New Jersey Sustainability Greenhouse Gas Action Plan

State of New Jersey
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DEP

Department of Environmental Protection
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NEW JERSEY SUSTAINABILITY GREENHOUSE GAS ACTION PLAN

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Acronyms

ANJEC	Association of New Jersey Environmental Commissions
AFVs	Alternative Fuel Vehicles
ATS	Advanced Turbine System
BISW	Bulky/Industrial Solid Waste
BTU	British Thermal Unit
C	Carbon
CO_2	Carbon Dioxide
CCAP	Center for Clean Air Policy
CFC	Chlorofluorocarbon
CH_4	Methane
EDECA	Electric Discount and Energy Competition Act
EIA	Energy Information Administration
ESCO	Energy Service Company
GHG	Greenhouse Gases
HCFC	Hydrochlorofluorocarbon
HVAC	Heating Ventilation Air Control
IPCC	Intergovernmental Panel on Climate Change
I/M	Inspection and Maintenance
LEV	Low Emission Vehicle
MM	Million
MMT	Million Metric Tons
MOU	Memorandum of Understanding
MSW	Municipal Solid Waste
Mw	Megawatt
NAS	National Academy of Sciences
NEPPS	National Environmental Performance Partnership System
NJBPU	New Jersey Board of Public Utilities
NJCF	New Jersey Clean Fleets
NJDEP	New Jersey Department of Environmental Protection
NJDOT	New Jersey Department of Transportation
NO_X	Oxides of Nitrogen
NJ Treasury	New Jersey Department of Treasury
NRCS	Natural Resource Conservation Service
O_2	Oxygen
PPG	Performance Partnership Grant
RPS	Renewable Portfolio Standard
SBC	Societal Benefits Charge
SF_6	Sulfur Hexafluoride
SP	Strategic Plan
PV	Photovoltaics
USDOE	United States Department of Energy
USEPA	United States Environmental Protection Agency
VMTs	Vehicle Miles Traveled

EXECUTIVE SUMMARY

New Jersey 1999 Sustainability Report - Living with the Future in Mind

In 1999, New Jersey Future, a non-profit, non-partisan group published its report, "Living with the Future in Mind - Goals and Indicators for New Jersey's Quality of Life". The report was part of New Jersey Future's Sustainable State project. The report is a "report card" on the long-term trends that can enhance or reduce the quality of life in New Jersey.

The 11 goals described in the 1999 report are the product of a four year dialog with citizens from all walks of life that helped to develop the 41 indicators outlined in the report. The indicators were selected to measure specific progress towards sustainability goals. This will allow for the establishment of meaningful targets or benchmarks for each indicator to assist in achieving the overall goal of sustainability. Among these indicators are energy consumption and greenhouse gas emissions, two topics that are central to the issues discussed in this Action Plan.

In Executive Order 96 (Appendix A) issued on May 20, 1999, Governor Whitman directed all state agencies to pursue policies that support the sustainability goals outlined in the "Living with the Future in Mind" report. Executive Order 96 directs all state departments and agencies to exchange information and establish institutional mechanisms to encourage and facilitate achieving the sustainable State goal in the New Jersey Future report. Executive Order 96 requires each department/agency to report on progress towards the sustainable State goal. The New Jersey Department of Environmental Protection (NJDEP) Sustainability Greenhouse Gas (GHG) Action Plan is one tool the NJDEP will use to track the State's progress towards sustainability. NJDEP, through its Strategic Plan and National Environmental Performance Partnership System (NEPPS) process, will develop specific GHG indicators that track the progress of the strategies in this Action Plan.

Greenhouse Gases and Global Warming

Despite some lingering debate about the impacts of greenhouse gases (GHGs) on global climate change, the international scientific consensus is that the primary cause of global climate warming during the last century is the anthropogenic input of GHGs in the atmosphere.

GHGs are chemical compounds that absorb infrared radiation in the form of heat, preventing the venting of this energy into space. A certain level of greenhouse gases in the atmosphere is essential to maintaining the earth's temperature at a level that can support life. However, as the concentration of GHGs in the atmosphere increases, more heat is trapped and the overall global climate is altered.

Sea Level Rise and New Jersey

One of the most significant environmental impacts attributable to global warming in New Jersey is sea level rise. Sea level rise may result in significant long-term environmental and economic impacts to states, such as New Jersey, with extensive shore communities and investment in coastal development. As sea level rises storm severity increases, causing greater damage. By the year 2050, higher sea levels would turn a storm from an event that might presently occur only once every 20 years into an event that would occur once every five years. At a time when commercial and

residential shore development is increasing, a changing climate places billions of dollars in infrastructure and personal property in New Jersey at risk.

New Jersey Coastal Alliance and Coastal Plan

In 1994 Governor Whitman highlighted the connection between changing climate and sea level rise while speaking at a conference on shore protection. In 1997, Governor Whitman released the New Jersey Coastal Report: A Framework for a Coastal Management Partnership[1] (at a shore summit). The report highlights issues such as the Coastal Area Facility Review Act (CAFRA), water quality, biodiversity and contains a section discussing climate change and sea level rise.

New Jersey Actions to Reduce Greenhouse Gases

A number of actions have been taken in New Jersey to begin to address the potential environmental and economic impacts of global warming for the State and the international community. The basis for these actions is that they, in and of themselves, make environmental and economic sense. These actions are described in this Action Plan and Addendum and will be used to assist in developing indicators that will be used to inform NJDEP's progress toward our sustainable state goal.

The NJDEP Global Change Workgroup

On June 16, 1997, New Jersey Department of Environmental Protection Commissioner Robert C. Shinn, Jr. formed the New Jersey Global Change Workgroup. The NJDEP Workgroup was formed to establish work with external stakeholders to assist in the development of New Jersey's Action Plan in response to global climate change. External stakeholders included representatives from academia, industry, public interest groups, nine state agencies and two federal agencies. A copy of this memo may be found in Appendix B.

Commissioner Shinn's Administrative Order on Climate Change

NJDEP Commissioner Shinn issued Administrative Order 1998-09 (Appendix C) on climate change on March 17, 1998. It presents the broad policy goals of the NJDEP on this subject, establishes the quantitative target of a 3.5% reduction in New Jersey's GHG emissions below our 1990 baseline by 2005 and describes procedures to accomplish this milestone.

Letter of Intent with the Netherlands Environmental Ministry

Recognizing the importance of cooperation, the NJDEP and the Netherlands Environmental Ministry signed a Letter of Intent on June 5, 1998 that outlines a number of areas where the two will work together to address issues related to global climate change, including the development of an emissions banking system. A copy of the Letter of Intent is located in Appendix D.

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[1]New Jersey Coastal Report: A Framework Document for a Coastal Management Partnership, 1997, NJDEP

The New Jersey Sustainability Greenhouse Gas Action Plan

The New Jersey Sustainability GHG Action Plan identifies the major sources of GHGs by source and sector in 1990. These are illustrated in Figures E1 and E2. In Figure E1 it is evident that the major source of GHGs comes from the combustion of fossil fuel. More than 80% of the GHGs in New Jersey result from the combustion of fossil fuel to produce energy for heating, cooling, electricity and transportation. Figure E2 further refines the analysis by identifying fossil fuel CO_2 emissions by sector.

Figure E1
Greenhouse Gas Emissions by Source 1990 NJ Emissions CO_2 Equivalents

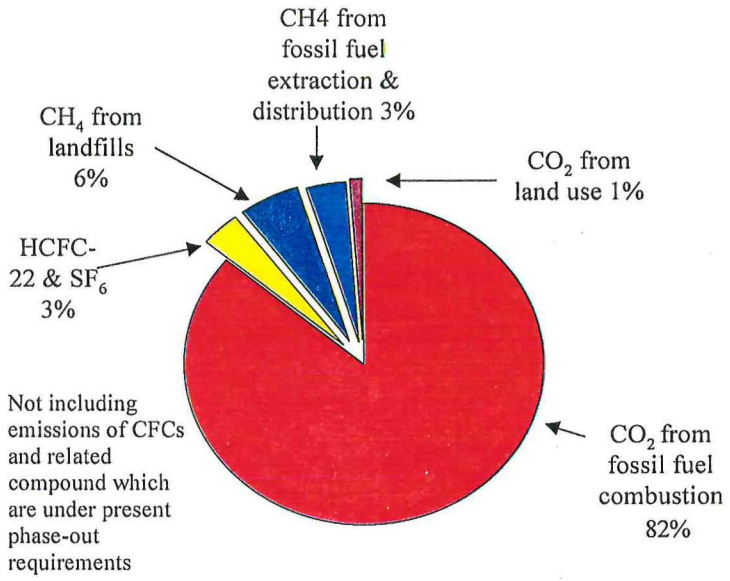
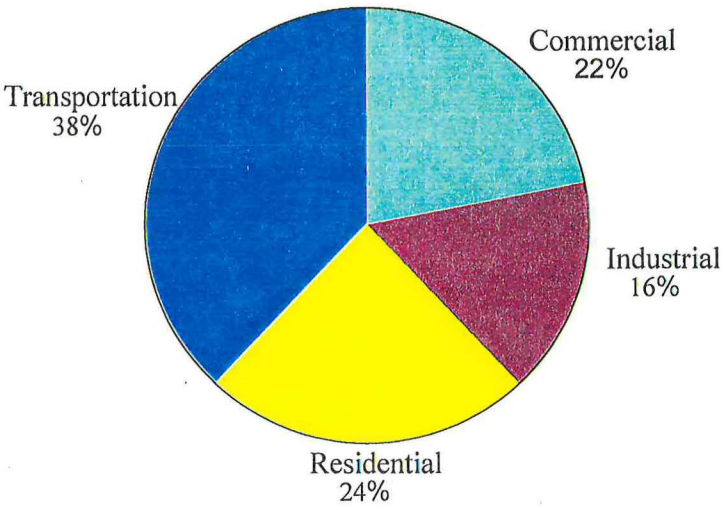


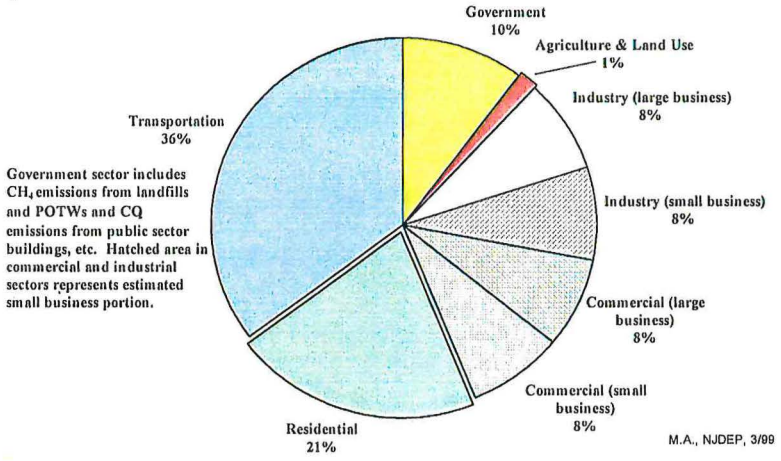
Figure E2
Fossil Fuel CO_2 Emissions by Sector New Jersey: 1990



1999.

