Fuel Savings (million gallons)
Total	0.65		3.92			337

Economic Benefits of Transit Investment

There is a broad literature on the role of transit as a part of a modern economy and as a key contributor to creating and maintaining certain aspects of quality of life. Overarching reviews of that literature are done only periodically. One of the most comprehensive reviews is Cambridge Systematics, Inc.'s, *Public Transportation and the Nation's Economy: A Quantitative Analysis of Public Transportation's Economic Impact*, 1999. The study demonstrates that transit produces net economic returns on investment nationally:

> "Transit capital investment is a significant source of job creation. This analysis indicates that in the year following the investment 314 jobs are created for each $10 million invested in transit capital funding.
>
> "Transit operations spending provides a direct infusion to the local economy. Over 570 jobs are created for each $10 million invested in the short run.
>
> "Businesses would realize a gain in sales 3 times the public sector investment in transit capital; a $10 million investment results in a $30 million gain in sales.
>
> "Businesses benefit as well from transit operations spending, with a $32 million increase in business sales for each $10 million in transit operations spending.
>
> "Business output and personal income are positively impacted by transit investment, growing rapidly over time. These transportation user impacts create savings to business operations, and increase the overall efficiency of the economy, positively affecting business sales and household incomes. A sustained program of transit capital investment will generate an increase of $2 million in business output and $0.8 million in personal income for each $10 million in the short run (during year one). In the long term (during year 20), these benefits increase to $31 million and $18 million for business output and personal income respectively.
>
> "Transit capital and operating investment generates personal income and business profits that produce positive fiscal impacts. On average, a typical state/local government could realize a 4% to 16% gain in revenues due to the increases in income and employment generated by investments in transit.
>
> "Additional economic benefits which would improve the assessment of transit's economic impact are difficult to quantify and require a different analytical methodology from that employed in this report. They include "quality of life" benefits, changes in land use, social welfare benefits and reductions in the cost of other public sector functions.
>
> "The findings of this report complement studies of local economic impacts, which carry a positive message that builds upon the body of evidence that shows transit is a sound public investment. [L]ocal studies have shown benefit/cost ratios as high as 9 to 1."

Other Benefits of New Jersey Transit Improvements

Transit services have a large number of other impacts which provide additional benefits. Transit service provides mobility, accessibility, and safety benefits that are not included in the analysis above. Other important co-benefits include improved air quality, public health (e.g., due to walking), and quality of life. Transit benefits from reducing congestion and facilitating land use patterns such as transit-oriented development and smart growth are very significant and as noted are partially reflected in the analysis above.

The provision of transit service provides other more direct benefits and cost impacts. Most importantly are travel time benefits that accrue to transit users, reduced air pollution, and congestion relief that affect road users on parallel routes. Reducing VMT and increasing reliance on public transit will also result in reduced parking demand, lower household costs for transportation, decreased traffic congestion, improved air quality, reduced need and cost for roadway expansion, and improved health for new transit riders who walk or bicycle to transit.

Because consideration of New Jersey Transit' capital and operating expenditures in isolation could produce a misleading picture of the overall balance of costs and benefits, this analysis examines certain of the benefits of the New Jersey Transit capital program and the related land use measures. The benefits examined are those that are most readily quantifiable using spreadsheet methods.

Many of the benefits of New Jersey Transit's capital program and the related land use measures discussed above under TLU-5 stem from the ability of public transit to reduce the use of private automobiles, as measured by the change in VMT. VMT-related benefits are as follows:

- Savings on fuel and vehicle maintenance costs;
- Reduction in time lost from traffic delays;
- Reduction in number of highway fatalities and injuries;
- Reduction in amount of accident-related property damage;
- Improvements in air quality, as measured by emissions of PM_{10} and $PM_{2.5}$; and
- Reduction in GHG emissions, especially carbon dioxide.

Several other benefits cannot readily be measured and are therefore omitted from this analysis:

- Gains in quality of life from reduced traffic noise, driving stress, etc.;
- Savings on costs of vehicle ownership for those who decide to forego vehicle ownership (e.g., of second cars); and
- Economic multiplier effects (e.g., stimulus to businesses from transit construction projects (see above)). This gain will be offset to an unknown extent by losses to businesses that service the highway sector, and a separate study would be needed to evaluate these trade-offs.

Table 6.12 summarizes the estimated magnitude of the quantifiable direct and indirect benefits based on New Jersey Transit's projection of the effect of its capital program on aggregate VMT in New Jersey. It should be noted that the savings in gasoline consumption depend on the price of gasoline (assumed here at $2.50/gallon). As recent years have shown, that price can fluctuate by a dollar or more within a relatively short time period, and the magnitude of this particular benefit is therefore highly volatile.

As Table 6.13 shows the New Jersey Transit capital program and the related land use measures clearly have very substantial economic benefits that go far to balance the large costs of the measures and, therefore, improve the cost-effectiveness in terms of mitigating GHG emissions.

Table 6.13. Benefits of New Jersey Transit Capital Program

	Direct Effects	Indirect Effects	Total Effects
1. Fuel saved	$140,612,986	$733,942,948	$874,555,934
2. Fatalities avoided	$97,816,018	$510,560,072	$608,376,090
3. Vehicle maintenance	$78,532,924	$409,910,116	$488,443,040
4. $PM_{2.5}$ avoided	$44,860,389	$234,153,095	$279,013,484
5. CO_2 avoided	$17,353,401	$90,577,740	$107,931,142
6. PM_{10} avoided	$9,910,955	$51,731,178	$61,642,132
7. Avoided injuries	$1,137,700	$5,938,332	$7,076,032
8. Property damage avoided	$846,736	$4,419,621	$5,266,357
9. Delay avoided	$54,984,738	$286,998,108	$341,982,846
10. Quality of life gains	not quantified	not quantified	not quantified
11. Ownership cost savings	not quantified	not quantified	not quantified
12. Multiplier effects (net)	not quantified	not quantified	not quantified
GRAND TOTAL	**$446,055,847**	**$2,328,231,210**	**$2,774,287,058**

Appendix A: Strength of the Transit Leverage Effect

This appendix reports results of some of the more noteworthy studies of the transit leverage or land use multiplier effect. The studies are listed in order of the magnitude of the effect found in the study; where a study provided a range of results, the ordering is based on the low end of the range.

Holtzclaw (2000) compared three prototypical cities in the San Francisco Bay Area (San Francisco, Walnut Creek and San Ramon), and computed a reduction in vehicle travel of between 1.4 and 9 for every mile of transit passenger travel.

The most recent major study in this area was done for APTA by ICF and Patricia Mokhtarian of UC Davis (Bailey, Mokhtarian et al. 2008). This study applied multivariate statistical analysis using structural equation modeling (SEM) to National Household Travel Survey data to produce estimates of the 'direct' and 'indirect' effects of transit on VMT, energy consumption, and by extension, GHG emissions. In contrast to other techniques, which mainly identify correlations between auto and transit travel, SEM can help explain the extent to which transit causes denser, more walkable land-use patterns, and conversely the extent to which these land-use patterns create a need for improved transit service. This study concludes (p. 12) that “the magnitude of the secondary effect is approximately twice as large as [1.9 times] the primary effect of actual public transit trips,” The study also found (p. 1) “a significant correlation between transit availability and reduced automobile travel, independent of transit use.”

After reviewing three major reports of the European Commission on regional scenario analyses that used “state-of-the-practice methods”, Johnson found that the combination of either auto use pricing policies or urban growth boundaries with transit provision appears to approximately double the VMT reduction effect of additional transit investment as compared with transit investment undertaken alone. Johnston concluded that “we may view these [European] projections as the upper bounds of what could be achieved in most regions in the U.S.” It is not clear from the from the Johnston review what would be a reasonable conclusion regarding the expected combined VMT reduction effect of transit investment and land use intensification near transit stations.

Bailey and Mokhtarian (2008) found that their model “confirms the hypothesis that public transportation availability has a significant secondary effect on VMT beyond the primary effect of using transit. The secondary effect is mainly generated through land use patterns. The magnitude of the secondary effect is approximately twice as large as the primary effect of actual public transit trips. This result suggests that public transit is a significant enabler of an efficient built environment.”[44]

[44] TCRP Project J-11/Task 3, Transit Cooperative Research Program, Transportation Research Board, “The Broader Connection between Public Transportation, Energy Conservation and Greenhouse Gas Reduction, “ (February 2008) Requested by the American Public Transportation Association, project managed by ICF International. Authors: Linda Bailey, Patricia Mokhtarian, Ph.D. (UC Davis), Andrew Little, p. 12.

The indirect "leverage effect" of public transportation was estimated at three to four times the direct effect of transit service by the American Public Transportation Association, "Public Transportation Reduces Greenhouse Gases and Conserves Energy" (4/2008) http://www.apta.com/research/info/online/greenhouse_brochure.cfm.

In a study of U.S. metropolitan areas with populations of at least 2 million, Pushkarev and Zupan (1982) documented the empirical observation that cities with high public transit use show far lower rates of auto travel than would be implied by the direct substitution of auto with transit trips alone; they found a leverage effect of 4:1.

One of the most influential studies in this area (Newman and Kenworthy, 1999, Sustainability and Cities, page 87) used a worldwide statistical analysis of cities in a World Bank study to estimate that the transit leverage effect is between 5:1 and 7:1. In other words, for every one unit of direct effect from transit investment that results in mode shift, there are between 5 and 7 units of indirect effect that shows up in the entire transportation system. A good proportion of this indirect effect is related to the patterns of land development and land use.

In a study of 32 global cities, Newman and Kenworthy (1999) estimate a land-use multiplier of between 5 and 7, meaning that for every extra passenger mile on transit per capita, vehicle miles per capita decline by five to seven miles.

Neff (1996) used travel time budget theory to analyze the substitution of transit travel for auto travel in U.S. urbanized areas. He concluded that every mile of transit travel replaces 5.4 to 7.5 miles of auto travel.

Newman concluded that transit leverage in the U.S. has been found to be 1 in 6 to 7: "[t]hat is, for every passenger km added to a new transit system that replaces cars there are 6 to 7 passenger km [kilometers] of car use removed from the city. If the quality of the transit is not as good and there are large numbers of park and ride facilities provided then it may reduce to 1 in 3. But it is always more than one."

More recent, as-yet-unpublished work by Newman, Kenworthy and Glazebrook identifies an exponential relationship between transit and auto travel: As the use of public transport increases linearly, auto travel decreases exponentially.

In addition to the empirical research on transit leverage in urban regions around the world and around the United States, a corroborating body of research from regional modeling and scenario forecasting studies has made similar findings about the integrative impacts of combinations of policies, expressed in terms of the percentage reduction in VMT obtainable under various policy scenarios.

The Sacramento region conducted regional scenario analyses and adopted a plan that reduces VMT per day by 12.3 miles per household in 2050, with 1.5 million more people in the region and fuel savings estimate of 75 million gallons per year, with dollar value equivalent of $180 million per year. The California Energy Commission survey of Metropolitan Planning Organizations in California found results that indicate potential low range estimate for 2.6%

reduction in VMT per capita (59,573 billion Btu energy savings) and potential high range estimate for 10.2 reduction in VMT per capita (233,621 billion Btu energy savings) between 2000 and 2020.

The Center for Climate Strategies, during the course of review of studies, surveyed metropolitan region results from around the United States. The Center for Climate Strategies' review found ranges of estimated VMT reductions for 12 metro regions, including a 4.6% reduction in VMT for San Francisco Bay Area (Regional Livability Footprint) and a 31.7% VMT reduction in Sacramento region for Sacramento Blueprint. As a result, Center for Climate Strategies' analyses have used a range of 3% to 11% of urban VMT below baseline for the 2020 time frame.