These two figures are combined to allocate the GHG generation by sectors in six areas as illustrated in Figure E3.

Figure E3*
Greenhouse Gas Emissions; New Jersey CO_2 equivalents
Based on 1990 emissions inventory and more recent estimates for some sectors



* Government Sector includes municipal waste and waste water operations.
Commercial Sector includes office buildings, including government buildings, schools and hospitals.
Industrial Sector includes manufacturing operations.
Transportation Sector includes on and off road vehicles.

This data was used by the Stakeholders involved in the process to identify "no regrets" strategies that achieved the State's 3.5% reduction in New Jersey's GHG emissions below 1990 levels by 2005.

"No regrets" strategies include actions that are currently readily available and that pay for themselves within the short term. In addition, they provide environmental benefits.

The recommended strategies are organized under the following five categories:

- Energy Conservation
- Innovative Technologies
- Pollution Prevention
- Waste Management - MSW Landfill Gas Recycling
- Natural Resources
  Open Space

Energy Conservation

Energy conservation strategies were identified by stationary sources, such as residential buildings, commercial buildings and industrial operations, and by transportation sources. The greatest potential for savings in residential and commercial buildings includes the installation of high efficiency equipment for space and water heating and lighting.

The approaches to reducing energy consumption, and concurrently GHG emissions in industrial operations, include improved maintenance, the utilization of efficient manufacturing systems and the use of new process improvements, such as low carbon technologies.

The primary initiative identified to reduce GHGs in the transportation sector was New Jersey's Enhanced Inspection and Maintenance (I/M) Program. This program was estimated to result in a 10% reduction in the GHG emissions from vehicles with serious emission problems.

Innovative Technologies

Innovative technologies that improved the efficiency of fossil fuel combustion or by generating energy from renewable sources offer opportunities to reduce GHGs in a number of sectors. Renewable sources of energy are generated from sources that are replenishable in the short-term, such as biomass, wind and solar. Alternative Fuel Vehicles offer opportunities for reduction in the transportation sector. Innovative technologies, such as geothermal heat pump systems, fuel cells, and photovoltaics offer opportunities to reduce GHGs in the residential, commercial and industrial sectors.

Pollution Prevention

New Jersey has been a pioneer in advancing the concept of pollution prevention, which minimizes the amount of hazardous materials placed in the waste stream. Improving materials efficiency with pollution prevention improves energy efficiency. This involves the promotion of processes that produce the same amount of product with less energy. In terms of growth, this can be viewed as increasing the production unit output at the same time as stabilizing or decreasing energy consumption needs. To assist in this process, the NJDEP is contracting with Rutgers University to develop a self-audit for all companies to examine their energy and GHG management strategies.

Waste Management - MSW Recycling and Landfill Gas Recycling

MSW Recycling

Recycling reduces the consumption of natural resources and the subsequent strain on disposal facilities. The United States Environmental Protection Agency (USEPA) calculated that on average, approximately 1.67 metric tons of CO_2 equivalents are avoided for every ton of Municipal Solid Waste (MSW) recycled. If the MSW recycling rate increases from 34% in 1990 (1995 MSW recycling rate is 45%) to 60% by the year 2005, a total of 7.7 million metric tons of CO_2 equivalent in avoided GHG emissions would result.

Landfill Gas Recycling

Methane, a naturally occurring byproduct of anaerobic decomposition of organic matter, is a powerful greenhouse gas with a global warming potential 21 times greater than that of CO_2. Methane emissions in New Jersey account for about 9% of the total CO_2 equivalents. Solid waste landfills are by far the largest anthropogenic source of methane emissions in the State, representing 72% (13.3 million tons) of CO_2 equivalent emissions (.63 million tons of methane).

GHG savings could be realized through the installation of methane collection and combustion systems at certain landfills that are currently undergoing closure or other structurally related construction. There are ten such facilities.

The remaining 47 landfills, some open, but most closed, account for about 35% (1.9 million tons) of methane's CO_2 equivalent emissions. Utilizing this methane for energy recovery further reduces GHGs from the current fossil fuel usage and is defined as a renewable energy source. Cost effective methods to recover methane from these landfills are available.

Open Space - Natural Resources

Over 2 million acres or approximately 47% of New Jersey's open land is forestland. Additionally, it has been estimated that over 4 million trees occupy the space between the curb and sidewalk in our cities and towns. Trees are CO_2 users and at the same time O_2 producers; they are nature's land based counterweight for CO_2 emissions.

Through management and technology strategies our forests can make significant improvements in carbon storage and CO_2 reductions. Some of the management strategies recommended in the report include the following:

1. afforestation of marginal cropland, pasture and riparian zones for biomass production;
2. tree planting in urban and suburban areas;
3. increase recycling of urban tree removals;
4. reduce forest loss to non-forest use;
5. improved forest management; and,
6. the reduction of waste in wood processing.

The two technology related strategies recommended include the use of renewable biomass for fossil fuel energy and the increase in paper and wood recycling.

Open Space Initiative: Governor Whitman's Program to Protect 1 Million Acres of Open Space

Governor Whitman's initiative to protect 1 million acres of open space is inextricably linked to the goals of the GHG Action Plan. Building home and shopping malls without planned development consumes natural resources and increases the amount of fossil fuels that must be burned to heat homes and drive cars, as well as increases the amount of carbon dioxide gas emitted. Maintaining open space or planting trees in non-forested areas, can serve to act as a carbon sink.

Agreements with Other State Agencies

NJDEP has reached conceptual agreement with the Department of Community Affairs (DCA) and the Department of Transportation (DOT) on issues related to reducing GHGs. NJDEP has supported DCA in its pilot program to construct affordable housing that is 30% more efficient than current building codes, and has also supported DOT's program to promote the use of electric vehicles.

Alternate Technology and Alternate Fuel Vehicle Initiative

Governor Whitman's Executive Order 94 (Appendix E) signed April 16, 1999, establishes policies to promote the use of alternate fuel vehicles in New Jersey. These policies include an increase in the use of alternate fuel vehicles in the state fleet and the creation of a task force to evaluate alternate fuel technologies.

An example is the New Jersey biodiesel initiative, where vegetable oils and other natural products are being investigated for use as a substitute for conventional diesel fuel. The advantage of this approach is that the biodiesel fuel is non-toxic, biodegradable and virtually free of sulfur and aromatics.

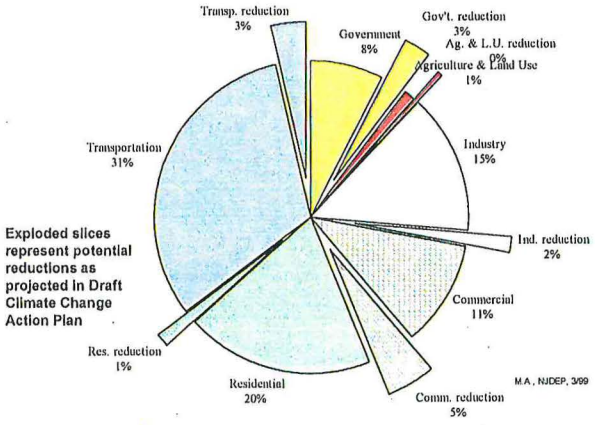
New Jersey Transit is proposing that one of its bus garages be converted to a biodiesel operation where 20% of the fuel mix will be biodiesel. A grant proposal has been drafted and funding is pending.

Additionally, a "travel blending" pilot project has been proposed for 200 households along interstate 1-80 in New Jersey. Travel blending is a new approach to reducing car use that focuses on changing household travel behavior. This is a collaborative project proposed by the Center for Clean Air Policy, in consultation with Steer Davies Gleave, the consulting firm that developed travel blending, and the NJDOT

Potential Reduction of GHG with No-Regrets Strategies

The potential reduction of GHG emissions by sector upon implementation of the above mentioned strategies is illustrated in Figure E4.

Figure E4
Potential Reductions of Greenhouse Gas Emissions; New Jersey CO_2 Equivalents



Electric Discount and Energy Competition Act

The "Electric Discount and Energy Competition Act", (EDECA) NJSA: 48:3-49 et.al. was signed into law by Governor Whitman on February 9, 1999. There are two sections in the EDECA

that promote the use of energy efficiency and renewable energy technologies such as photovoltaics, wind energy and fuel cells, and are therefore relevant to GHG reductions.

Societal Benefit Charge (SBC)

NJSA 48:3-49 et al establishes a new Energy Efficiency and Renewable Energy Fund at 50% of the current standard offer (SO) program. This fund is to be used for energy efficiency programs and renewable energy technologies over and above the current SO program. The REF increases by up to 50% of the total SBC funds, or $140 million as current SO programs are retired. The type of funding and the technologies to be supported will be determined through discussions that are underway between the Board of Public Utilities in consultation with NJDEP.

Renewable Portfolio Standard (RPS)

NJSA 48:3-49 et al requires all electricity suppliers in New Jersey selling in the retail market to have a portfolio standard for renewables according to the following criteria:

- Beginning in 2000, the RPS is established at 2.5% of total kwhs sold, to be provided by Class I or Class II renewables
- Beginning in 2001, the RPS must include an additional 0.5% from Class I renewables. The Class IRRPS increases to 1% by 2006, and increases annually by 0.5% for a total of 4% Class IRPS by 2012. The total RPS by 2012 would be 6.5% of all Class I and Class II renewables.

Research Needs

The GHG Action Plan identifies several areas where additional research in terms of data gathering and analysis are required for New Jersey to meet its goal of reducing GHG emissions. The importance of better data on CO_2 emissions and fuel uses is emphasized.

These data can be used to quantify the economic and environmental impacts of various GHG reduction strategies therefore optimizing choices and maximizing the effectiveness of programs.

Research is currently underway to develop a carbon emissions trading program. With a USEPA grant, the NJDEP in collaboration with the Center for Clean Air Policy (CCAP) are developing a banking system for carbon emissions reduction credits that could operate on a national or international scale.

Outreach and Education

New Jersey's strategy to achieve reductions in GHG emissions will involve the promotion of "no regrets" voluntary actions that when implemented will achieve the GHG goals. Government, industry and the public will all need to make informed choices that will result in GHG emission reductions. The key to both implementation and achieving the voluntary GHG reduction goals is outreach and education. The report identifies a number of issues, obstacles and misconceptions that are being addressed and linked to incentives to reduce these barriers. It also presents a series of actions that can be taken to educate school children, the public, local and state government and the private sector.

Future Actions

The New Jersey Sustainability GHG Action Plan represents the State's initial commitment to reducing GHGs. This Plan outlines strategies that will be implemented and may be modified with time as new activities are initiated and implemented to achieve the State's goal of 3.5% reduction in New Jersey's GHG emissions below 1990 levels by 2005. The establishment of a goal and implementation of the reduction strategies is a continual process that will be informed by new activities.

New Jersey's GHG reduction progress and the associated strategies will be reviewed and updated to ensure that we are moving in the right direction. This process will include a two-prong approach. One is a periodic update of new activities related to GHG reductions. Since this field is currently dynamically changing, initially this will be performed on a six month basis. The first update is included with this report as an Addendum. The second is an evaluation process to track indicators for GHG reductions and to forecast longer range reductions. This evaluation process and longer range forecast will be developed within an external stakeholder process to continually inform NJDEP's GHG goal setting process. The success of this process is contingent upon the voluntary cooperation of a variety of stakeholders, including citizens, students, government and corporate leaders.

NJDEP Strategic Plan and NJDEP-USEPA National Environmental Performance Partnership System (NEPPS)

In 1998 NJDEP published its Strategic Plan for the years 1998-2001. The Strategic Plan conveys six broad goals that reflect the environmental concerns, needs and responsibilities of the more than eight million people who work live and raise families in New Jersey. These goal areas include: Clean Air; Clean and Plentiful Water; Safe and Healthy Communities; Healthy Ecosystems; Abundant Open Space; and Open and Effective Government. The Strategic Plan expresses the primary milestones and strategies to be emphasized and advanced over the next four years. The Plan outlines the key milestones against which NJDEP will measure its progress towards our environmental goals.

The Performance Partnership Agreement (PPA), a comprehensive cross program planning document which was developed under NEPPS, provides a detailed description of NJDEP's goals and includes milestones, strategies/activities and indicators by which to measure progress in each goal area.

In both these documents the reduction of GHG emissions are noted as either a subgoal or a milestone. Indicators are being developed that will track our progress in the area of GHG reduction within the sustainable state goal directives of Executive Order 96.

INTRODUCTION

New Jersey 1999 Sustainability Report - Living with the Future in Mind

In 1999 New Jersey Future, a non-profit, non-partisan group published its report, "Living with the Future in Mind - Goals and Indicators for New Jersey's Quality of Life" (the Report). The Report was part of the New Jersey Future's Sustainable State project. The Report is a "report card" on the long-term trends that can enhance or destroy the quality of life in New Jersey.

The eleven goals described in the Report are the product of a four year dialog with citizens from all walks of life that helped to develop the 41 indicators outlined in the Report. The indicators were selected to measure specific progress towards sustainability goals. This will allow for the establishment of meaningful targets or benchmarks for each indicator to assist in achieving the overall goal of sustainability. Among these indicators are energy consumption and GHG emissions, two topics that are central to the issues discussed in this Action Plan.

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The Greenhouse Effect and Global Warming

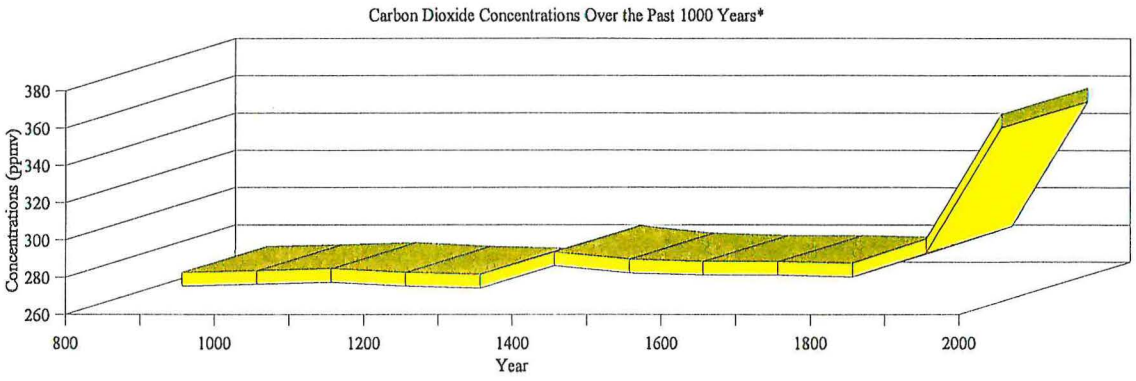
GHGs are chemical compounds that absorb infrared radiation in the form of heat, preventing the venting of this energy into space. A certain level of greenhouse gases in the atmosphere is essential to maintain the earth's temperature at a level that can support life. However, as the concentration of GHGs in the atmosphere increases, more heat is trapped and the overall global temperature rises. Current scientific consensus is that the primary cause of change in global climate during the last century is the anthropogenic input of GHGs to the atmosphere. The most significant man-made GHG contributors are:

- carbon dioxide (CO_2): a product of fossil-fuel combustion
- methane (CH_4): a product of animal activity and landfills
- nitrous oxide (N_2O): results from fertilizer application and fuel combustion
- hydrofluorocarbons: (HFCs): used as refrigerants in industrial processes and motor vehicles
- perfluorocarbons (PFCs): used in manufacturing
- sulfur hexafluoride (SF_6): used as an electrical insulator

CO_2 accounts for approximately half of the warming that has been caused by past emissions, as well as half of all projected future global warming. Before the industrial age began, global levels of CO_2 were about 270 parts per million (ppm). The present level is estimated at about 350 ppm

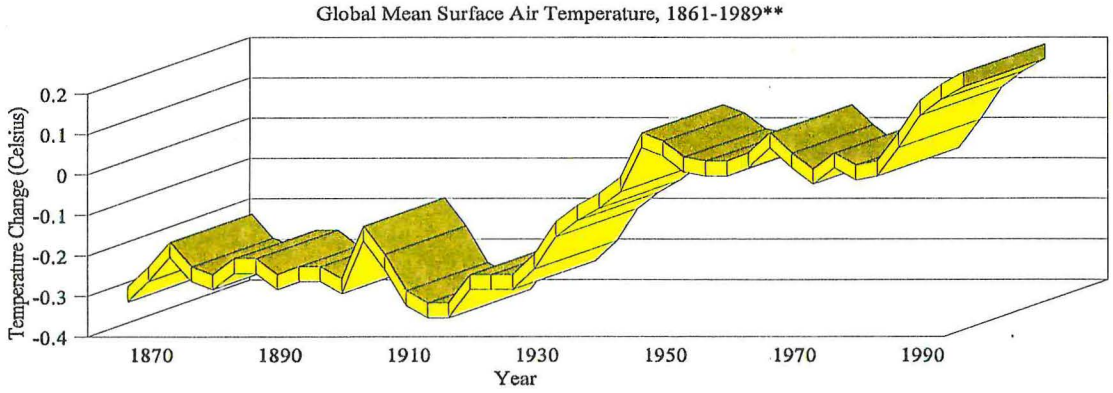
(about a 30% increase), and is increasing at a rate of about 0.4% (1.5 ppm) per year.[2] These trends are shown in Figure 1. Changes in atmospheric inputs of other GHGs range from annual increases of 1% per year for methane, 0.3% for N_2O and 9% for SF_6. Inputs of chlorofluorcarbons (CFC) should be greatly reduced due to laws and international agreements restricting their production and application.

Figure 1



Increased levels of atmospheric GHG are closely correlated with changes in global temperature. Figure 2 presents the temperature trend of an increase of 0.4 degrees Centigrade over the last 150 years.[3] The historic relationship of the amount of CO_2 introduced into the environment and temperature is illustrated in Figure 3.[4] As the concentration of greenhouse gases in the atmosphere increase, the temperature of the earth is also expected to increase. This, in turn, causes the sea to expand and water levels to rise.

Figure 2



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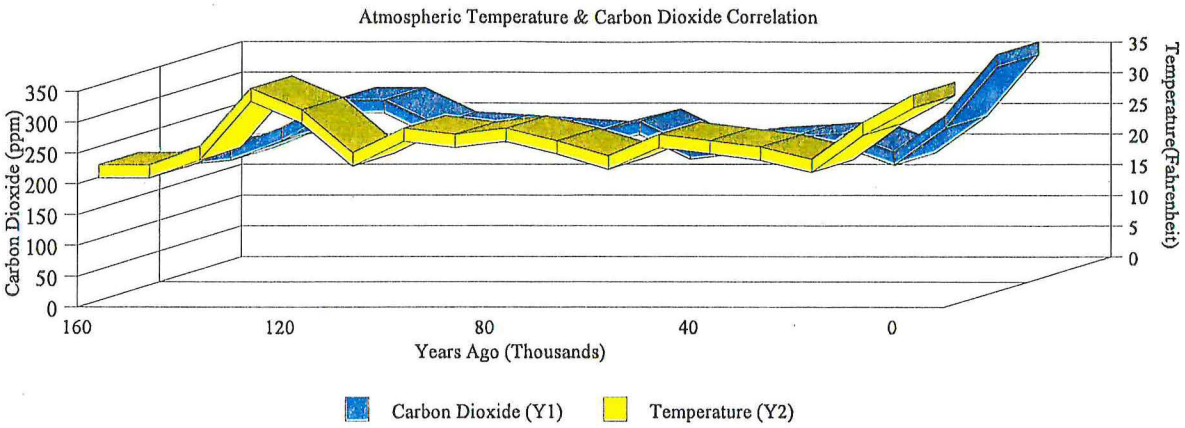
[2]The Challenge of Global Warming, D.A. Abrahamson Ed., National Resources Defense Council, Island Press, 1989.

[3]Ibid

[4]Ibid

Figure 3



The consensus among scientific authorities is that GHGs do contribute to global warming, and the problem is getting worse. There is general agreement that GHGs will contribute to an increase in the mean global temperature and sea level to increase at a rate exceeding that which can be attributed solely to natural causes.

These findings have been confirmed by subsequent scientific studies by the United States Environmental Protection Agency (USEPA), the Intergovernmental Panel on Climate Change (IPCC), the National Academy of Sciences (NAS) and many national and international scientists. The IPCC has compiled a set of internationally accepted reports on how to conduct emission inventories of gases that may affect the atmospheric heat balances. In its 1996 report, the IPCC states "the balance of evidence suggests a discernable human influence on global climate", that "warming since 1860 is a statistically rare event that is unlikely to be highly natural in origin" and "patterns of temperature change are consistent with the combined effects of greenhouse gases and aerosols".[5] Figure 4 compares historic trends in sea level and global mean temperature, showing a cause and effect relationship.[6]

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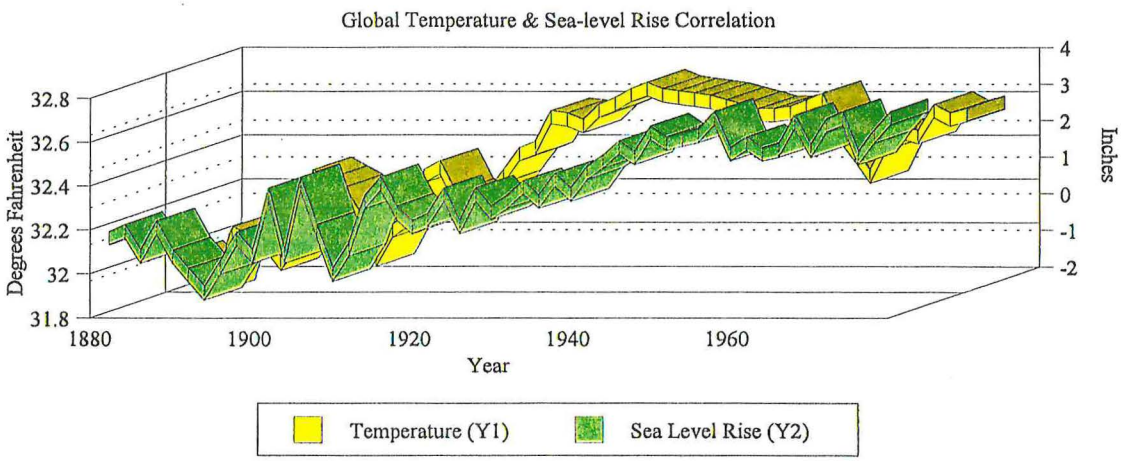
[5]International Panel on Climate Change (IPCC): Climate Change 1992: The Supplemental Report to the Scientific Assessment, Cambridge University Press, New York, 1992