A 2005 Canadian study concluded that "[h]igh transit investment could reduce annual GHG emissions by approximately 2% relative to the BAU case (2020 year). In terms of TDM measures, low TDM measures could further reduce annual GHG emissions by approximately 1% while an annual GHG emissions reduction of approximately 3% could be achieved with high TDM measures. Therefore, a total of approximately 5% of annual GHG emissions could be achieved with the implementation of both high transit investment and high TDM measures."[45]

A study sponsored by the U.S. Department of Transportation Federal Highway Administration found in the Bartholemew study (2005, 2007) results showing potential for compact development to on average result in 8% fewer VMT as compared with BAU scenario.

One of the important reviews of regional modeling studies around the world presents good evidence about the integrated effects of alternative strategies to reduce VMT, fuel use, and associated emissions. Professor Robert Johnston conducted the review entitled; "Review of U.S. and European Regional Modeling Studies of Policies Intended to Reduce Congestion, Fuel Use, and Emissions" The Johnston review looks at 40 long range scenario exercises performed in the United States and Europe. The main conclusion of the Johnston review is that VMT reductions for the 20 year time horizon are achievable in the range from 10% to 20% for U.S. regions, compared to the future trend scenario, while supporting the same level of future job and housing growth.

[45] "The Impact of Transit Improvements on GHG Emissions: A National Perspective: Final Report," (March 2005) Prepared for Transport Canada, prepared by Cansult and TSi Consultants, p. 31.

Chapter 7
Electricity Generating Units

Introduction

Under this supporting recommendation, the New Jersey Department of Environmental Protection (NJDEP) will develop an electricity generating unit (EGU) – related rulemaking to establish a maximum carbon dioxide (CO_2) emissions performance standard expressed in pounds of CO_2 emitted per megawatt-hour of electricity generated. The proposed performance standard (amount of CO_2 per megawatt (MW) hour of net electricity) would apply to all in-state new fossil fuel-fired EGUs and reconstructed EGUs.

Table 7.1 summarizes the estimated greenhouse gas (GHG) emission reductions and net costs for this supporting recommendation. The supporting recommendation is assumed to totally overlap in the short run with the Regional Greenhouse Gas Initiative (RGGI), which is one of New Jersey's core GHG mitigation recommendations. Therefore, the emission reductions and costs are estimated here for the purpose of understanding the potential impacts of a minimum CO_2 performance standard but are not included in the aggregated costs associated with the other supporting recommendations to avoid double-counting of the emission reductions and costs associated with RGGI. The remainder of this chapter provides information on the parameters for analysis, methods, data sources, and assumptions used to prepare the analysis for this supporting recommendation.

Table 7.1. Estimated GHG Emission Reductions and Net Costs for EGU Supporting Recommendation

No.	Supporting Recommendation Name	Annual Results (2020)		Cumulative Results (2009-2020)		
		GHG Reductions ($MMtCO_2e$)	Costs (Million $)	GHG Reductions ($MMtCO_2e$)	Costs (NPV, Million $)	Cost-Effectiveness ($/tCO_2e$)
EGU-1	Generation Performance Standard	1.40	$75.8	4.70	$162.2	34.52
Sector Total [sum of results before adjusting for overlaps]		1.40	$75.8	4.70	$162.2	34.52
Sector Total After Adjusting for Overlaps with RGGI		0.0	$0	$0.0	$0	$0

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalent; $/tCO_2e$ = dollars per metric ton of carbon dioxide equivalent; NPV = net present value.

Costs are discounted to year 2009 in 2007 dollars using a 3% real discount rate.

It is likely that the improved air pollution control of new coal-fired integrated gasification combined cycle (IGCC) units would result in significant reductions in the emissions of criteria air pollutants, provided existing coal units are retired and replaced with new IGCC units. The benefits associated with such reductions are not reflected above.

Quantification Methods

The business-as-usual (BAU) scenario for this analysis was defined as the result of the prior Rutgers projections associated with the development of the Energy Master Plan and was provided to CCS in order to prepare the analysis. The results of that scenario for generation and GHG emissions are summarized in Tables 7.2 through 7.4.

New coal generation was defined as incremental generation in excess of 2010 levels. This generation is assumed to be the subject of the performance standard and would need to be replaced with baseload power from a facility in compliance with the standard, assumed in the analysis to be a suitably-sized natural gas combined cycle (NGCC) unit having a CO_2e intensity equal to 0.57 metric tons of carbon dioxide equivalent emissions per megawatt hour (tCO_2e/MWh). The source for the coal-fired generation displaced was assumed to be a supercritical pulverized coal steam unit. The starting year for the analysis is assumed to be 2011.

Levelized costs were calculated using cost and performance assumptions from a variety of sources, including the U.S. Department of Energy's National Energy Technology Laboratory (NETL), ICF International assumptions for Integrated Planning Model (IPM) modeling in the northeast U.S., and Black & Veatch, an engineering firm. Fuel prices were taken from the US Department of Energy/Energy Information Administration's Annual Energy Outlook (AEO) 2009 results for the mid-Atlantic region. A summary of assumptions appears in the Annex using a 3% real discount rate. The results are presented in Table 7.4. NPV costs are equal to $162 million, cumulative GHG emission reductions reach 4.7 million metric tons of carbon dioxide equivalent ($MMtCO_2e$) by 2020, and the cost of avoided GHG is $34.5/$tCO_2e$.

Table 7.2. Business-as-Usual (BAU) Generation

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
BAU generation																	
Coal (pulverized)	10,322	10,649	10,975	11,302	11,628	11,955	12,282	12,328	12,374	12,420	12,466	12,513	13,116	13,720	14,323	14,927	15,531
Waste coal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Natural Gas	16,036	14,338	12,641	10,943	9,245	7,547	5,850	6,404	6,957	7,511	8,065	8,619	11,232	13,845	16,458	19,072	21,685
Other Gases	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Petroleum	1,391	1,159	927	696	464	232	0	0	0	0	0	0	3	6	8	11	14
Nuclear	27,082	28,167	29,252	30,337	31,422	32,507	33,592	33,592	33,592	33,592	33,591	33,591	33,611	33,631	33,651	33,671	33,691
Hydroelectric	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Geothermal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Solar/PV	10	111	212	314	415	516	617	761	905	1,049	1,193	1,337	1,472	1,606	1,741	1,875	2,010
Wind	0	5	9	14	19	23	28	259	490	721	952	1,183	1,211	1,240	1,269	1,298	1,326
MSW	1,051	1,025	1,000	974	948	923	897	894	891	888	885	881	885	888	892	895	899
Landfill Gas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Biomass	0	61	122	182	243	304	365	590	815	1,039	1,264	1,489	1,863	2,237	2,612	2,986	3,360
Other wastes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
On-site	1,227	1,227	1,227	1,227	1,227	1,227	1,227	1,227	1,227	1,227	1,227	1,227	1,294	1,361	1,428	1,495	1,562
Exports	0	0	0	0	0	0	0	5	9	14	19	23	169	315	461	607	753
Imports	21,710	23,176	24,641	26,107	27,573	29,039	30,504	30,252	30,000	29,748	29,496	29,244	27,093	24,942	22,791	20,640	18,489
Total (production-based)	57,119	56,742	56,365	55,988	55,611	55,234	54,857	56,054	57,250	58,447	59,643	60,840	64,687	68,535	72,382	76,230	80,077
Total (consumption-based)	78,829	79,918	81,007	82,095	83,184	84,273	85,362	86,301	87,241	88,181	89,121	90,060	91,611	93,161	94,712	96,263	97,813

Table 7.3. Business-as-Usual (BAU) GHG Emissions*

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
BAU CO2e emissions																	
Coal (pulverized)	10.38	10.71	11.04	11.37	11.69	12.02	12.35	12.40	12.44	12.49	12.54	12.58	13.19	13.80	14.40	15.01	15.62
Waste coal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Natural Gas	9.21	8.24	7.26	6.29	5.31	4.34	3.36	3.68	4.00	4.32	4.63	4.95	6.45	7.96	9.46	10.96	12.46
Other Gases	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Petroleum	1.10	0.92	0.73	0.55	0.37	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
Nuclear	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydroelectric	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Geothermal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Solar/PV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wind	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MSW	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30
Landfill Gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Biomass	0.00	0.02	0.05	0.07	0.10	0.12	0.15	0.12	0.09	0.06	0.03	0.00	0.27	0.55	0.82	1.09	1.37
Other wastes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
On-site	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.77	0.81	0.85	0.89	0.93
Exports	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Imports	0.00	3.13	6.26	9.39	12.52	15.65	18.78	18.62	18.46	18.30	18.15	17.99	16.57	15.16	13.75	12.33	10.92
Total (production-based)	22.72	21.92	21.11	20.31	19.50	18.70	17.89	18.23	18.56	18.90	19.23	19.57	21.99	24.41	26.84	29.26	31.69
Total (consumption-based)	22.72	25.05	27.37	29.70	32.02	34.35	36.67	36.85	37.02	37.20	37.38	37.55	38.56	39.58	40.59	41.60	42.61

*GHG emissions are a million metric tons of carbon dioxide equivalent ($MMtCO_2$) basis.

Table 7.4. Incremental Emissions and Costs associated with the Generation Performance Standard (3% discount rate)

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
New coal																		
Generation (GWh)	0	0	0	0	0	0	0	46	92	139	185	231	835	1,438	2,042	2,645	3,249	
CO2e emissions (MMtCO2e)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.09	0.14	0.19	0.23	0.84	1.45	2.05	2.66	3.27	
Replacement generation (NGCC)																		
Generation (GWh)	0	0	0	0	0	0	0	46	92	139	185	231	835	1,438	2,042	2,645	3,249	
CO2e emissions (MMtCO2e)	0	0	0	0	0	0	0	0.0265	0.0531	0.0796	0.1062	0.1327	0.4796	0.8264	1.1733	1.5201	1.867	
Annual Reductions																		
Generation (GWh)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
CO2e emissions (MMtCO2e)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.06	0.08	0.10	0.36	0.62	0.88	1.14	1.40	
Costs of Annual Reductions																		**NPV (million 2006$)**
New Coal Generation (million 2006$)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	3.4	5.1	6.8	8.6	30.9	53.3	75.7	98.1	120.4	$257.61
New NGCC Generation (million 2006$)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8	5.6	8.4	11.2	14.0	50.4	86.9	123.3	159.8	196.3	$419.82
Incremental cost (million 2006$)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	2.2	3.2	4.3	5.4	19.5	33.6	47.7	61.7	75.8	$162.21
Cumulative Reductions																		**CSC (2006$/TCO2e avoided)**
Generation (GWh)	0	0	0	0	0	0	0	46	92	139	185	231	835	1,438	2,042	2,645	3,249	
CO2e emissions (MMtCO2e)	0	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.06	0.12	0.20	0.30	0.66	1.28	2.16	3.30	4.70	$34.52
Impact of GPS (consumption basis)																		
BAU CO2e emissions (MMtCO2	22.72	25.05	27.37	29.70	32.02	34.35	36.67	36.85	37.02	37.20	37.38	37.55	38.56	39.58	40.59	41.60	42.61	
Alternative CO2e emissions (MI	22.72	25.05	27.37	29.70	32.02	34.35	36.67	36.83	36.98	37.14	37.30	37.45	38.21	38.96	39.71	40.46	41.21	

References

Black & Veatch, "20 Percent Wind Energy Penetration in the United States", p. 52
http://www.20percentwind.org/Black_Veatch_20_Percent_Report.pdf

EIA, 2009. "Supplemental tables to the AEO2009" available from
http://www.eia.doe.gov/oiaf/aeo/supplement/stimulus/regionalarra.html

ICF International, General Assumptions Document (for IPM Modeling), PowerPoint Presentation dated December 28, 2008.