[6]United States Department of Environmental Protection, Report 230-R-95-008, J. Titus and V. Narayanan, 1995

Figure 4



New Jersey's Contribution

New Jersey is one of more than 30 states working with the USEPA to develop their own strategies to reduce GHG. Other states have also completed GHG emission inventories. Data from New Jersey's Inventory of Greenhouse Gas Emissions show that New Jersey produces approximately 2.2% of the United States' GHG emissions, a low value considering we represent 3.1% of the U.S. population.[7] More than 80% of New Jersey's GHGs are from CO_2, which is similar to proportions reported by other states that have compiled similar inventories. The levels of most other GHGs in New Jersey are similar to national trends.[8]

Figures 5 and 6 identify New Jersey's major sources of GHGs by source and sector in 1990. As of 1990, transportation (38%), residential (24%), industrial (16%) and commercial operations (22%) are the market sectors that are the most significant GHG contributors.

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[7]New Jersey Inventory of Greenhouse Gas Emissions, 1990, Prepared by the New Jersey Department of Environmental Protection and the New Jersey Board of Public Utilities, C. Johnson and M. Aucott,1996.

[8]Reducing Greenhouse Gases & Air Pollution: A Menu of Harmonized Options Final Report, State and Territorial Air Pollution Administrators (STAPPA) and Association of Local Air Pollution Control Officials (ALAPCO), October 1999, page 18.

Figure 5
Greenhouse Gas Emissions by Source 1990 NJ Emissions CO_2 Equivalent

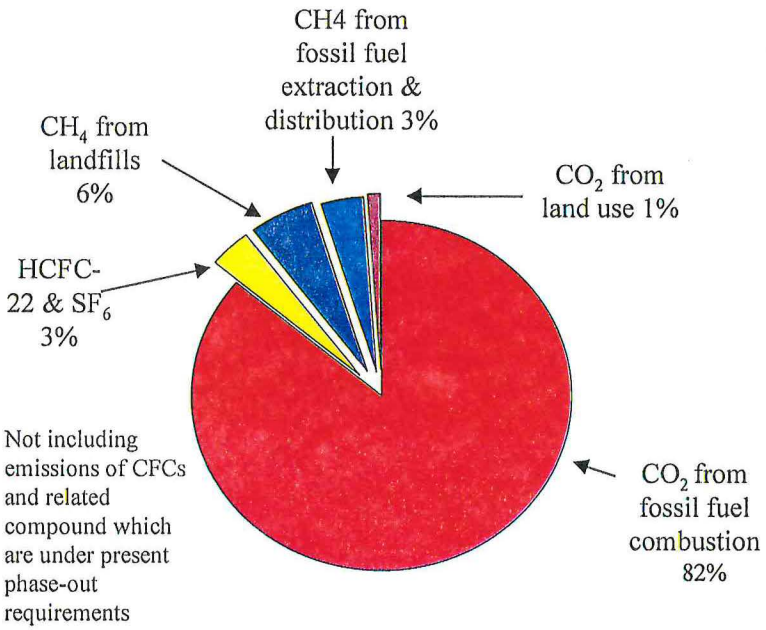
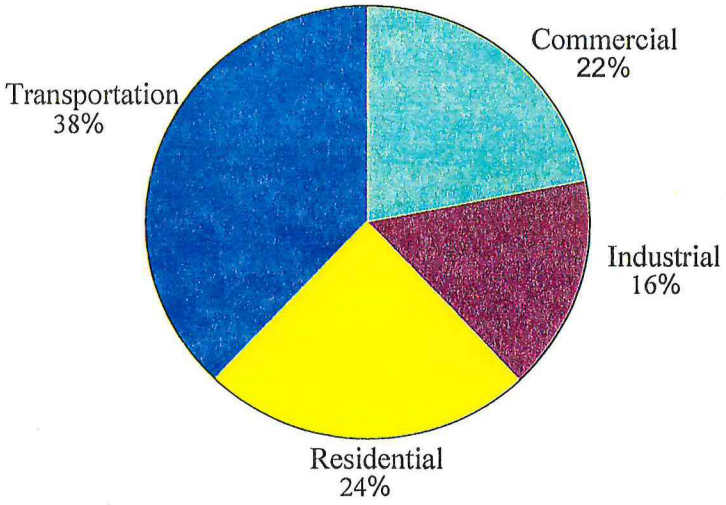


Figure 6
Fossil Fuel CO_2 Emissions by Sector New Jersey: 1990



Sea Level Rise and New Jersey

There are a number of environmental impacts attributable at least in part to global warming. One of the most significant to New Jersey is sea level rise. Sea level rise refers to an increase in the relative level of the sea as compared to the elevation of the adjacent shore. There is broad scientific consensus that sea levels are rising as a result of natural and man-induced activities affecting the global climate. During the last century, the sea levels along the Atlantic coast have risen by 30 centimeters (12 inches) and the average worldwide sea level has risen by as much as 15 centimeters. Studies show the level of the sea rising an additional 1-2 mm per year along the New Jersey coast

as compared to other areas.[9] The level of the sea is projected to rise at an even more rapid pace in the next century.

Sea level rise may result in significant long-term environmental and economic impacts to states such as New Jersey, with extensive shore communities and investment in coastal development. Shorelines are subjected to increased rates of erosion. Property built close to the ocean becomes increasingly vulnerable to damage from storms. A diminished and/or damaged shore area decreases recreational opportunities as well as property values. Potential consequences include greater costs for shore protection, greater frequency and magnitude of storm damage and intrusion of salt water into ground water. Because of rising sea levels, New Jersey can anticipate there will be increased shoreline displacement, loss of wetlands and potentially the inundation of barrier islands. For example, the undeveloped Rainbow Islands in Great Egg Harbor have lost about 5% of their total area; one island has completely disappeared. These issues have a significant impact upon state coastal policy and shore development. The impacts of sea level rise in New Jersey are summarized in an Information Circular prepared by the New Jersey Geological Survey and shown in Appendix F.

Most climate modelers and atmospheric scientists predict that global warming will affect worldwide patterns of precipitation. The amount of rain and snow that falls each year depends upon many factors, including global heat and water cycles that are impacted by the concentration of GHGs in the atmosphere. A recent analysis of precipitation data from more than 5000 sampling sites worldwide from 1800 to the late 1980s reveals increased variability in precipitation events over time.[10] This means that episodes of heavy rain and snow, as well as periods of drought, are becoming more frequent.

More frequent severe storms and higher sea levels increase the vulnerability of shore damage (see Figure 7). As sea levels continue to rise, storms become increasingly damaging, and frequent. By the year 2050, higher sea levels would turn a storm from an event that might presently occur only once every 20 years into an event that would occur once every five years. Similarly, a storm that presently occurs only once in a 100-year period would become as common as one that would occur every 20 years.[11] The likelihood of New Jersey impacts from severe coastal storms is shown in Figure 8, as a member of the Mid Atlantic region. The amount of GHGs in the atmosphere contribute to the frequency and the severity of the problem. Those communities most prone to erosion and flooding will see the effects first.

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[9]US Department of Commerce, NOS, Yearly Sea Level and Monthly Tidal Summary Reports for Atlantic City, New Jersey, Battery, New York, Lewes, Delaware, Philadelphia, Pennsylvania and Sandy Hook, New Jersey, 1994

[10]A. Tonis, Nature, 382, 700 (1996)

[11]A White Pape on the Measurements of Sea Level Rise in New Jersey and a Perspective on the Implications for Management, N. Psuty, Rutgers University, 1996

Figure 7

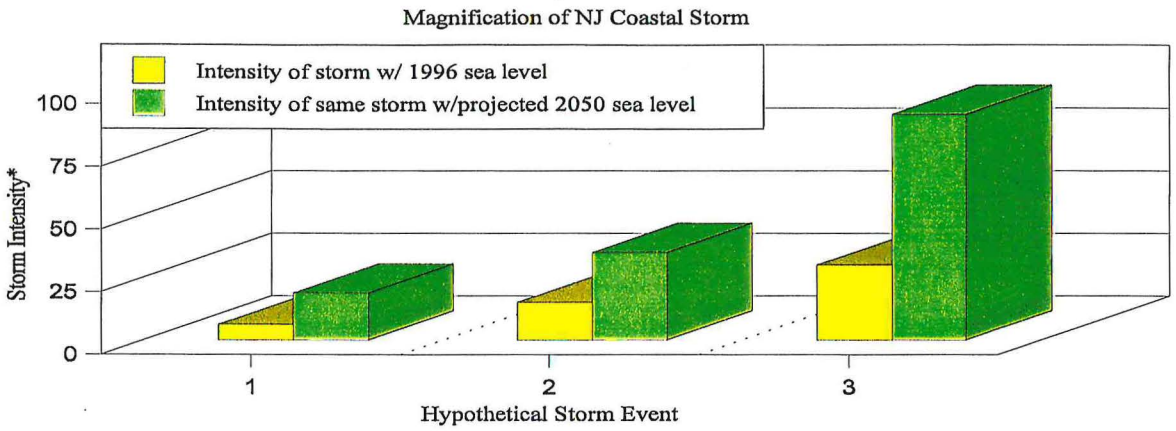
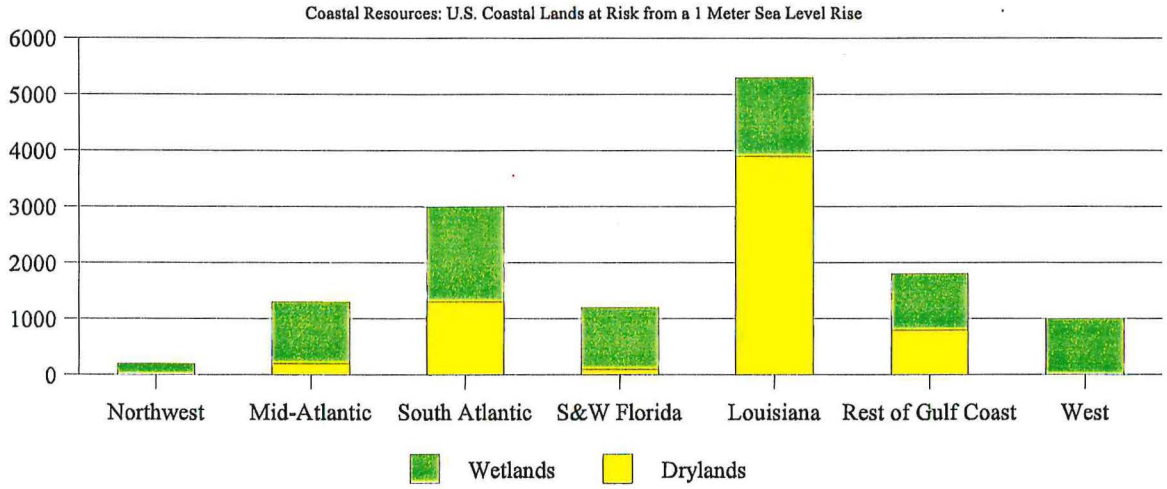


Figure 8



Insurance companies, who pay for much of the damage caused by improbable events such as 100 year storms several times in a decade, have realized their vulnerability to climate change. Worldwide levels of weather-related financial loss reached a new high of $38 billion in 1995; see Figure 9.[12] Severe storms such as Hurricane Opal, where $3 billion in claims were paid, have resulted in many insurance companies reducing their exposure in coastal and island real estate, most notably in Florida and the Caribbean. At the 1996 Conference of the Parties to the Convention on Climate Change in Geneva, Switzerland, more than 60 insurance companies signed a statement asking governments to substantially reduce their emissions of GHGs. At a time when commercial and residential shore development is increasing, a changing climate places billions of dollars in infrastructure and personal property in New Jersey at some risk.

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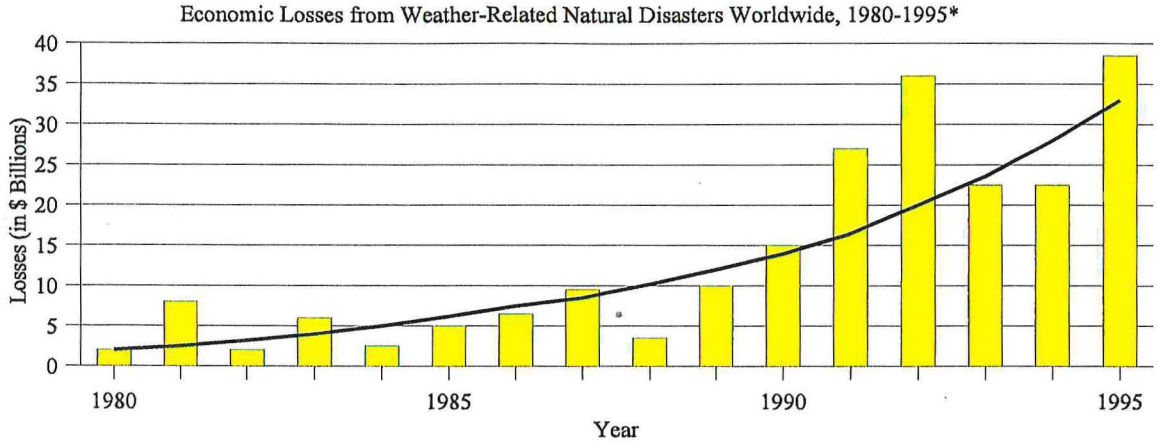
[12]C. Flavin, World Watch, January/February 1997

Figure 9



A summary of New Jersey specific GHG related impacts prepared by the EPA is shown in Appendix G.

Options to address the problem of sea level rise, other than reducing levels of GHGs, include: modifying the extent of coastal development, shore replenishment, buy-outs and abandonment of most vulnerable structures; and infrastructure improvements such as seawall construction. However, efforts to reduce GHGs will in the long run be most effective. It will be a case of addressing the cause, rather then the symptoms. GHG reductions will also neatly dovetail with efforts that are mandated by federal and state laws to reduce emissions of other contaminants to the air, such as fine particulates, oxides of nitrogen and volatile organic carbon-containing compounds. These ancillary benefits could have significant economic, environmental and public health benefits that serve as additional justification for implementation of GHG-reduction measures.

STAKEHOLDER PROCESS

Responsibility for increasing amounts of GHG emissions, and their deleterious effects upon the environment, is assignable to all aspects of society. Any discussion regarding proposed measures to reduce the amounts of GHG emissions requires participation from a proportionally diverse group of individuals and organizations.

The New Jersey Climate Change Workgroup was established by NJDEP Commissioner Robert Shinn in June 1997 (see Appendix B) to coordinate all statewide activities on the issue of climate change and to prepare this GHG Action Plan. To assist in the development of proposed strategies, outreach and education programs and research projects the Workgroup organized a group of external stakeholders representing academia, industry, public interest groups, nine New Jersey State agencies and two federal agencies. This external stakeholder group met with the New Jersey Climate Change Workgroup six times between October 1997 and June 1998. The product of the meetings with the external stakeholder group are the proposed strategies for energy conservation, innovative technologies, pollution prevention and waste management, that are contained in this report. This external stakeholder workgroup will be continued to advance the goals of the GHG Action Plan as part of the updating process.

The external stakeholders to the New Jersey Climate Change Workgroup consisted of representatives from the following groups:

New Jersey Climate Change Workgroup External Stakeholders

American Reinsurance Corp.
Association of NJ Environmental Commissions
Atlantic Electric
AZKO - Nobel
City of Newark
Coopers & Lybrand
Cumberland County Improvement Authority
Ensys Energy & Systems
General assembly Republican Office
GPU Generation, Inc
Hackensack Meadowlands Dev. Commission
Johnson & Johnson
Littoral Society
Mayor of Avalon
Mercer County TMA
Mobil
Natural Resources Defense Council
NJ Builder's Association
NJ Dept. of Community Affairs
Office of State Planning
NJDEP
NJ Geological Survey
NJ Heat Pump Council
NJIT - School of Architecture
NJ Public Interest Research Group
NJ Dept. of Treasuy - Office of Energy & Utility Management
Office of Sustainability
Partners for Environmental Quality, Inc.
Princeton Plasma Physics
PSE&G
Rutgers, The State University
South Jersey Land Trust
Syscom Enterprises
Township of Maplewood
US Department of Energy
US Department of Environmental Protection
United Jewish Federation of Metrowest
United Technologies

A more specific list of the stakeholders can be found in Appendix H.

EMISSIONS INVENTORY AND PROJECTIONS

The New Jersey GHG Emissions Inventory established New Jersey's baseline level of GHG emissions as of 1990, listing GHGs by total amount, market sector, global warming potential and source. A projection has been made regarding the trend that can be expected in New Jersey for GHG emissions through the year 2012. These values are shown graphically in Figure 10. We project that the total GHG emissions in the State would increase by 6% annually from the 1980 - 1997 data, if we assume a "business-as-usual" situation with an increase in the future comparable to the linear trend of the 1980-1997. The amount of New Jersey's GHG emissions in 1990 was 136 million tons of CO_2 equivalents. The amount in 2005 is projected to be approximately 150 million tons of CO_2 equivalents. Reducing New Jersey's GHG emissions by 3.5% below the 1990 value in 2005 (the NJDEP goal) means New Jersey's GHG emissions would need to be 131 million tons of CO_2 equivalents by that date. This means we will need to take action to reduce New Jersey's GHG emissions by approximately 19 million tons of CO_2 equivalents [from 150 million tons of CO_2 equivalents (where we would be) to 131 million tons of CO_2 equivalents (where we want to be)] in approximately seven years. Figure 10 presents the projected trend and shows the projected reductions by market sector. Table 1 summarizes the proposed CO_2 reductions by market sector.

Figure 10
NJ GHG Emissions and Target Level
Projected emissions and reductions with Climate Change Action Plan Strategies (emissions estimates based on US DOE/EIA data, augmented by NJ solid waste data)

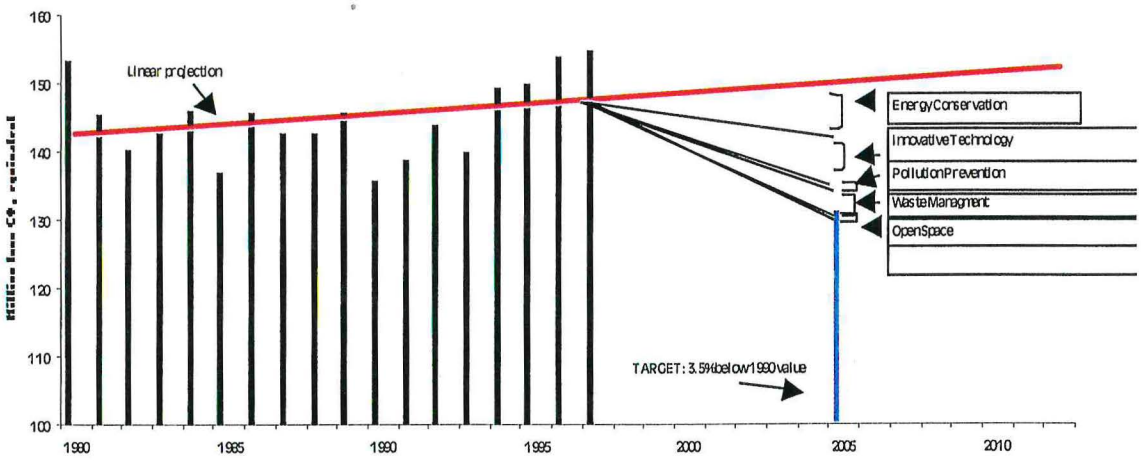


Table 1

Proposed CO_2 Reductions by Market Sector

Market Sector	Projected Mmtons of CO_2 in 2005 w/"Business as Usual" (A)	Proposed Mmtons of CO_2 in 2005 with GHG Action Plan	Mmtons of CO_2 Reduced (B)	% of Strategy Red. (B/A)	% of Total Red. (B/C)
Energy Conservation - Residential Bldgs.	25.8	24.3	1.3	6	6
Innovative Tech. - Residential Bldgs.			0.2	0.8	1
Energy Conservation- Commercial Bldgs.	26.7	18.5	4.5	16.9	22
Innovative Tech. Commercial Bldgs.			3.7	13.9	18
Energy Conservation - Industrial	25.6	22.9	0.4	1.6	2
Innovative Tech. - Industrial			2.3	9	11
Energy Conservation - Transportation	46.2	44.0	1.5	3.3	7
Innovative Tech. - Transportation			0.7	1.5	4
Pollution Prevention	5.4	4.6	0.8	14.8	4
Waste Management	19.8	15.3	4.5	22.7	22
Natural Resources	1.7	1.2	0.5	29.4	3
Total	151.2	130.8	**20.4 (C)**	13.5	100

NJDEP Strategic Plan and NJDEP-USEPA National Environmental Performance Partnership System (NEPPS)

In 1990 NJDEP published its strategic Plan for the years 1998-2001. The Strategic Plan conveys six broad goals that reflect the environmental concerns, needs and responsibilities of the more then eight million people who work, live and raise families in New Jersey. These goal areas include: Clean Air, Clean and Plentiful Water, Safe and Healthy Communities, Healthy Ecosystems, Abundant Open Space, and Open and Effective Government. The Strategic Plan expresses the primary milestones and strategies to be emphasized and advanced over the next four years. The Plan outlines the key milestones against which NJDEP will measure its progress towards our environmental goals.