NETL, 2007. "Cost and Performance Baseline for Fossil Energy Plants," U.S. Department of Energy's National Energy Technology Laboratory, DOE/NETL-2007/1281, Volume 1: Bituminous Coal and Natural Gas to Electricity, Final Report (Original Issue Date, May 2007), Revision 1, August 2007. Report available from:
http://www.netl.doe.gov/energy-analyses/pubs/Bituminous%20Baseline_Final%20Report.pdf.

Annex: Assumptions – Supercritical Coal

Technology type & description				
Type	Supercritical pulverized coal steam cycle			
Size	580	MW		
Online year	2008			
Description	Coal introduced into a pulverized coal plant is combusted in a furnace to heat water to the gas phase to power a steam turbine and generator. The supercritical stage operates at 21.4 Mpa and 1100 degrees celcius.			
Heat rate				Source:
Central estimate	8,721	btu/kWh	**(default)**	Central Estimate: ICF International, General Assumptions for IPM Modeling, slide 80
Low estimate	7,849	btu/kWh		
High estimate	9,593	btu/kWh		
Selected	**8,721**	**btu/kWh**		
Capacity factor				Source:
Central estimate	85%	percent	**(default)**	Central estimate: Black & Veatch, "20 Percent Wind Energy Penetration in the United States", p. 52 http://www.20percentwind.org/Black_Veatch_20_Percent_Report.pdf
Low estimate	77%	percent		
High estimate	94%	percent		
Selected	**85.0%**	**percent**		
Financial parameters				
Book life				Source:
Central estimate	30	years	**(default)**	Assumption
Low estimate	27	years		
High estimate	33	years		
Selected	**30**	**years**		
Real discount rate				
Central estimate	3.0%	%	**(default)**	Source:
Low estimate	4.0%	%		N/A
High estimate	6.0%	%		
Selected	**3.0%**	**percent**		
Capacity credit				Source:
Central estimate	100%	%	**(default)**	N/A
Low estimate	100%	%		
High estimate	100%	%		
Selected	**100.0%**	**percent**		
Capital recovery factor				Source:
Calculated	**5.10%**	**percent**		Calculation
Overnight facility capital cost				Source
Central estimate	1,575	2006 $/kW	**(default)**	Central Estimate: ICF International, General Assumptions for IPM Modeling, slide 80, High Estimate: Black & Veatch, "20 Percent Wind Energy Penetration in the United States", p. 5-15, Table 5-5 http://www.20percentwind.org/Black_Veatch_20_Percent_Report.p
Low estimate	1,418	2006 $/kW		
High estimate	1,733	2006 $/kW		
Selected	**1,575**	**2006 $/kW**		
Overnight T&D capital cost				Source
Central estimate	80	2006 $/kW	**(default)**	Assumption
Low estimate	60	2006 $/kW		
High estimate	100	2006 $/kW		
Selected	**80**	**2006 $/kW**		
Start-up costs (i.e., contingency)				Source
Central estimate	2.0%	% of capital cost	**(default)**	Central Estimate: NETL, "Cost and Performance Baseline for Fossil Energy Plants," p.52 Exhibit 2-15
Low estimate	1.8%	% of capital cost		
High estimate	2.2%	% of capital cost		
Selected	**2.0%**	**% of capital cost**		

	Subbituminous coal			return to list
Fuel prices (2006$/mmbtu)				
	Central	Low	High	Selected
2006	1.94	1.94	1.94	**1.94**
2007	1.78	2.18	1.78	**1.78**
2008	1.79	2.19	1.79	**1.79**
2009	1.83	2.23	1.83	**1.83**
2010	1.90	2.32	1.90	**1.90**
2011	1.92	2.35	1.92	**1.92**
2012	1.90	2.32	1.90	**1.90**
2013	1.89	2.31	1.89	**1.89**
2014	1.87	2.29	1.87	**1.87**
2015	1.86	2.28	1.86	**1.86**
2016	1.85	2.27	1.85	**1.85**
2017	1.85	2.26	1.85	**1.85**
2018	1.86	2.27	1.86	**1.86**
2019	1.86	2.27	1.86	**1.86**
2020	1.86	2.28	1.86	**1.86**
2021	1.86	2.28	1.86	**1.86**
2022	1.86	2.27	1.86	**1.86**
2023	1.86	2.27	1.86	**1.86**
2024	1.85	2.27	1.85	**1.85**
2025	1.85	2.26	1.85	**1.85**
2026	1.84	2.25	1.84	**1.84**
2027	1.84	2.25	1.84	**1.84**
2028	1.84	2.25	1.84	**1.84**
2029	1.84	2.25	1.84	**1.84**
2030	1.85	2.26	1.85	**1.85**

Source	
central	AEO 2009 fuel price assumptions to the electric sector in the Mid-Atlantic census region
Low	AEO 2009 fuel price assumptions to the electric sector in the Mid-Atlantic census region
High	AEO 2009 fuel price assumptions to the electric sector in the Mid-Atlantic census region

Fixed Operations & Maintenance (O&M) cost				Source
Central estimate	35.62	2006 $/kW-yr	**default**	Central Estimate: NREL, "Gas-Fired Distributed Energy Resource Technology Characterizations," p. 3-9, Table 1, System 5
Low estimate	30.67	2006 $/kW-yr		
High estimate	40.56	2006 $/kW-yr		
Selected	**35.62**	**2006 $/kW-yr**		

Variable Operations & Maintenance (O&M) cost				Source
Central estimate	3.10	2006 mills/kWh	**(default)**	Central Estimate: NETL, "Cost and Performance Baseline for Fossil Energy Plants," p.462, Exhibit 5-14
Low estimate	2.66	2006 mills/kWh		
High estimate	3.53	2006 mills/kWh		
Selected	**3.10**	**2006 mills/kWh**		

Regional construction multiplier				Source
central estimate	1.04	dimensionless	**(default)**	Central Estimate: ICF International, General Assumptions for IPM Modeling, slide 83 for "Rest of State" High Estimate: Average of Long Island and NYC costs
low estimate	1.00	dimensionless		
high estimate	1.93	dimensionless		
Selected	**1.04**	**dimensionless**		

Levelized costs		
Capital costs		
overnight facility cost	1,575.00	2006 $/kW
overnight T&D cost	80.00	2006 $/kW
EPC	33.10	2006 $/kW
Regional multiplier	72.59	2006 $/kW
Total capital (unlevelized)	1,760.69	2006 $/kW
Total capital (levelized)	89.83	2006 $/kW
Capital (levelized)	**12.06**	**2006 $/MWh**
Fuel costs		
NPV (2009-2030)	32.39	2006 $/mmbtu
Fuel cost (levelized)	1.86	2006 $/mmbtu
Fuel (levelized)	**16.22**	**2006 $/MWh**
Fixed O&M costs		
Fixed O&M (levelized)	35.62	2006 $/kW-yr
Fixed O&M (levelized)	**4.78**	**2006 $/MWh**
Variable O&M costs		
Variable O&M (levelized)	3.10	2006 mills/kWh
Variable O&M (levelized)	**3.10**	**2006 $/MWh**
Total levelized costs		
Capital (levelized)	12.06	2006 $/MWh
Fuel (levelized)	16.22	2006 $/MWh
Fixed O&M (levelized)	4.78	2006 $/MWh
Variable O&M (levelized)	3.10	2006 $/MWh
Total (levelized)	**36.16**	**2006 $/MWh**

Annex: Assumptions – NGCC

Technology type & description				
Type	Conventional natural gas combined cycle			
Size	540	MW		
Online year	2008			
Description	A combined-cycle gas turbine power plant consists of one or more gas turbine generators equipped with heat recovery steam generators to capture heat from the gas turbine exhaust. The steam that is produced powers a steam turbine.			
Heat rate				
Central estimate	7,064	btu/kWh	**(default)**	Central Estimate: ICF International, General Assumptions for IPM Modeling, slide 80
Low estimate	6,880	btu/kWh		
High estimate	7,770	btu/kWh		
Selected	**7,064**	**btu/kWh**		
Capacity factor				Source:
Central estimate	65%	percent	**(default)**	Central estimate: Black & Veatch, "20 Percent Wind Energy Penetration in the United States", p. 52 http://www.20percentwind.org/Black_Veatch_20_Percent_Report.pdf
Low estimate	59%	percent		
High estimate	72%	percent		
Selected	**65.0%**	**percent**		
Financial parameters				
Book life				Source:
Central estimate	30	years	**(default)**	Assumption
Low estimate	27	years		
High estimate	33	years		
Selected	**30**	**years**		
Real discount rate				
Central estimate	3.0%	%	**(default)**	NA
Low estimate	4.0%	%		
High estimate	6.0%	%		
Selected	**3.0%**	**percent**		
Capacity credit				Source:
Central estimate	100%	%	**(default)**	N/A
Low estimate	100%	%		
High estimate	100%	%		
Selected	**100.0%**	**percent**		
Capital recovery factor				
Calculated	**5.10%**	**percent**		
Overnight facility capital cost				Source
Central estimate	703	2006 $/kW	**(default)**	Central Estimate: ICF International, General Assumptions for IPM Modeling, slide 80, High Estimate: Black & Veatch, "20 Percent Wind Energy Penetration in the United States", p. 5-15, Table 5-5
Low estimate	633	2006 $/kW		
High estimate	780	2006 $/kW		
Selected	**703**	**2006 $/kW**		
Overnight T&D capital cost				
Central estimate	80	2006 $/kW	**(default)**	Assumption
Low estimate	60	2006 $/kW		
High estimate	100	2006 $/kW		
Selected	**80**	**2006 $/kW**		
Start-up costs (i.e., contingency)				Source
Central estimate	2.0%	% of capital cost	**(default)**	Central Estimate: NETL, "Cost and Performance Baseline for Fossil Energy Plants," p.52 Exhibit 2-15
Low estimate	1.8%	% of capital cost		
High estimate	2.2%	% of capital cost		
Selected	**2.0%**	**% of capital cost**		

	Natural gas				
Fuel prices (2006$/mmbtu)					
	Central	Low	High	**Selected**	
2006	7.57	7.57	7.57	**7.57**	
2007	7.12	7.12	7.12	**7.12**	
2008	7.54	7.54	7.54	**7.54**	
2009	7.77	7.77	7.77	**7.77**	
2010	7.30	7.30	7.30	**7.30**	
2011	7.01	7.01	7.01	**7.01**	
2012	6.77	6.77	6.77	**6.77**	
2013	6.47	6.47	6.47	**6.47**	
2014	6.26	6.26	6.26	**6.26**	
2015	6.14	6.14	6.14	**6.14**	
2016	6.09	6.09	6.09	**6.09**	
2017	6.14	6.14	6.14	**6.14**	
2018	6.20	6.20	6.20	**6.20**	
2019	6.25	6.25	6.25	**6.25**	
2020	6.16	6.16	6.16	**6.16**	
2021	6.06	6.06	6.06	**6.06**	
2022	6.18	6.18	6.18	**6.18**	
2023	6.25	6.25	6.25	**6.25**	
2024	6.36	6.36	6.36	**6.36**	
2025	6.46	6.46	6.46	**6.46**	
2026	6.57	6.57	6.57	**6.57**	
2027	6.61	6.61	6.61	**6.61**	
2028	6.83	6.83	6.83	**6.83**	
2029	6.96	6.96	6.96	**6.96**	
2030	7.09	7.09	7.09	**7.09**	