The Performance Partnership Agreement (PPA) between NJDEP and USEPA Region 2, which developed under NEPPS, provides a detailed outline of NJDEP's goals and includes milestones, strategies, activities and indicators for each goal area. The PPA is the comprehensive cross-program planning document that provides more detail on the NJDEP goals and guides the relationship between NJDEP and the USEPA Region 2.

In both these documents the reduction of greenhouse gas emissions are noted as either a subgoal or a milestone; specifically that GHG emissions will be reduced to 3.5 percent below 1990 levels by 2005. The NEPPS agreement details a number of indicators that will be used to evaluate the State's performance. These indicators include the tracking of the total amount of New Jersey GHG emissions reductions by reviewing the following sources of information and programs:

- Tracking the annual measurement of sea level rise at Sandy Hook, the annual mean air temperature at New Brunswick, and the number of days per year where two inches or more of precipitation fall in a 24 hour period and wind speeds exceed 40 miles per hour in New Brunswick.

- Track the tons of CO_2 produced by cars, buses and trucks annually. This will include the tons of CO_2 avoided through the use of alternative fuels and alternative technology vehicles.

- Track the annual tons of CO_2 produced in the government, residential, commercial, industrial and agricultural sectors. This will include the tons of CO_2 avoided through the use of innovative technologies and energy efficiency products and practices.

- Track the total KW hours of electricity consumed in the government, residential, commercial, industrial and agricultural sectors. This will include the KW hours avoided through the use of innovative technologies and energy efficiency products and practices.

ENERGY CONSERVATION

I. Introduction

Energy use in New Jersey parallels the sector distribution itemized in the GHG emissions inventory. GHG emissions from stationary (non-transportation) sources come from the combustion of fossil fuels, such as petroleum products and natural gas for energy use in three general categories:

- residential buildings
- commercial buildings
- industrial operations

Transportation is the other major source of GHG emissions from fossil fuel combustion.

The aggregation of residential and commercial buildings is the largest source of greenhouse gas emissions nationally and in New Jersey. Combustion of fossil fuels for heating, lighting and equipment operation released over a third (50 million tons of CO_2) of New Jersey's 1990 greenhouse gas emissions and nearly half of carbon dioxide emissions. It is projected that residential space heating, refrigerators, air conditioning, water heating, lighting and television (in that order), fueled either directly by fossil fuels (16 million tons) or through electricity generated by fossil fuels (10 million tons), will produce 26 million tons of CO_2 emissions in 2005 in a "business as usual" scenario. Commercial lighting, space heating, air conditioning, and equipment fueled directly (12 million tons) or by electricity (14 million tons) together will result in another 26 million tons of CO_2 by 2005.

As shown in Table 2, as of 1990, the United States relied upon petroleum for 41.3% of its energy for industrial activity and received an additional 23.4% of its total needs from natural gas. Table 3 shows that as of 1990 in New Jersey, petroleum sources and natural gas are 49.8% and 17.7%, respectively of the total. The percentage of energy consumption from industrial activity as of 1990 was 36.8% nationally and 35.3% in New Jersey.[13] In our state, 1990 data indicates that waste and/or the use of inefficient process technologies resulted in a 21.4% loss of the energy designated for use in industrial activity never being applied for productive use.[14] Three general ways to reduce energy use and the concurrent GHG emissions from industrial operations are:

- generate energy using sources that produce less GHGs
- employ more efficient means of fuel consumption so less energy is used to perform the same tasks, or
- capture some of the wasted energy for productive use

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[13]United States Department of Energy, Energy Information Agency, 1992

[14]Ibid

Table 2

United States Energy Consumption by Fuel Source
(Quadrillion British Thermal Units)

Year	Coal	Nat Gas	Oil	Nuclear	Hydro	Geo	Total
1960	9.83	12.38	19.92		1.66		43.81
1965	11.58	15.78	23.25	0.04	2.06		52.71
1970	12.27	21.69	29.52	0.24	2.65	0.01	66.33
1975	12.66	19.98	32.73	1.91	3.22	0.07	70.57
1980	15.46	20.38	32.21	2.74	3.12	0.11	74.02
1985	17.54	17.84	30.92	4.15	3.41	0.21	74.05
1990	19.01	19.28	33.55	6.16	2.95	0.18	81.14
1993	19.48	20.87	33.84	6.52	3.05	0.16	83.96

Table 3

New Jersey Industrial Energy Consumption by Fuel Source
(Quadrillion British Thermal Units)

Year	Coal	Nat Gas	Oil	Electric	(A) Losses	(A/B) 100% % Total	(B) Total
1960	0.0612	0.0286	0.2885	0.0274	0.0681	14.4	0.4738
1965	0.0491	0.0546	0.3385	0.0393	0.0938	16.3	0.5753
1970	0.0186	0.0819	0.4144	0.0519	0.1258	18.2	0.6926
1975	0.0016	0.0541	0.3569	0.0497	0.1199	20.6	0.5822
1980	0.0008	0.0649	0.4003	0.0558	0.1356	20.6	0.6574
1985	0.0088	0.0831	0.2371	0.0534	0.1255	24.7	0.5079
1990	0.0071	0.0927	0.2608	0.0513	0.1121	21.4	0.5239
1993	0.0056	0.1957	0.2941	0.0498	0.1051	16.2	0.6503

As can be seen from Figure 10, the 1980-1997 emissions remained relatively level. Among the factors that may have helped minimize increases in GHG emissions are the switching of oil to gas fired space heating, increasing vehicle mile per gallon efficiency, some substitution of nuclear for coal fired generation of electricity with the New Jersey-Pennsylvania-Maryland electric pool and some substitution for energy efficient lighting and appliances. However, these factors may be reversing as vehicle mile per gallon efficiency decreases, decommissioning of older nuclear plants occurs and old equipment is replaced without the installation of higher efficiency heating/electric equipment. An additional factor that impacts on the year to year variability is weather.

II. Electric Discount and Energy Competition Act (EDECA)

The "Electric Discount and Energy Competition Act", NJSA: 48:3-49 et. al., was signed into law by Governor Whitman on February 9, 1999. The legislation mandates automatic rate discounts of five percent on current electric bills beginning August 1, 1999 and provides consumers with the option to choose their energy supplier.

There are two sections in the EDECA that promote the use of energy efficiency and renewable energy technologies, such as, photovoltaics, wind energy and fuel cells, and are therefore relevant to GHG.

Societal Benefits Charges (SBC)

The EDECA requires the development of a Comprehensive Resource Analysis (CRA) of renewable energy programs. This analysis will be used to determine appropriate levels of funding for energy efficiency and Class I renewable energy programs under the Renewable Energy Fund (REF). Funding for these programs will be generated through a societal benefits charge (SBC).

Section 12 of the EDECA establishes a new energy Efficiency and Renewable energy fund at 50% of the current standard offer (SO) program. This fund is to be used for energy efficiency programs and renewable energy technologies over and above the current SO program. The REF increases by up to 50% of the total SBC funds, or $140 million as current SO programs are retired. The type of funding support and the technolgies to be supported will be determined through discussions that are underway between the board of Public Utilities and the NJDEP.

Renewable Portfolio Standard (RPS)

Section 38 of the EDECA requires all electricity suppliers in New Jersey selling in the retail market to have a portolio standard for renewables according to the following criteria:

- Beginning in 2000, the RPS is established at 2.5% of the total KWH sold by each supplier in the State to be provided by Class I and/or Class II renewables.
- Beginning in 2001 the RPS must include an additional 0.5% from Class I renewables; this increases to 1% by 2006, and annually by 0.5% more, to a total of 4% by 2012. The total RPS is 6.5% of all Class I and Class II renewables.

The following definitions apply:

Renewable Energy means **electric** energy which is produced from a source of energy that is replenishable, which has negligible associated adverse environmental impacts, and which belongs to one of the following two classes.

Class I Renewable Energy means **electric** energy produced from solar technologies, photovoltaic technologies, wind energy, fuel cells, geothermal technologies, wave or tidal action, and methane gas from landfills or biomass facility, provided that the biomass is cultivated and harvested in a sustainable manner.

Class II Renewable Energy means **electric** energy produced at a resource recovery facility or hydropower facility, provided that such facility is located where retail competition is permitted and provided further that the Commissioner of Environmental Protection has determined that such facility meets the highest environmental standards and minimizes any impacts to the environment and local communities.

III. Residential Buildings

Many opportunities are available in the residential and commercial building sectors to expand the installation of high efficiency equipment for space and water heating and lighting. Some increases in efficiency of equipment come from federal requirements that set minimum efficiencies for major appliances, heating and cooling equipment. The most cost effective opportunities can be improved through controls that avoid overheating or under cooling, that reduce heat loss, and that turn equipment on and off automatically in response to need, such as occupancy sensors.

IV. Commercial Buildings

The issues for commercial space are similar to residential areas; the potential for savings is even greater since lighting and HVAC usage are higher overall, as well as being even greater percentages of overall unit energy consumption. An added source of potential energy savings is from office equipment such as computers.

V. Industrial Operations

New Jersey's manufacturing sector includes industries ranging from those that transform raw materials into refined forms such as petroleum, to those producing finished products such as pharmaceuticals, chemicals and electronics. Hundreds of different processes generate thousands of different products. The amount of energy needed to conduct these operations can vary widely depending upon the input fuel type, specific manufacturing process and the age, type and efficiency of the equipment used. In 1990, the New Jersey GHG inventory showed industry accounted for 24% of the total energy consumed in New Jersey and 14.5% of the total State GHG emissions.

The total amount of energy needed Statewide for industrial processes is critically dependent upon factors such as the national gross domestic product and extent of consumer consumptive practices. Our projections show New Jersey's total industrial CO_2 emissions from non-electric sources alone would rise to 20.9 million tons in a little more than 12 years.

VI. Transportation

The burning of gasoline and diesel fuels is the source of 38% of the GHG emissions in New Jersey. Many of the strategies to address this issue are described in the section on innovative technologies. A major contributor to the emission of CO_2 is that cars, buses and trucks do not burn the fuel they use at peak efficiency. Such "low technology" measures as keeping tires fully inflated, insuring the air filter is clean and that your engine is operating properly can improve operating efficiency and reduce GHG emissions.

VII. Strategies for GHG Reductions

The NJ Climate Change Workgroup met with its external stakeholder group to develop specific strategies and estimate potential emissions savings for this and other market sectors discussed later in this report. Tables 5 - 12, 15 and 16 estimate GHG reductions that might result from a menu of options. It lists measures that could reduce GHG emissions. They are organized by GHG sector strategy (e.g., energy conservation, innovative technologies) and by source of energy use (e.g., transportation, residential buildings) which includes landfill methane and CO_2, SF_6 and forest growth. Appendix I contains more detailed tables describing the assumptions for each measure/action listed.