Source	
central	AEO 2009 fuel price assumptions to the electric sector in the Mid-Atlantic census region
Low	AEO 2009 fuel price assumptions to the electric sector in the Mid-Atlantic census region
High	AEO 2009 fuel price assumptions to the electric sector in the Mid-Atlantic census region

Fixed Operations & Maintenance (O&M) cost				Source
Central estimate	12.14	2006 $/kW-yr	**default**	Central Estimate: NREL, "Gas-Fired Distributed Energy Resource Technology Characterizations," p. 3-9, Table 1, System 5
Low estimate	10.93	2006 $/kW-yr		
High estimate	13.35	2006 $/kW-yr		
Selected	**12.14**	**2006 $/kW-yr**		

Variable Operations & Maintenance (O&M) cost				Source
Central estimate	2.01	2006 mills/kWh	**(default)**	Central Estimate: NETL, "Cost and Performance Baseline for Fossil Energy Plants," p.462, Exhibit 5-14
Low estimate	1.81	2006 mills/kWh		
High estimate	2.21	2006 mills/kWh		
Selected	**2.01**	**2006 mills/kWh**		

Regional construction multiplier				Source
central estimate	1.04	dimensionless	**(default)**	Central Estimate: ICF International, General Assumptions for IPM Modeling, slide 83 for "Rest of State" High Estimate: Average of Long Island and NYC costs
low estimate	1.00	dimensionless		
high estimate	1.93	dimensionless		
Selected	**1.04**	**dimensionless**		

Levelized costs		
Capital costs		
overnight facility cost	703.00	2006 $/kW
overnight T&D cost	80.00	2006 $/kW
EPC	15.66	2006 $/kW
Regional multiplier	34.34	2006 $/kW
Total capital (unlevelized)	833.00	2006 $/kW
Total capital (levelized)	42.50	2006 $/kW
Capital (levelized)	**7.46**	**2006 $/MWh**
Fuel costs		
NPV (2009-2030)	116.67	2006 $/mmbtu
Fuel cost (levelized)	6.70	2006 $/mmbtu
Fuel (levelized)	**47.33**	**2006 $/MWh**
Fixed O&M costs		
Fixed O&M (levelized)	12.14	2006 $/kW-yr
Fixed O&M (levelized)	**2.13**	**2006 $/MWh**
Variable O&M costs		
Variable O&M (levelized)	2.01	2006 mills/kWh
Variable O&M (levelized)	**2.01**	**2006 $/MWh**
Total levelized costs		
Capital (levelized)	7.46	2006 $/MWh
Fuel (levelized)	47.33	2006 $/MWh
Fixed O&M (levelized)	2.13	2006 $/MWh
Variable O&M (levelized)	2.01	2006 $/MWh
Total (levelized)	**58.93**	**2006 $/MWh**

Appendix 6

Center for Energy, Economic & Environmental Policy (CEEEP) of Rutgers University Microeconomic Impact of CO_2 Reductions in New Jersey

RUTGERS
Edward J. Bloustein School
of Planning and Public Policy

Center for Energy, Economic & Environmental Policy
Rutgers, The State University of New Jersey
33 Livingston Avenue, First Floor
New Brunswick, NJ 08901

www.policy.rutgers.edu/ceeep

732-932-5680
Fax: 732-932-0394

Date: October 29, 2009

To: New Jersey Department of Environmental Protection

From: Center for Energy, Economics & Environmental Policy

Re: Microeconomic Impact of CO_2 Reduction in New Jersey

The New Jersey Department of Environmental Protection (DEP) has asked the Center for Energy, Economic and Environmental Policy (CEEEP) and the Rutgers Economic Advisory Service (R/ECON™), both part of the Edward J. Bloustein School of Planning and Public Policy at Rutgers University, to analyze the economic impacts of the proposed Supporting Recommendations prepared in response to Governor Corzine's Executive Order 54 and the Global Warming Response Act (GWRA). Both organizations have previously worked together on behalf of the State to analyze the economic impacts of the State's Renewable Portfolio Standard (RPS), the Energy Master Plan (EMP), and the Low Emission Vehicle (LEV) program.

This memorandum identifies, describes and, where possible, quantifies the economic benefits of certain of the policies within the Supporting Recommendations including the benefits of avoiding damages associated with the emission of greenhouse gases and other co-benefits not related to greenhouse gases.[1] It is organized in the following sections. First, the costs and direct and co-benefits associated with greenhouse gas emission reduction policies are characterized. Next, a brief review of economic impact analyses of other jurisdictions' policies to reduce greenhouse gas emissions is presented. The third and fourth sections quantify, respectively, the direct greenhouse gas reduction benefits and non-greenhouse gas reduction co-benefits of the proposed Supporting Recommendations.

I. Identifying and Quantifying the Economic Impacts of Greenhouse Reduction Policies

The emission of greenhouse gases and their associated impact on global climate change presents policymakers with extensive technical, economic and policy challenges. Different greenhouse gas reduction measures have different costs. Some measures are economical; the adoption of such a measure should occur regardless of its greenhouse gas reduction benefits. Energy efficiency measures generally fall into this category because the energy savings are sufficient to more than pay for the cost of the measure. Any additional direct benefits, such as a reduction of greenhouse gases, would only make that measure even more cost-effective. In the work performed by the Center for Climate Strategies (CCS) on the Supporting Recommendations,

---

[1] In this memorandum, the term "co-benefits" refers to benefits of a particular measure other than those associated with reducing greenhouse gas emissions.

measures that are cost-effective are identified as having “negative” costs (reported per metric ton of equivalent CO_2), indicating that the measure’s benefits outweigh its cost.

Other measures have costs that exceed the narrowly defined economic benefits before their impact on greenhouse gas emissions and other co-benefits are accounted for. In the work performed by CCS, these measures are characterized as having a positive cost. The costs of the policy measures proposed in the Supporting Recommendations are not known with complete certainty. They are based upon engineering estimates performed prior to the implementation of the measures. Over time, as more experience is gained with individual measures, their actual costs may turn out to be different from their estimated costs. Since these measures would be implemented by the State of New Jersey, the costs associated with them would be borne by the State’s residents.

The benefits associated with the proposed measures in the Supporting Recommendations can be categorized in several ways. The most prominent category of benefit is the reduction in greenhouse gas emissions. Reduced emissions should translate into lower increases in global temperatures and should therefore lower the net economic and other costs associated with global climate change. Other benefits may also occur that are not related to global climate changes, such as reductions in other air emissions or improved flood control. In some cases the greenhouse gas reduction benefits and the non-greenhouse gas reduction benefits can be quantified, although the range of uncertainty around specific point estimates may be large. In other cases, it is not practical to provide any reasonable quantification of these two categories of benefits; nonetheless these unquantifiable benefits are real and should be considered a part of the economic impact analysis.

Table 1 summarizes the types of benefits associated with each major category of additional measures in the Supporting Recommendations.

Table 1: Direct and Co-Benefits Associated with Supporting Recommendations of the Supporting Recommendations

Category	**Benefit**	**Benefit Type**	**Quantified/ Unquantified**
All Categories	CO2 Reduction	Direct	Quantified
	Sea Level Rise Abatement	Co-Benefit	Unquantified
	Job Creation	Co-Benefit	Unquantified
Green Buildings	Electricity Reduction	Direct and Co-Benefit	Quantified
	Natural Gas Reduction	Direct and Co-Benefit	Quantified
	Reduced SO_2 and NO_x	Co-Benefit	Quantified
Waste Management	Electricity Reduction	Direct and Co-Benefit	Quantified
	Reduced SO_2 and NO_x	Co-Benefit	Quantified
	Enhancement of Aesthetic and Property Values	Co-Benefit	Unquantified
Warming Gases from C&I Refrigeration and A/C	Indoor Air Quality	Co-benefit	Unquantified
Terrestrial Sequestration of Carbon	Reduction of Urban Heat Island Effect	Co-Benefit	Unquantified
	Stormwater Control	Co-Benefit	Unquantified
	Wildlife Protection	Co-Benefit	Unquantified
	Water Quality Protection	Co-Benefit	Unquantified
Transportation and Land Use	Gasoline Use Reduction	Direct and Co-Benefit	Quantified
	Renewable Energy Use	Direct and Co-Benefit	Quantified
	Reduced Dependence on Foreign Oil	Co-Benefit	Unquantified
	Improved Road Conditions	Co-Benefit	Unquantified
Electricity Generating Units	Reduced SO_2 and NO_x	Co-Benefit	Quantified

As a direct consequence of the greenhouse gas effect, the greenhouse gas reduction benefits occur throughout the world, although New Jersey is particularly affected by global climate change as discussed in the Supporting Recommendations. Moreover, the greenhouse gas reduction benefits due to the Supporting Recommendations depend on reductions in greenhouse gas emissions by other states and countries. The non-greenhouse gas reduction benefits accrue primarily, if not exclusively, to New Jersey. In many cases, the benefits, whether greenhouse gas related or not, are uncertain. In other words, wide variations exist among the various estimates of the economic benefits.

How should policymakers respond to the difficulties in both quantifying the costs and benefits associated with greenhouse gas reduction measures? Despite the relative uncertainties as to the timing and location of the costs and benefits, substantial actions taken immediately, such as those proposed in the Supporting Recommendations, are reasonable. Certainly, the above mentioned issues do not justify inaction or delay. Given the range in costs associated with various measures, it makes sense, as the State of New Jersey is doing, to pursue the most cost-effective measures first, subject to regulatory and legislative restrictions. It is also reasonable for the State to identify, characterize, and in some cases even pursue more expensive measures, even if in some cases those measures' costs exceed their expected benefits. As a matter of public policy, the State may decide that there are issues of equity that justify certain measures even if the strict economics relating to those measures do not. In addition, the State may be risk-averse and therefore willing to incur costs that avoid or limit the likelihood of extremely bad climate change outcomes even if the measures are not strictly justified on an economic basis. Finally, in identifying and characterizing measures based upon the best information available today, the State creates the flexibility to pursue these measures in the future when they may be more economical based upon new and better information.

II. Studies of Economic Impacts of Greenhouse Gas Reduction Policies from Jurisdictions Other Than New Jersey

Florida recently completed a statewide study of the impacts of the Florida Energy and Climate Change Action Plan on the State's economy.[2] The Florida Energy and Climate Change Action Plan designs policies and measures to mitigate the emissions of greenhouse gases. The report highlights 28 mitigation and sequestration strategies including energy supply and demand (Renewable Portfolio Standards, nuclear power and combined heat and power), transportation and land use (low greenhouse gas fuels and improving transportation system management), and agriculture, forestry and waste (forest retention and forest management for carbon sequestration). Most of the strategies discussed in the paper had positive macroeconomic impacts. Overall, the strategies are expected to increase the Gross State Product by about $33 billion (0.66%). The study also estimates that about 129,000 full time equivalent jobs (direct and indirect) will result from the mitigation strategies. This represents an increase of nearly one percent over baseline projections.