This process assumes that utilities will implement many of the energy savings measures and does not include them as a sector. As utility deregulation takes place utilities or independent electricity suppliers, together with energy service companies (ESCO's), may change patterns of generation by installing or subsidizing or funding small scale generation at or near user facilities. These entities may install advanced turbine systems (ATS) or fuel cells or cogeneration or a renewable non-fossil fuel technology. These generation units would run on natural gas and would feed power generation units. Through these changes electricity services may be delivered to users at lower CO_2 per kilowatt levels. The savings are quantified in this table under the sector served.

Emissions reduction in Y2005 are shown as a percent of the tonnage reduction necessary to lower emissions to 3.5% below the 1990 inventory emissions.

A. Residential Buildings

In homes, major opportunities to reduce GHGs exist in replacing inefficient older refrigerators that consume on average 25 percent of a household's electricity and put out excessive heat in the summer. Replacement of an older furnace or boiler and use of timed thermostatic controls can reduce annual fuel cost by 20 to 30 percent (about $240 to $360 annually for a 2400 square foot home).[15] Replacement of an older gas water heater with a high efficiency model may have as much as a $300 purchase cost premium, but the payback, at the rate of $110 per year in reduced gas charges, results

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[15]U.S. DOE Office of Building Technology, State and Community Programs, Heating and Cooling Your Home. Printed from Website 5/18/99
http://www.eren.doe.gov/buildings/home_saving.html

in an equivalent of 37 percent annual interest on the extra cost.[16] Efficient refrigerators often cost less than less efficient models and the entire purchase cost can be recovered in four years at the equivalent of 25 percent annual return on investment ($180 annual reduction in electricity on an investment of $700).[17] Many low cost maintenance and weatherization measures, such as insulating hot water pipes, repairing broken panes, weatherstripping doors, windows and attic hatches have a pay back period of one year, or less.

Savings of approximately 1.26 million tons of CO_2 equivalents, or 7% of the total energy used in New Jersey to run New Jersey homes, can be accomplished by implementing the energy conservation measures shown in Table 4. This goal can be achieved by improving the rate at which homeowners replace energy-efficient heating and cooling systems and appliances with more efficient ones. Improvements in existing building codes and the creation of a percentage of new construction meeting EPA "Energy Star" efficiency criteria would also contribute to reducing the amount of GHGs emitted from new residential construction. For existing homes, the stimulus could come from a public information campaign on the benefits of these actions, incentives from energy suppliers and/or appliance manufacturers and/or tax rebates or credits for energy conservation measures.

Table 4
Potential New Jersey GHG Reductions from Energy Conservation in Year 2005
Measures for Residential Buildings

Measures/Action	Year 2005 MMT Saved
Increase rate of residential non-electric space heating system upgrade.	0.31
Increase rate of residential natural gas domestic hot water heater upgrade.	0.48
Increase rate of refrigerator upgrade.	0.44
Increase building efficiency through update building codes.	0.02
Increase building efficiency through the Energy Star Building program.	0.01
Sector Subtotal	1.26

Construction of new residential housing can contribute to savings in GHG emissions if their construction recognizes this issue. A pilot program by New Jersey's Department of Community Affairs, in collaboration with the USEPA and the Public Service Electric and Gas Company, has received proposals to build or rehabilitate 100 units of cluster housing, where each unit will use at least 30% less energy for heating, cooling and water heating than homes meeting the standards of the 1993 Model Energy Code of the Council of American Building Officials. This pilot project will demonstrate that sustainable and affordable housing units can be built;

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[16]U.S. DOE Office of Building Technology, State and Community Programs, Saving Water and Heating It Efficiently. Printed from Website 5/18/99 http://www.eren.doe.gov/buildings/home_saving.html

[17]U.S. DOE Office of Codes and Standards: Why Buy an Energy Efficient Refrigerator?, Printed from Website 5/18/99 http://www.energystar.gov/products/

the co-benefit here is significant reductions in GHG emissions.

B. Commercial Buildings

In commercial space, a major opportunity is replacement of older fluorescent tube lighting with newer fixtures with electronic ballasts, offering a 40 percent reduction in lighting energy requirements.[18] This change usually pays back within a year. Incorporation of day lighting decreases use of artificial light and is an innovative and highly beneficial means to cost effectively lower CO_2 emissions. Ancillary benefits to lower energy and maintenance cost include better employee satisfaction, higher productivity and fewer sick days. Re-engineering, improved controls and downsizing of space heating, refrigeration and cooling equipment require larger capital outlays, but can pay back in a few years. More efficient equipment and improved control systems offer the greatest benefit in schools, government and institutional buildings that can be expected to remain in use for long periods of time. Advanced lighting powered for large open spaces, warehouses, parking garages, and offices is six times more efficient than fluorescents. Other areas of economy involve improved maintenance in space heating and HVAC systems and increased use of Energy Star office equipment. These savings are detailed in Table 5.

Table 5
Potential New Jersey GHG Reductions from Energy Conservation in Year 2005
Measures for Commercial Buildings

Measures/Actions	Year 2005 MMT Saved
Increase rate of Space heating system tune up and maintenance to reduce non-electric fuel use.	0.91
Increase rate of Lighting upgrade.	1.93
Increase rate of heating/cooling and distribution of system tune up/maintenance to reduce electric requirement.	.82
Increase rate of Office equipment upgrade to Energy Star level.	.85
Sector Subtotal	4.51

[18]U.S. Department of Energy, Energy Efficiency and Renewable Energy Network (EREN) http://www.eren.doe.gov/erec/factsheets/eelight.html Consumer Energy Information: EREC Fact Sheets: Energy Efficient Lighting. Buildings that Save Money with Efficient Lighting, published for local government agencies. Produced for the (publication number DOE/CH10093-212), by the National Renewable Energy Laboratory, Document Distribution Center, 1617 Cole Boulevard, Golden, CO 80401, 1993.

C. Industrial Operations

The approaches to reducing energy and concurrently GHG emissions in industrial operations reside in the three key subject areas cited in the introduction: expand energy efficient operations due to improved maintenance, utilize more efficient manufacturing systems, and implement the use of new process improvements such as low carbon technologies and co-generation. In 2005, we have projected that this segment of New Jersey will generate 25.6 million metric tons of CO_2 equivalents. Individual strategies and the amounts of reductions to reduce this total are described below:

EPA's Climate Wise has been successful in implementing voluntary programs resulting in energy and GHG reductions. Climate Wise is a voluntary program where companies agree to develop action plans to reduce energy and CO_2 emissions. Quarterly meetings are held to share success stories and enlist new members. The 13 original New Jersey participants saved 9.7% of their total annual energy use. This quantity includes strategies involving industrial processes, including capital investments in infrastructure such as installation of high efficiency boiler/burners, internal energy auditing, solid waste reduction, office space energy efficiency upgrades such as lighting updates (EPA Green Lights Program), and computerized management of HVAC systems. As an example, Cosmair-Clark, a manufacturer of hair care products located in central New Jersey, estimates that these types of efforts have resulted in a 24.7% savings in their annual utility costs with concurrent reductions in the amounts of emissions they generate. Total energy use by New Jersey's Climate Wise partners was 35 MMBTU in 1990, making them only 6.7% of New Jersey's total. Estimates are that this 9.7% reduction in energy use translates into a reduction of 0.1 million tons of CO_2 emitted annually. It is recommended that New Jersey target three common aspects of industrial processes where energy is wasted and unnecessary CO_2 emissions can be reduced:

- repair of steam distribution traps (fixing leaks)
- improved performance of air compressors, and
- use of more efficient motors.

Savings of the magnitude described above can only be accomplished in conjunction with some of the public information programs described later in this report. Expansion of these activities will require more industries and companies to overcome some of the barriers listed above as is common to Climate Wise Partners. Systematic efforts, such as monitoring of overall energy performance, utility system improvements and process equipment modifications have large impacts upon the chemical and petrochemical industries, which are a major portion of New Jersey's industrial infrastructure.

Savings from action items in the industrial operations sector are shown in Table 6.

Table 6
Potential New Jersey GHG Reductions from Energy Conservation in Year 2005
Measures for Industrial Operations

Measures/Actions	Year 2005 MMT Saved
Increase rate of undertaking steam distribution and trap repair programs	0.10
Increase rate of undertaking ongoing repair and maintenance of air compressor systems.	0.10
Increase rate of use of Variable Speed Drives for high use motors.	0.17
Sector Subtotal	0.37

D. Transportation

New Jersey's Enhanced Inspection and Maintenance (I/M) Program focuses on these issues. It is estimated that the Enhanced I/Ms bi-yearly inspection program could identify up to 4% of the vehicles now on the road with serious emissions problems. Without any diminution of the number of vehicle miles traveled, implementation of an Enhanced I/M program could result in a 10% improvement in the GHG emissions for these vehicles. This translates into a savings of 800,000 tons of CO_2 by 2005. Mass transit improvements such as the new AMTRAK station in Hamilton, New Jersey and projected light rail from Camden should serve to decrease the amount of vehicle miles traveled.

Savings from energy conservation in the transportation sector are shown in Table 7.

Table 7
Potential New Jersey GHG Reductions from Energy Conservation in Year 2005
Measures for Transportation

Measures/Actions	Year 2005 MMT Saved
Implement an Inspection/Maintenance Program for New Jersey registered vehicles	.86
Increase improvements to Mass Transit to reduce Trip to Work	.63
Sector Subtotal	1.49

VIII. Issues for Implementation

In the residential housing sectors, consumers often choose energy-inefficient appliances or heating and cooling systems that may have the lowest purchase price but will consume much larger quantities of energy, and thus cost much more to operate. Builders and buyers frequently prefer aesthetics in new construction over more costly upgrades for insulation, weatherization and heating and cooling systems. What costs slightly more now can cost much less over the life cycle of the system.

Reductions in GHG emissions parallel improvements in energy efficiency. Operations within the manufacturing sector require investment in expensive capital items such as process equipment and HVAC systems. Increasingly competitive world markets for goods and services have tightened profit margins, thus heightening concerns about the rate of return on investments to improve the energy efficiency of manufacturing processes. The following factors may impact the implementation of energy efficiency measures:

- Changes in process technology often require modifications to existing permits with state and federal regulatory agencies, which have historically come slowly and at a high cost.
- Return on investment from the acquisition of new process equipment may take several years; some companies want quicker (< 3 years) payback periods.
- Amount saved from energy efficiencies may make only a small difference in a company's overall financial status.
- Information on potential reduction measures and savings to be realized may not be known by many smaller companies.
- Correlation between energy production and GHG emissions may not be understood by many smaller companies.
- Reluctance to invest in today's alternative technologies due to the belief that it may be obsolete in only a few years.
- Concern about the long-term impacts of energy deregulation upon energy prices and their impact on choices for energy generation and supply.

These concerns can be addressed by developing a partnership between the energy suppliers, manufacturers of energy consuming systems for both buildings and industry, the end-users of energy, and government on the issue of GHG reductions. The long-term economic and environmental advantages of making existing homes and commercial space more energy efficient must be communicated to a wider audience. Builders who install energy efficient systems in new construction should be identified and publicized; government policy should encourage such construction practices. EPA's Climate Wise Partnership Program must be publicized to educate and inform operators of industrial facilities. These are all roles of an education and outreach or public information campaign on the benefits of energy conservation. Practices such as updating regulations to promote greater utilization of energy-efficient practices, and policies such as providing low interest loans to encourage businesses to purchase CO_2 reducing technologies at a reasonable cost, are the responsibility of government.