CCS summarized the results of a study designing a regional cap-and-trade system in Michigan.[3] For an economy-wide cap-and-trade system, the net impact on the economy will be positive, with a cost savings to the Michigan economy of $193 millionby 2020. Overall, the Midwestern Greenhouse Gas Reduction Accord States would save $3.6 billion by 2020.

---

[2] Rose, A. and D. Wei, "The Economic Impact of The Florida Energy and Climate Change Action Plan on the State's Economy." The Center for Climate Strategies, May 15, 2009.
[3] Rose, A., D. Wei, J. Wennberg, and T. Peterson. "Climate change policy formation in Michigan: the case for integrated regional policies." Forthcoming in International Regional Science Review.

Many other states have recently assessed or are currently in the process of assessing the economic impacts of climate change policies. Ruth et al. present a case study of the potential economic and energy impacts on Maryland from its participation in the Regional Greenhouse Gas Initiative (RGGI).[4] RGGI is the first mandatory market-based effort in the United States to reduce greenhouse gases from the production of electricity. Ten Northeastern and Mid-Atlantic states have the goal of capping and then reducing CO_2 emissions from the power sector 10% by 2018.[5] Using three models, Haiku, JHU-OUTEC, and IMPLAN, the authors showed that there would be only a limited impact on the economy and electric power markets in Maryland. Specifically, RGGI participation lowered net electricity demand by between 1.5 percent in 2010 and nearly three percent in 2025, reduced investment in new generation capacity by nearly 45 percent by 2025, and had virtually no impact on retail electricity prices paid by ratepayers. In addition, the study showed that RGGI would not lead to significant retirement of existing electricity generation capacity. Total profits of existing generators would fall by 13 percent in 2010 and 12 percent in 2025, with coal-fired generators experiencing the largest drop. Some of the economic impacts included an overall electricity bill decrease of $100 million in 2010 and more than $200 million by 2025, with the average residential ratepayer seeing $22 in annual savings by 2010, and an overall positive impact on Gross State Product and job growth (0.1 percent, each).

Prindle et al. examined the regional effects of increased energy efficiency investment in the RGGI framework using the REMI model.[6] The REMI runs showed that RGGI would have a very small impact on the regional economy. In general, the impact was less than one-tenth of one percent for key indicators such as gross regional product, personal income and private sector employment. The authors also note that the REMI runs indicated small but positive individual economic impacts from RGGI. For example, average household electricity bills are expected to decrease by about $30 by 2015 and $50 by 2021.

ISO New England conducted its own analysis of RGGI impacts by surveying generators and stakeholders on likely compliance strategies and potential operating risks, and by using sensitivity analyses for those factors.[7] The analysis found that four New England states (Connecticut, Maine, New Hampshire, and Vermont) would be able to meet the New England RGGI cap through 2015 if the CO_2 allowance price is $5/ton or higher. New generating resources would need to have zero or low CO_2 emissions to maintain emissions below the cap

---

[4] Ruth, M., S.A. Gabriel, K.L. Palmer, D. Burtraw, A. Paul, Y. Chen, B.F. Hobbs, D. Irani, J. Michael, and K.M. Ross, “Economic and Energy Impact from participation in the regional greenhouse gas initiative: a case study of the State of Maryland.” Energy Policy, 36 (2008), 2279-2289.

[5] Information provided by Regional Greenhouse Gas Initiative website. Available at http://www.rggi.org/home

[6] Prindle, W.R. A.M. Shipley, and R.N. Elliott, “Energy Efficiency’s role in a carbon cap-and-trade system: modeling results from the regional greenhouse gas initiative.” American Council for an Energy-Efficient Economy, Report Number E064m May 2006.

[7] “ISO Evaluation of Regional Greenhouse Gas Initiative,” Presentation from PAC Meeting, Sturbridge, MA, June 2006. http://www.masstech.org/renewableenergy/public_policy/DG/resources/2006-06-06_ISO-NE_study-of-RGGI.pdf

after 2015. Leakage from non-RGGI units will be a significant problem for remaining below the RGGI cap (3 million tons in 2015, allowance cost of $10/ton). The addition of Rhode Island and Massachusetts would cause CO_2 emissions to exceed the six-state cap of 55.8 million tons in 2010 at $5/ton and 2014 at $20/ton.

III. Estimate of the Global Climate Change-Related Direct Benefits from the Proposed Supporting Recommendations beyond the NJ EMP and LEV Standard

The supporting climate change policy recommendations that are quantified in this section are in addition to the policy options presented in the New Jersey Energy Master Plan (EMP) and New Jersey's Low Emission Vehicle program (LEV). The New Jersey EMP proposes policies that relate to energy efficiency, renewable energy, and the development of clean energy technologies. The New Jersey LEV or Clean Car Program implements the California Low Emission Vehicles (LEV) standard, which contains programs for vehicle emission standards, fleetwide emission requirements, and a Zero Emission Vehicle (ZEV) sales requirement.

Emission reductions of equivalent CO_2 can be quantified in dollars using estimates for the negative economic impact per ton of equivalent CO_2 emitted. One difficulty in this analysis is the wide range of estimates for the benefits per ton of equivalent CO_2 reduction. The Intergovernmental Panel on Climate Change (IPCC) produced a study based on a survey of 100 estimates of this parameter, with ranges from $3 to $95 per metric ton and a mean of $12 per metric ton.[8] These estimates were used in the modeling effort for the New Jersey Energy Master Plan (EMP) to estimate the monetary benefits of reducing CO_2 through the implementation of the EMP strategies.[9] The methodology and savings estimates used for the EMP are applied here to the supporting recommendations. When equivalent CO_2 reductions from reduced electricity usage are excluded, the supporting recommendations reduce equivalent CO_2 by 24.8 million metric tons in 2020 and by 138.8 million metric tons from 2009 to 2020. In the year 2020 alone, this translates into economic benefits of approximately $65 million as the low estimate, $260 million as a mean estimate, and $2.06 billion as a high estimate, in 2020 dollars. Table 2 lists the economic benefits of reduced equivalent CO_2 emissions from 2010 through 2020. The net present value of savings from 2009 to 2020 is $291 million as a low estimate, $1.16 billion as a mean estimate, and $9.22 billion as high estimate.[10] The economic benefits accrue to the global economy, not just New Jersey's economy, due to the nature of global warming.

---

[8] Gilbert E. Metcalf, *A Proposal for a U.S. Carbon Tax Swap: An Equitable Tax Reform to Address Global Climate Change*, The Brookings Institution, Oct. 2007 citing the Intergovernmental Panel on Climate Change (IPCC), *Contribution of Working Group II to the Fourth Assessment Report*, Geneva, Switzerland, 2007.

[9] Center for Energy, Economic & Environmental Policy, *Modeling Report for the New Jersey Energy Master Plan*, Rutgers, The State University of New Jersey, October 2008, on behalf of the New Jersey Board of Public Utilities.

[10] Note: A real interest rate of 3% was used for all net present value calculations to match the interest rate used in the CCS report.

Table 2: Direct Economic Benefit of Reduced Equivalent CO_2 Emissions Beyond EMP and LEV Strategies

	CO2 Savings (Million Metric Tons)	Low Savings Estimate	Mean Savings Estimate	High Savings Estimate
2009	0.07	$ 195,990	$ 783,960	$ 6,206,347
2010	2.10	$ 6,298,173	$ 25,192,690	$ 199,442,133
2011	3.50	$ 10,502,646	$ 42,010,585	$ 332,583,800
2012	5.05	$ 15,138,492	$ 60,553,969	$ 479,385,587
2013	6.74	$ 20,212,821	$ 80,851,284	$ 640,072,664
2014	8.56	$ 25,690,380	$ 102,761,521	$ 813,528,709
2015	10.52	$ 31,557,506	$ 126,230,023	$ 999,321,017
2016	12.55	$ 37,651,907	$ 150,607,627	$ 1,192,310,381
2017	14.70	$ 44,088,069	$ 176,352,274	$ 1,396,122,170
2018	16.99	$ 50,970,102	$ 203,880,407	$ 1,614,053,219
2019	19.34	$ 58,025,053	$ 232,100,212	$ 1,837,460,013
2020	21.73	$ 65,204,178	$ 260,816,713	$ 2,064,798,979
	Total NPV	**$ 291,376,116**	**$ 1,165,504,464**	**$ 9,226,910,343**

IV. Estimate of the Non-Global Climate Change Related Benefits from the Proposed Supporting Recommendations beyond EMP and LEV Strategies

In addition to a reduction in equivalent CO_2, implementation of the supporting recommendations also reduces other air emissions that are detrimental to human health and the environment, mainly SO_2 and NO_x. SO_2 and NO_x are the principal pollutants that cause acid precipitation. The SO_2 and NO_x emission savings were determined by multiplying the electricity and natural gas savings for the supporting recommendations by emission factors in the New Jersey Protocols to Measure Resource Savings.[11] In order to monetize the benefits of emissions reduction, the reduced emissions were multiplied by forecasted emission permit prices.[12] On this basis, SO_2 savings account for $6.3 million and NO_x savings account for $10.5 million in 2020 alone. Table 3 shows the estimated economic benefits of reduced SO_2 and NO_x emissions from 2010 through 2020. The net present value in 2009 dollars of the estimated savings is $27.2 million for SO_2 and $47.6 million for NO_x.

[11] New Jersey Clean Energy Program. *Protocols to Measure Resource Savings*. December 2007. Available at www.njcleanenergy.com.

[12] SO_2 allowance prices were taken from the EPA Annual Auction Results. NO_x allowance prices were taken from the Chicago Climate Exchange.

Table 3: Economic Benefit of Reduced SO_2 and NO_x Emissions beyond EMP and LEV Strategies

	SO2 Savings	NOx Savings
2009	$ 72,918	$ 966,739
2010	$ 201,706	$ 1,584,292
2011	$ 578,075	$ 2,403,459
2012	$ 2,122,723	$ 3,408,449
2013	$ 2,818,313	$ 4,671,417
2014	$ 2,677,046	$ 3,076,158
2015	$ 2,413,479	$ 4,075,921
2016	$ 3,073,088	$ 5,173,853
2017	$ 3,793,812	$ 6,369,911
2018	$ 4,592,814	$ 7,690,765
2019	$ 5,432,086	$ 9,078,552
2020	$ 6,308,017	$ 10,528,854
Total NPV	**$ 27,203,370**	**$ 47,598,303**

Although the economic benefits from reduced emissions are significant, the economic benefits have a relatively minor impact on the overall state economy. In 2020, taking the mean equivalent CO_2 savings estimates combined with the SO_2 and NO_x benefits, the overall economic benefit is $308 million. When compared to the projected total Gross State Product in 2020 of $474 billion, emission savings benefits only account for approximately 0.06% of New Jersey's Gross State Product.[13] By comparison, the New Jersey EMP is projected to have a 0.1% impact on New Jersey's Gross State Product, and New Jersey's Renewable Portfolio Standard is projected to have a negligible impact on the growth of New Jersey's economy.[14]

The preservation of New Jersey's natural capital is another benefit of the supporting recommendations. Natural capital includes the natural assets that provide natural goods (commodities such as fish and timber), and those that provide ecosystem services. Ecosystem services include carbon sequestration, pest and disease control, and purification of water and air. The benefits of New Jersey's natural capital were quantified in a study performed by the New Jersey Department of Environmental Protection.[15] To monetize these benefits for the present study, dollar values per acre were multiplied by the number of acres saved by land type due to the supporting recommendation. In 2020, this translates in real dollars into approximately $5.7 million in natural goods benefits and $37 million in ecosystem services benefits. Table 4 shows the economic benefits of preserved natural capital from 2009 through 2020. The net present

---

[13] Gross State Product projections provided by the July 2009 R/ECON™ Econometric Forecast.

[14] Center for Energy, Economic & Environmental Policy, *Economic Impact Analysis of New Jersey's Proposed 20% Renewable Portfolio Standard.* Rutgers, The State University of New Jersey, December 2004, On behalf of the New Jersey Board of Public Utilities.

[15] New Jersey Department of Environmental Protection. *Valuing New Jersey's Natural Capital*. April 2007. Available at http://www.state.nj.us/dep/dsr/naturalcap/.

value of savings from 2009 through 2020 is $148 million in natural goods benefits and $1.4 billion in ecosystem services benefits.[16]

Table 4: Economic Benefits of New Jersey's Natural Capital[17]

Year	Goods Benefits	Services Benefits	Total Benefits
2009	$ 25,393,568	$ 247,599,691	$ 272,993,259
2010	$ 25,393,568	$ 247,599,691	$ 272,993,259
2011	$ 25,393,568	$ 247,599,691	$ 272,993,259
2012	$ 25,393,568	$ 247,599,691	$ 272,993,259
2013	$ 25,393,568	$ 247,599,691	$ 272,993,259
2014	$ 5,203,825	$ 34,608,658	$ 39,812,483
2015	$ 5,203,825	$ 34,608,658	$ 39,812,483
2016	$ 5,203,825	$ 34,608,658	$ 39,812,483
2017	$ 5,203,825	$ 34,608,658	$ 39,812,483
2018	$ 5,203,825	$ 34,608,658	$ 39,812,483
2019	$ 5,203,825	$ 34,608,658	$ 39,812,483
2020	$ 5,203,825	$ 34,608,658	$ 39,812,483
Total NPV	**$ 148,589,868**	**$ 1,359,529,223**	**$ 1,508,119,091**

Each of the benefits discussed in the previous sections are additive, which means that the benefits from CO_2, SO_2, NO_x, and Natural Capital can be added together to determine the overall co-benefit economic impact. The cumulative effects of these co-benefits is almost $350 million in the year 2020 alone and lifetime benefits are $2.75 billion when using the mean estimate for CO_2 savings.

V. Other Non-Quantifiable Benefits

Even though there are many quantifiable benefits from the supporting recommendations, there are other benefits of implementing climate change policy options that cannot be economically quantified. One significant benefit is the reduced dependence on foreign oil. Other benefits that have not been quantified in this analysis include increased visibility due to the reduction of smog caused by SO_2 and NO_x, improved driving conditions due to transportation policy options, and the cultivation of new businesses and markets aimed at reducing greenhouse gas emissions.

---

[16] Note: There is a sharp drop in benefits from 2013 to 2014, this is caused by the expiration of the RGGI 5-Year Investment Program.

[17] Note: CEEEP used acre savings estimates from William Mates of the NJ DEP.

Appendix 7

Center for Energy, Economic & Environmental Policy (CEEEP) of Rutgers University
Macroeconomic Impact of CO_2 Reductions in New Jersey

RUTGERS
Edward J. Bloustein School
of Planning and Public Policy

Center for Energy, Economic & Environmental Policy
Rutgers, The State University of New Jersey
33 Livingston Avenue, First Floor
New Brunswick, NJ 08901

www.policy.rutgers.edu/ceeep

732-932-5680
Fax: 732-932-0394

Date: October 20, 2009

To: New Jersey Department of Environmental Protection

From: Center for Energy, Economics & Environmental Policy and the Rutgers Economic Advisory Service

Re: Macroeconomic Impact of CO_2 Reduction in New Jersey – Simulations for NJDEP

The New Jersey Department of Environmental Protection (NJDEP) solicited the Center for Energy, Economic and Environmental Policy (CEEEP) and the Rutgers Economic Advisory Service (R/ECON™) to analyze the economic impacts of the proposed Climate Action Plan prepared in response to Governor Corzine's Executive Order 54 and the Global Warming Response Act. Both organizations have previously worked together on behalf of the State to analyze the economic impacts of the State's Renewable Portfolio Standard (RPS), the Energy Master Plan (EMP), and the Low Emission Vehicle (LEV) program.

R/ECON Model

R/ECON™ is home to an econometric model of New Jersey. The model is comprised of over 300 equations, based on historical data for New Jersey and the United States, which are solved simultaneously. The historical data covers the period from 1970 to 2008. The heart of the model is a set of equations modeling employment, wages, and prices by industry. In general, employment in an industry depends on demand for that industry's output and the state's wages and prices relative to the nation's. Demand can be represented by a variety of variables including (but not limited to) New Jersey personal income, population, and sectoral output, or U.S. employment in the sector. Other sectors in the model include population, housing, vehicle registrations, state tax revenue, and energy. The data for the U.S. comes from IHS Global Insight, Inc., a national leader in economic forecasting.

Methodology

Eighteen supporting recommendations are proposed to assist in achieving the 2020 greenhouse gas emissions limit established in the 2007 Global Warming Response Act. The supporting recommendations affect the following sectors:

- Green Buildings;
- Waste Management;

RUTGERS
Edward J. Bloustein School
of Planning and Public Policy

Center for Energy, Economic & Environmental Policy
Rutgers, The State University of New Jersey
33 Livingston Avenue, First Floor
New Brunswick, NJ 08901

www.policy.rutgers.edu/ceeep

732-932-5680
Fax: 732-932-0394

- Commercial and Industrial Refrigeration and Air Conditioning;
- Terrestrial Carbon Sequestration; and
- Transportation and Land Use.

CEEEP and R/ECON analyzed the economic impacts of the supporting recommendations; the environmental benefits of the proposed measures were not accounted for in the analysis. The baseline forecast for this scenario includes the programs in the EMP, LEV, and the Regional Greenhouse Gas Initiative (RGGI). The baseline forecast begins in the 2nd quarter of 2009 and runs through the end of 2020.

CEEEP estimated adjustments of several variables in the R/ECON model over the period from 2010 to 2020 to account for the supporting recommendations. All adjustments were applied to gross state product in the construction, transportation, and state and local government sectors, or to prices for vehicles, homes, or commercial and industrial buildings. Additionally, CEEEP estimated the direct employment resulting from these supporting recommendations, which was added to the construction and state government job base.

Besides the economic changes, the plan also indicates estimated future energy consumption for the supporting recommendations that apply to use of electricity, natural gas, diesel fuel, and motor fuel. Overall consumption of these energy sources has been directly reduced in the R/ECON model. Due to the interconnectivity of the model (and the economy), total consumption falls by slightly more in a few areas where no direct changes were made.

Key Assumptions

CEEEP utilized the Center for Climate Strategies (CCS) and NJDEP's September 2009 report, *Analysis of Potential Greenhouse Gas Emission Reductions and Costs of Supporting Recommendations for New Jersey's Climate Action Plan* to develop the adjustments for several of the R/ECON variables. The following tables provide the key assumptions and data gleaned from the report and the back-up data provided by NJDEP.

<u>Green Buildings</u>

The Green Buildings recommendations increase the cost of new and existing homes and commercial buildings. The total costs and benefits and the additional cost per residential home are shown in Tables 1 (a) and (b) respectively. The energy savings associated with the program can be found in Table 1 (c).

RUTGERS
Edward J. Bloustein School
of Planning and Public Policy

Center for Energy, Economic & Environmental Policy
Rutgers, The State University of New Jersey
33 Livingston Avenue, First Floor
New Brunswick, NJ 08901

www.policy.rutgers.edu/ceeep

732-932-5680
Fax: 732-932-0394

Table 1 (a): Total Costs and Benefits 2010 to 2020 (millions $2007)

	Total Costs	Total Benefits	Net Benefits
New Residential	$734	$973	$239
New Commercial	$180	$241	$61
Existing Residential	$502	$1,213	$711
Existing Commercial	$123	$288	$165

Table 1 (b): Cost per New and Existing Residential Home

	Cost per New Home	Cost per Existing Home
2010	$2,067	$1,413
2011	$2,264	$1,547
2012	$2,479	$1,695
2013	$2,714	$1,855
2014	$2,969	$2,030
2015	$3,247	$2,220
2016	$3,550	$2,427
2017	$3,880	$2,652
2018	$4,239	$2,897
2019	$4,630	$3,165
2020	$5,056	$3,456

Table 1 (c): Electricity and Natural Gas Savings[1]

	Electricity Savings (MWh)				Natural Gas Savings (Million Cubic Feet)			
	Residential		***Commercial***		***Residential***		***Commercial***	
	New	*Existing*	*New*	*Existing*	*New*	*Existing*	*New*	*Existing*
2010	78,229	97,568	20,001	23,948	401	501	103	123
2011	156,728	195,474	40,071	47,979	804	1,003	206	246
2012	251,252	313,366	64,238	76,915	1,289	1,608	330	395
2013	362,149	451,679	92,592	110,863	1,858	2,318	475	569
2014	489,597	610,634	125,177	149,878	2,512	3,133	642	769
2015	633,772	790,451	162,039	194,014	3,252	4,056	831	995
2016	794,852	991,353	203,222	243,324	4,078	5,087	1,043	1,249
2017	956,817	1,193,359	244,632	292,906	4,909	6,123	1,255	1,503
2018	1,119,774	1,396,600	286,296	342,791	5,746	7,166	1,469	1,759
2019	1,283,721	1,601,078	328,213	392,980	6,587	8,215	1,684	2,016
2020	1,448,660	1,806,792	370,383	443,471	7,433	9,271	1,900	2,275

[1] Electricity savings is presented in megawatt hours, abbreviated MWh, equivalent to 1,000 kilowatt hours.

Center for Energy, Economic &
Environmental Policy
Rutgers, The State University of New Jersey
33 Livingston Avenue, First Floor
New Brunswick, NJ 08901

www.policy.rutgers.edu/ceeep

732-932-5680
Fax: 732-932-0394

Waste Management

The Waste Management recommendation is comprised of three programs. Overall, these programs will lower the cost of waste disposal to local governments, see Table 2.

Table 2: Total Costs, Total Savings, and Electricity Savings

	Wastewater Treatment Plant Efficiency		**Municipal Solid Waste**	**Landfill Gas Control**
	Total Cost ($2007)	*Electricity Savings (MWh)*	*Total Savings ($2007)*	*Total Costs ($2007)*
2010	$30,900	-	-	$66,333
2011	$95,481	65,403	$4,667,960	$132,665
2012	$240,400	130,805	$9,615,998	$198,998
2013	$450,204	196,208	$14,856,716	$265,331
2014	$718,750	261,611	$20,403,224	$331,663
2015	$1,062,707	327,013	$26,269,151	$331,663
2016	$1,426,654	392,416	$32,468,670	$331,663
2017	$1,874,820	457,818	$39,016,519	$331,663
2018	$2,387,735	523,221	$45,928,016	$331,663
2019	$2,970,055	588,624	$53,219,089	$331,663
2020	$3,059,157	654,026	$60,906,290	$331,663

Commercial and Industrial Refrigeration and Air Conditioning

The Commercial and Industrial Refrigeration and Air Conditioning recommendation lowers the construction costs of commercial and industrial properties. The total annual savings for New Jersey are shown in the table below. Construction jobs were estimated utilizing the California Air Resources Board's 2009 report, *High-Global Warming Potential Stationary Source Refrigerant Management Program Appendix A and B.*

Table 3: Total Annual Savings

Center for Energy, Economic & Environmental Policy
Rutgers, The State University of New Jersey
33 Livingston Avenue, First Floor
New Brunswick, NJ 08901

www.policy.rutgers.edu/ceeep

732-932-5680
Fax: 732-932-0394

Total Annual Savings	
2010	$757,452
2011	$853,970
2012	$962,471
2013	$1,082,653
2014	$1,215,795
2015	$1,364,595
2016	$1,531,491
2017	$1,719,038
2018	$1,930,338
2019	$2,166,954
2020	$2,430,736

Terrestrial Carbon Sequestration

The Terrestrial Sequestration recommendation is comprised of five programs that propose restocking or planting trees in various areas of the state and removing land from the private sector. Removal of land from the private sector will increase the cost of building new homes. The annual costs of each program are shown in Table 4 (a) below.

The Urban Forest Canopy/Cover electricity savings were determined using the No Net Loss cost of electricity. The Sustainable Agriculture fuel savings were determined using the cumulative acres and cost of diesel per acre provided in the CCS and NJDEP report; see Table 4 (b).

Table 4 (a): Annual Costs ($2007)

	Forest Stewardship	No Net Loss	Urban Forest	Sustainable Agriculture	Garden State Preservation
2010	$146,926	$315,775	$2,866,881	$245,000	$50,000,000
2011	$187,277	$524,975	$8,167,763	$280,000	$50,000,000
2012	$227,627	$734,174	$13,468,644	$315,000	$50,000,000
2013	$267,977	$943,373	$18,769,526	$350,000	$50,000,000
2014	$308,327	$1,152,573	$24,070,407	$385,000	$50,000,000
2015	$348,678	$1,361,772	$29,371,289	$420,000	$50,000,000
2016	$389,028	$1,570,972	$34,672,170	$455,000	$50,000,000
2017	$429,378	$1,780,171	$39,973,051	$490,000	$50,000,000
2018	$469,728	$1,989,370	$45,273,933	$525,000	$50,000,000
2019	$510,079	$2,198,570	$50,574,814	$560,000	$50,000,000
2020	$550,429	$2,407,769	$55,875,696	$595,000	$50,000,000

RUTGERS
Edward J. Bloustein School
of Planning and Public Policy

Center for Energy, Economic & Environmental Policy
Rutgers, The State University of New Jersey
33 Livingston Avenue, First Floor
New Brunswick, NJ 08901

www.policy.rutgers.edu/ceeep

732-932-5680
Fax: 732-932-0394

Table 4 (b): Energy Savings

	No Net Loss	**Urban Forest Canopy/Cover**	**Sustainable Agriculture**
	Electricity Saved (MWh)		*Diesel Savings (Million Gallons)*
2010			0.012
2011	54	1,936	0.025
2012	81	3,872	0.039
2013	108	5,615	0.053
2014	135	7,238	0.067
2015	162	8,746	0.083
2016	189	10,147	0.099
2017	216	11,444	0.116
2018	243	12,644	0.133
2019	270	13,751	0.152
2020	296	14,771	0.171

Transportation and Land Use

The Transportation Land Use recommendation is comprised of six programs that aim to boost transit ridership and the availability of hybrid electric and zero-emissions vehicles (PHEV and ZEV), reduce vehicle miles traveled (VMT), improve road infrastructure, and upgrade trucks and truck stops.[2] The increased availability of hybrid electric and zero emissions vehicles will increase the price of new cars and light trucks (see Table 5 (a)). The increased prices of new vehicles and homes will cause an increase in the consumer price index that R/ECON uses for New Jersey.

The four tables below present the inputs utilized by CEEEP to determine the adjustments to the R/ECON model variables. The annual incremental vehicle costs for the plug-in hybrid electric vehicles and zero emission vehicles, annual net costs and savings, and additional annual costs are shown in Tables 5 (a) and (b). Table 5 (c) shows energy consumption data and Table 5 (d) shows the key assumptions utilized for the remaining program, Road Infrastructure.

[2] Increasing shuttle rail goods movement was not included in the analysis because R/ECON does not account for changes in rail. The recommendation would have no net result on the economy because wholesale retail will increase as trucking decreases.

RUTGERS
Edward J. Bloustein School
of Planning and Public Policy

Center for Energy, Economic & Environmental Policy
Rutgers, The State University of New Jersey
33 Livingston Avenue, First Floor
New Brunswick, NJ 08901

www.policy.rutgers.edu/ceeep

732-932-5680
Fax: 732-932-0394

Table 5 (a): Incremental Costs, Net Costs and Savings

	PHEV		**ZEV**		**Reduce VMT**	**Double Transit Ridership**
	Incremental Vehicle Costs (2005$)				*Net Savings (Million $2007)*	*Net Cost (Million $2007)*
	Auto	*Truck*	*Auto*	*Truck*		
2010	$8,934	$11,930	$14,842	$18,496	$112	$974
2011	$8,746	$11,777	$14,761	$18,471	$224	$946
2012	$8,558	$11,625	$14,680	$18,446	$336	$918
2013	$8,370	$11,472	$14,599	$18,421	$448	$890
2014	$8,181	$11,320	$14,517	$18,396	$560	$863
2015	$7,993	$11,167	$14,436	$18,371	$672	$835
2016	$7,805	$11,014	$14,355	$18,346	$784	$807
2017	$7,617	$10,862	$14,274	$18,321	$896	$779
2018	$7,429	$10,709	$14,193	$18,296	$1,008	$752
2019	$7,241	$10,557	$14,112	$18,271	$1,120	$724
2020	$7,053	$10,404	$14,031	$18,246	$1,233	$696

Table 5 (b): Low Carbon Goods Movement Annual Costs

Trailer Refrigeration Units/Truck Stop Electrification		
Additional Cost per Standby	$1,300	2002$
Annual Cost of Extra Weight	$10	2004$
Annual Maintenance Costs	$555	2004$
Cost/Electric Berth	$ 4,416	2004$
Idle Air Price per Hour	$2.67	2008$

Center for Energy, Economic & Environmental Policy
Rutgers, The State University of New Jersey
33 Livingston Avenue, First Floor
New Brunswick, NJ 08901

www.policy.rutgers.edu/ceeep

732-932-5680
Fax: 732-932-0394

Table 5 (c): Electricity Consumed and Gasoline Savings

	PHEV	**ZEV**	**Reduce VMT**	**Transit Ridership**	**PHEV**	**ZEV**	**Trailer Refrigerator Units**	**Truck Stop Electrification**
	Gasoline Reduction (Million Gallons)				*Electricity Consumption (MWh)*			
2010	7	5	27	5	8,733	57,447	17,780	0.0038
2011	20	16	53	10	26,366	181,582	30,617	0.0038
2012	40	33	80	15	53,925	365,709	43,608	0.0038
2013	66	55	106	20	90,023	591,449	56,759	0.0038
2014	97	82	133	26	129,842	845,319	70,075	0.0038
2015	134	113	160	31	180,583	1,123,654	83,560	0.0038
2016	176	148	186	36	238,252	1,427,506	97,219	0.0038
2017	221	186	213	41	304,245	1,739,946	111,058	0.0038
2018	275	228	240	46	381,172	2,056,189	125,083	0.0038
2019	324	273	266	51	448,544	2,362,965	128,835	0.0038
2020	368	320	293	56	500,126	2,656,546	132,700	0.0038

Table 5 (d): Key Assumptions Associated with Road Infrastructure Improvement

Signal Synchronization	
Fuel Saved per Year (Gallon Gasoline)	580,038
Traffic Controller Cost	18,816,000
Time Value ($)	$ 5,287,042
Expand Emergency Service Patrols	
Gasoline Saved per Year (Gallons)	160,000
Diesel Consumed per Year (Gallons	14,000
Time Value ($)	$ 1,458,400
Capital Cost of Trucks	$ 601,450
Indirect Costs	20.29%

Results

In general, the proposed NJDEP programs have a slightly negative impact on the macro-economy, as seen in Table 6. By 2020, the scenario shows a 7,000 job (0.2 percent) reduction from the base case, as well as a small increase in the unemployment rate. There is also a 0.6 percent reduction in real gross state product in 2020, a 0.05 decrease in personal income, and a 0.4 percent increase in the consumer price index. Over the 12 year period from 2008 to 2020 the program would decrease total job creation by 4 percent, from 158,000 to 151,000.

Center for Energy, Economic & Environmental Policy
Rutgers, The State University of New Jersey
33 Livingston Avenue, First Floor
New Brunswick, NJ 08901
www.policy.rutgers.edu/ceeep
732-932-5680
Fax: 732-932-0394

There are a few areas where the decreases would be greater—the areas where the recommendations are targeted. The green building program would increase the prices of both new and existing homes, resulting in a small decrease in residential building permits, a 2.6 percent decrease in existing home sales and a 1.5 percent decrease in new home sales in 2020. Vehicle prices are likely to rise by as much as 14 percent by 2020 to pay for conversion to low or no carbon fuel use, with the price of automobiles rising somewhat more than the price of light trucks. By 2020 vehicle registrations (the proxy for sales) will be 3.3 percent lower in the NJDEP scenario than in the baseline. Both the number of automobiles and light trucks registered will decline in the NJDEP scenario compared to the baseline. However, light truck registrations will fall more steeply, so that they will decrease from 43 percent of total registrations in 2008 to 38 percent in 2020 in the NJDEP scenario, compared to 39 percent in 2020 in the baseline. Retail sales will be 1.8 percent lower in 2020 in the NJDEP scenario than in the baseline because of the decrease in both vehicle sales and motor fuel sales. One result of the decline in vehicle sales will be a decline of 0.3 percent in vehicle miles traveled in 2020 in the NJDEP scenario compared to the baseline.

Overall tax revenues in 2020 will be 0.3 percent lower in the NJDEP scenario compared to the baseline. However, in 2020, higher vehicles prices will result in a 4.7 percent increase in motor vehicle registration fees, while the decline in the number of vehicles and vehicle miles traveled will result in lower motor fuel tax revenues. Real property transfer tax revenues will also be lower in the NJDEP scenario because the decline in home sales is larger than the increase in home prices.

As noted earlier, these results do not reflect the co-benefits that would accrue to the state from implementing the recommendations discussed in this report. For example, reducing greenhouse gas emissions emitted by fossil fuel-fired electric generating units will also reduce emissions of sulfur dioxide and various nitrogen oxides that are air pollutants in their own right as well as components of acid rain. Certain nitrogen oxides are also ozone precursors, and ozone is known to have adverse health effects in some circumstances. Reducing greenhouse gas emissions will also help protect New Jersey's natural capital, which produces a variety of valuable ecosystem goods and services. Some of these co-benefits are being quantified in a separate study which is expected to be completed during the fall of 2009.

Table 6: Comparison of New Jersey Economy under NJDEP Baseline August 2009 and NJDEP Scenario October 12, 2009

RUTGERS
Edward J. Bloustein School of Planning and Public Policy

Center for Energy, Economic & Environmental Policy
Rutgers, The State University of New Jersey
33 Livingston Avenue, First Floor
New Brunswick, NJ 08901

www.policy.rutgers.edu/ceeep

732-932-5680
Fax: 732-932-0394

	NJDEP Baseline		**NJDEP Scenario**		**Difference in 2020**	
	2008	*2020*	*2008*	*2020*	*Scenario-Baseline*	
Non-Agriculture Employment (thousands)	4,058	4,216	4,058	4,209	-7.0	-0.17%
Unemployment Rate (%)	5.5%	4.8%	5.5%	4.8%	0.0	0.41%
Population (thousands)	8,683	9,286	8,683	9,283	-2.7	-0.03%
Households (thousands)	3,253	3,442	3,253	3,441	-0.3	-0.01%
Personal Income (billions)	$442	$706	$442	$705	-0.4	-0.05%
Retail Sales (billions)	$147	$206	$147	$202	-3.7	-1.81%
New Vehicle Registrations	529,575	703,070	529,575	679,941	-23,129	-3.29%
New Car Registrations	299,600	425,661	299,600	423,274	-2,387	-0.56%
New Light Trucks and Vans	229,975	277,409	229,975	256,667	-20,742	-7.48%
Vehicle Miles Traveled (Millions)	74,163	76,636	74,163	76,394	-242.5	-0.32%
Residential Building Permits	19,000	36,759	19,000	36,468	-291.2	-0.79%
Commercial Floorspace (Mill. Sq.Ft.)	2,331	2,844	2,331	2,825	-19.8	-0.70%
Consumer Price Index (1982=100)	230	288	230	290	1.2	0.40%
Gross State Product ($2000 billions)	$390	$472	$390	$469	-2.8	-0.60%
Total Taxes ($millions)[3]	$27,649	$45,411	$27,649	$45,296	-115.7	-0.25%
Motor Vehicle Fees	$131	$127	$131	$133	5.9	4.65%
Motor Fuel Taxes	$138	$124	$138	$123	-1.2	-0.98%
Property Transfer Tax	$67	$102	$67	$100	-1.4	-1.42%

It is important to note that energy use under the NJDEP scenario will be 3.3 percent lower in 2020 than in the baseline scenario. The state will lower electricity usage by 3.3 percent, natural gas usage by 3.2 percent, fuel oil usage (including diesel) by 0.5 percent, and motor fuel usage by 5.4 percent. See Table 7 for additional energy results. These reductions will help increase the

[3] Total taxes includes about 80% of state tax revenues: gross income tax, corporation business tax, sales tax, motor fuel tax, motor vehicle fee, transfer inheritance tax, alcoholic beverage tax, property transfer tax, petroleum products tax, cigarette tax, corporate business and financial institutions tax, and public utility tax.

RUTGERS
Edward J. Bloustein School of Planning and Public Policy

Center for Energy, Economic & Environmental Policy
Rutgers, The State University of New Jersey
33 Livingston Avenue, First Floor
New Brunswick, NJ 08901

www.policy.rutgers.edu/ceeep

732-932-5680
Fax: 732-932-0394

country's energy independence and the security of our energy supplies, benefits which are not included in this report because of the difficulty in quantifying them.

Table 7: Comparison of New Jersey Fuel Use under NJDEP Baseline August 2009 and NJDEP Scenario October 12, 2009

	NJDEP Baseline		**NJDEP Scenario**		**Difference in 2020**	
	2008	*2020*	*2008*	*2020*	*Scenario-Baseline*	
Electricity (MWh)						
Residential Use	29,131,708	24,028,685	29,131,708	23,718,248	-310,437	-1.3%
Commercial Use	40,280,110	36,735,323	40,280,110	35,999,534	-735,789	-2.0%
Industrial Use	9,158,167	8,306,391	9,158,167	8,258,607	-47,784	-0.6%
Other Use	286,391	270,523	286,391	265,241	-5,282	-2.0%
Total	78,856,376	69,340,922	78,856,376	68,241,630	-1,099,292	-1.6%
Natural Gas (Billion Cubic Feet)						
Residential Use	184,635	158,352	184,635	142,609	-15,743	-9.9%
Commercial Use	145,584	241,487	145,584	236,875	-4,612	-1.9%
Industrial Use	38,251	55,167	38,251	55,165	-2	0.0%
Electricity Use	147,615	74,405	147,615	70,657	-3,748	-5.0%
Total	516,085	529,411	516,085	505,306	-24,105	-4.6%
Fuel Oil (Thousand Gallons)						
Residential Use	310,568	71,975	310,568	71,857	-118	-0.2%
Commercial Use	160,971	25,143	160,971	25,143	0	0.0%
Industrial Use	8,749	146	8,749	146	0	-0.1%
Other Use	90,556	108,279	90,556	108,279	0	0.0%
Transportation Use	1,000,748	1,231,097	1,000,748	1,145,730	-85,367	-6.9%
Residual Use	900,113	270,290	900,113	268,065	-2,226	-0.8%
Total	2,471,706	1,706,929	2,471,706	1,619,219	-87,711	-5.1%
Annual Sales Motor Fuel (Million Gallons)	4,192	3,475	4,192	2,992	-483	-13.9%
Total Annual Use (Billion British Thermal Units)	1,661,989	1,447,945	1,661,989	1,347,329	-100,617	-6.9%

RUTGERS
Edward J. Bloustein School
of Planning and Public Policy

Center for Energy, Economic & Environmental Policy
Rutgers, The State University of New Jersey
33 Livingston Avenue, First Floor
New Brunswick, NJ 08901

www.policy.rutgers.edu/ceeep

732-932-5680
Fax: 732-932-0394

A Comparison of the R/ECON Baseline and NJDEP Baseline Scenarios

The macroeconomic effects of changes in energy prices and consumption are seen in Table 1. Most of the effects of the Energy Master Plan policies are marginal. However, they do indicate that the EMP policies lead to an increase in non-agricultural employment (approximately 18,600 jobs), a decline in the unemployment rate, a 1.7 percent increase in personal income, and a 1.9 percent increase in major state tax revenues. As noted in Section III, the results below do not include the economic benefits of reducing greenhouse gases in the Energy Master Plan Scenario. Thus, even without accounting for the greenhouse gas reduction, the economy improves slightly under the Energy Master Plan Scenario as compared to the Baseline.

Table 1. Macroeconomic Indicators Based on R/ECON™ Output

	2020 Average BAU	2020 Average Alt.	% Difference
Non-ag. Employment(thous)	4392.1	4410.7	0.4%
Unemployment Rate(%)	4.8%	4.7%	-0.8%
Personal Income($bill)	$791.0	$804.8	1.7%
Real Personal Income($bill, 2000)	$274.0	$278.5	1.6%
Retail Sales($bill)	$270.3	$274.0	1.4%
Real Retail Sales($bill, 2000)	$93.6	$94.8	1.3%
New Vehicle Registrations(thous)	658.8	659.0	0.0%
New Car Registrations	397.9	398.0	0.0%
New Light Trucks and Vans	260.9	261.0	0.1%
Residential Building Permits	26,204	25,466	-2.8%
Contract Construction($mill)	$14,818	$15,156	2.3%
Consumer Price Index(1982=100)	288.6	289.0	0.1%
Gross State Product($2000 bill)	$507.0	$507.4	0.1%
Total Tax Revenues($bill)	$51.2	$52.1	1.9%

Source: R/ECON™ model output generated on 9/30/2008 (BAU) and 10/10/2008 (Energy Master Plan).

The above table does not include the Low Emissions Vehicles (LEV) policy. To compare this set of data accurately to the latest version the LEV policies must be included. The macroeconomic effects of changes in energy prices and consumption including LEV are seen in Table 2. Most of the effects of the Energy Master Plan policies are marginal. However, they do indicate that the EMP policies lead to an increase in non-agricultural employment (approximately 16,500 jobs), a decline in the unemployment rate, a 1.7 percent increase in personal income, and a 1.6 percent increase in major state tax revenues. However, they also show a tiny decrease in real Gross State Product. Higher vehicle and home prices result in lower new vehicle registrations and residential building permits, and consequently lower nominal and real retail sales. The latter results are the consequence of higher vehicle and home prices. Thus the EMP including LEV produces a mixed set of results for the state's economy.

Rutgers
Edward J. Bloustein School of Planning and Public Policy

Center for Energy, Economic & Environmental Policy
Rutgers, The State University of New Jersey
33 Livingston Avenue, First Floor
New Brunswick, NJ 08901

www.policy.rutgers.edu/ceeep

732-932-5680
Fax: 732-932-0394

Table 2. Macroeconomic Indicators Based on R/ECON™ Output Inclusive of LEV

	2020 Average BAU	2020 Average Alt.with LEV	% Difference
Non-ag. Employment(thous)	4,392.1	4,408.6	0.4%
Unemployment Rate(%)	4.80%	4.73%	-1.4%
Personal Income($bill)	$791.0	$804.5	1.7%
Real Personal Income($bill, 2000)	$274.1	$278.4	1.6%
Retail Sales($bill)	$270.3	$269.7	-0.2%
Real Retail Sales($bill, 2000)	$93.7	$93.3	-0.4%
New Vehicle Registrations(thous)	658.8	658.0	-0.1%
New Car Registrations	397.9	398.0	0.0%
New Light Trucks and Vans	260.9	260.0	-0.4%
Residential Building Permits	26,204	25,435	-2.9%
Consumer Price Index(1982=100)	288.6	289.0	0.1%
Gross State Product($2000 bill)	$507.0	$505.8	-0.2%
Total Tax Revenues($bill)	$51.2	$52.0	1.6%

Source: R/ECON™ model output generated on 9/30/2008 (BAU) and 11/2/2008 (Energy Master Plan with LEV).

Table 3 shows the results of the EMP with LEV using the latest R/ECON model and data updated through the first quarter of 2009. For the most part the levels of the indicators are lower than in the simulations from last summer, because of the impact of the recession on the state's economy. That is not true of either vehicle registrations or residential building permits. That is an artifact of the pattern of recovery. Both are quite low during most of the forecast period and only begin to catch up after 2015. Again, most of the effects of the Energy Master Plan policies are marginal, although they do indicate that the EMP plus LEV policies lead to an increase in non-agricultural employment (approximately 18,300 jobs) and a decline in the unemployment rate. However, they also show tiny decreases in personal income, real Gross State Product. Higher vehicle and home prices result in lower new vehicle registrations and residential building permits, and consequently lower nominal and real retail sales and lower tax collections. The latter results are the consequence of higher vehicle and home prices. Thus the EMP including LEV produces a mixed set of results for the state's economy.

RUTGERS
Edward J. Bloustein School of Planning and Public Policy

Center for Energy, Economic & Environmental Policy
Rutgers, The State University of New Jersey
33 Livingston Avenue, First Floor
New Brunswick, NJ 08901

www.policy.rutgers.edu/ceeep

732-932-5680
Fax: 732-932-0394

Table 3. Macroeconomic Indicators Based on R/ECON™ Output Inclusive of LEV

	2020 Average BAU	2020 Average Alt.with LEV	% Difference
Non-ag. Employment(thous)	4,197.4	4,215.7	0.4%
Unemployment Rate(%)	4.8%	4.8%	-0.5%
Personal Income($bill)	$706.4	$705.8	-0.1%
Real Personal Income($bill, 2000)	$245.2	$244.8	-0.2%
Retail Sales($bill)	$208.4	$206.0	-1.2%
Real Retail Sales($bill, 2000)	$72.4	$71.4	-1.3%
New Vehicle Registrations(thous)	705.4	703.1	-0.3%
New Car Registrations	425.6	425.7	0.0%
New Light Trucks and Vans	279.8	277.4	-0.9%
Residential Building Permits	38,026	36,759	-3.3%
Consumer Price Index(1982=100)	288.1	288.4	0.1%
Gross State Product($2000 bill)	$473.8	$471.7	-0.4%
Total Tax Revenues($bill)	$45.6	$45.4	-0.3%

Source: R/ECON™ model output generated August 2009 (BAU) and September 2009 (Energy Master Plan with LEV).