INNOVATIVE TECHNOLOGIES

I. Introduction

An innovative technology is a device or system that offers significant environmental benefits and/or operational efficiencies when compared to processes currently in use. Innovative technologies impact the generation of GHGs either by producing energy through improved efficiency of fossil fuel combustion or by generating energy in other ways. Innovative technologies exist in all market sectors: examples include geothermal systems, fuel cells, photovoltaics and synthetic fuels. Specific applications to transportation, industrial operations and commercial buildings are discussed below.

II. Transportation

New Jersey's transportation sector generated approximately 43.4 million tons of CO_2 equivalents in 1990, nearly 30% of the State's total GHG inventory. The major GHG sources related to transportation are:

Transportation Type	MMTons of CO_2 Equivalents
Passenger cars, trucks and buses	31.3
Heavy-Duty trucks	6.0
Marine vehicles	4.0

GHG emissions related to jet fuel combustion are not included in the State inventory due to the complexity of allocating these emissions among states. CO_2 emissions from jet fuel in 1990 were estimated to be 20.7 MMtons nationwide. If New Jersey's share was apportioned, this would increase transportation-related emissions by 16%.

Projections suggest vehicle miles traveled (VMTs) will increase by 2 million miles annually between 1999 and 2012. The factors that determine the level of CO_2 emissions from motor vehicles use are illustrated by the following equation:

$$E = C \times V \times G$$

Where E = CO_2 emissions per year

C = on-road average fuel consumption (gallons/mile)
V = total vehicle miles traveled (VMT)
G = CO_2 emissions per unit of fuel consumed (grams/gallon)

Reductions in GHG emissions can be achieved through strategies that either increase the efficiency of fossil fuel consumption (C), reduce the amount of VMTs (V) or substitute alternate means to power cars or trucks (G). The application of new technologies, such as the use of fuels other than gasoline to power cars, trucks and buses, can contribute to

reductions in CO_2 emissions attributable to mobile sources. Strategies related to the transportation sector are summarized below:

A. Regulatory Initiatives

Several regulatory actions and legislative initiatives are needed to support specific GHG reduction strategies described below:

1. Amend the New Jersey Clean Fleets (NJCF) program to require mandatory participation of all centrally fueled fleets of 10 or more vehicles. Currently participation is voluntary.
2. Encourage USDOE to add municipal and private fleets to EPAct, a federal USDOE program to increase average fuel economy, requiring mandatory participation as soon as the statute allows.
3. Support legislation such as "Comprehensive Alternative Motor Fuels Promotion Act" (A646) that would uses tax incentives to support infrastructure development supporting alternative fuels.

Compliance with the new ozone and particulate matter standards adopted by USEPA will have the corollary benefit of reducing other emissions such as CO_2.

B. State Operations

New Jersey State Government must lead by example if the public is expected to take actions that will reduce GHGs. Although the actual emissions savings from government actions are a very small amount compared to the total reductions required, the symbolic nature of these actions are nonetheless quite important. Most of these actions require the enhancement and/or development of partnerships among several New Jersey and interested federal agencies.

1. Multi-agency collaboration (NJDEP, NJBPU, NJ Treasury and NJDOT) to ensure the State's new vehicle contract has standards that require fuel-efficient vehicles and a broad selection of Alternate Fueled Vehicles (AFVs).
2. Multi-agency cooperation to develop a "5 Year AFV Purchase Plan" that will help the State meet its EPAct requirements. NJDEP, NJBPU and NJ Treasury should also work with the Legislature and the Governor's Office to comply with EPAct when making their new vehicle purchases.
3. An Executive Order that requires all State dual-fueled AFVs to operate at least 25% of the time on the clean, alternative fuel.
4. Reduce the State vehicle fleet by a fixed percentage each year.
5. State and local government must develop policies and procedures that allow for the use of AFVs/ATVs in their operations. Government must lead in the development of refueling infrastructure and support services. Public entities such as State universities and colleges should be encouraged to purchase energy efficient vehicles.

6. Expand alternate fuel demonstration project: The NJDEP Division of Parks and Forestry, NJBPU and the NJDOT are collaborating on an electric vehicle demonstration project in the state parks. Four electric powered off-road vehicles have replaced gasoline powered units for use in maintenance and in park patrols. This project is an excellent demonstration of the potential of this technology in a venue that enhances public visibility.

C. Clean Vehicles & Clean Fuels

Improving the efficiency of the next generation of vehicles is a long-term solution that will reduce the amount of GHGs emitted in New Jersey. To accomplish this goal, we need to support and/or increase the use of the following:

1. Implement a Low Emission Vehicle (LEV) program to reduce emissions of CO_2 and other air pollutants.
2. Develop AFVs: compressed natural gas, liquefied natural gas, electric, hybrid electric vehicles in New Jersey. Support research and development and pilot programs that would lead to large-scale use. AFVs are inherently cleaner burning and generally produce less CO_2 per unit of useful work.

D. AFV & ATV Infrastructure

To support an alternate fuel vehicle fleet, we need to implement the following:

1. Refueling Infrastructure for AFVs and ATVs (e.g., public AFV refueling stations, public PV recharging stations, etc.)
2. Support Services for AFVs and ATVs (e.g., mechanic training for AFV/ATV repairs, AFV/ATV inspection & maintenance, AFV/ATV parts availability, etc.).
3. Support expansion of the NJDOT Station Car program, which encourages employees to take the train rather than drive to work by making electric vehicles available at commuter train stations for transportation to and from the office.

E. Alternate Fuels

The use of sources other than fossil fuels to power cars can lead to significant savings in GHG emissions and, if generated on an appropriate scale, can be cost effective. One example of this is a P-series fuel that has been developed by researchers at Princeton University. The P-series fuel uses renewable biomass such as waste paper, wood waste and agricultural waste to make a non-petroleum fuel. GHG emissions from the combustion on P-series fuels are negligible because of the biogenic source of the fuel. The USDOE estimates that P-series fuels have the potential to displace 1 billion tons of gasoline nationally by 2005.

In fiscal year 1997, approximately 4 billion gallons of gasoline were sold in the State of New Jersey.[19] Replacement of 2% of New Jersey's annual total amount of petroleum motor fuel with biofuels means NJ would need to generate 80 million gallons of biofuels per year. The source material for P-series fuel is readily available in New Jersey. Estimated costs to construct a manufacturing facility to produce P-series fuels is approximately $60 million dollars.[20] Of the nearly 6 million cars in New Jersey, 120,000 are needed to operate on biofuels. Investment capital may be available to produce the fuel and provide the infrastructure to provide the fuel for this number of vehicles. This is one example of how alternative fuels can be used to replace a portion of the gasoline now used to power cars and have a benefit towards New Jersey's GHG emissions.

New Jersey Transit is proposing that one of its bus garages be converted to a biodiesel operation where 20% of the fuel mix will be biodiesel. A grant proposal has been drafted and funding is pending.

Additionally, a "travel blending" pilot project has been proposed for 200 households along interstate I-80 in New Jersey. Travel blending is a new approach to reducing car use that focuses on changing household travel behavior. This is a collaborative project proposed by the Center for Clean Air Policy, in consultation with Steer Davies Gleave, the consulting firm that developed travel blending, and the NJDOT.

Each member of a household is given a one-week diary to allow them to track their travel. The diaries are analyzed to create a profile of household travel behavior, detailing the number of trips, hours spent in the car, amount of pollutants emitted, etc. This profile is presented to households along with specific suggestions as to how the household could reduce car use. Accompanying the profile is a second set of diaries that the households complete. There are used to analyze the impacts of the program.

F. Outreach & Education

State agencies, such as the NJDEP, NJBPU and NJDOT must take the lead in conducting outreach and education, including the impact these transportation strategies will have in achieving the New Jersey GHG reduction goal. For example, a "Motorist Clean Vehicle Awareness" brochure could be distributed by the Division of Motor Vehicles with vehicle registrations and and/or made available at new car dealerships throughout the State.

The savings in GHG emissions from these transportation strategies are shown in Table 8.

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[19]New Jersey Petroleum Council, J. Maxwell, personal communication

[20]Princeton University, S. Paul, personal communication

Table 8
Potential New Jersey GHG Reductions from Innovative Technology in Year 2005
Measures for Innovative Transportation Technology

Measures/Actions	Year 2005 MMT Saved
Increase Mass Transit Ridership by adding to Electric Station Car Project	.24
Substitute Electric & Hybrid electric cars for Fossil Fuel powered cars	.24
Replace Fossil with Biofuels made primarily from waste materials.	.24
Sector Subtotal	0.72

III. Industrial Operations

The industrial sector is extraordinarily complex and heterogeneous. GHG savings from applications of innovative technologies are maximized in those areas classified by the North American Industry Classification System as those expending the greatest number of BTUs per dollar of output. The industry groups which have the highest representation in New Jersey are:

- petroleum and coal products
- paper and allied products
- chemical and allied products

This report focuses on those technologies that are not process-specific or product-specific and therefore have the greatest applicability to the widest range of industrial applications. Some example are discussed below:

A. Low-Carbon Technologies

There are several low-carbon technologies that have been suggested to achieve additional reductions in GHG emission. One of the most promising is the Advanced Turbine System (ATS), which uses waste heat energy such as steam to power other operations. ATS systems have been shown to produce 29-73% less carbon per KWH than conventional technologies. Penetration of this technology into the New Jersey market at a rate of 5% per year could yield savings of 0.49 million tons of CO_2 in 2005.

B. Power System Maximization/Expanded Use of Cogeneration

Cogeneration is the simultaneous production of electricity and useful thermal energy. While conventional electric power plants operate at overall efficiencies of greater than 35%, cogeneration facilities can achieve performance levels that exceed 80%, by producing electricity and using the thermal energy (such as steam) that otherwise would be wasted, for plant operations or for sale to other nearby consumers. Cogeneration is most effective in large industrial settings where the use for the auxiliary energy can be applied for steam and hot water usage. If conventional

technologies are replaced by co-generation, the savings in 2005 over "business as usual" could be 0.42 million tons of CO_2.

C. Fuel Cells

This approach to energy generation produces electricity without any GHG emissions. Megawatt (MW) scale systems capable of providing power for industrial parks and shopping centers are currently commercially available. If the use of fuel cells by New Jersey industries increased at a rate of 1% each year, savings of 0.02 million tons of CO_2 could accrue. Other ancillary benefits from this strategy would be a demonstration of the commercial viability of this technology, which hopefully could lead to even greater market penetration in the future. If these strategies are implemented, we could realize a savings of 1.1 million tons of CO_2.

Projected GHG reductions from the application of these innovative technologies are shown in Table 9.

Table 9
Potential New Jersey GHG Reductions from Innovative Technology in Year 2005
Measures for Industrial Operations

Measures/Actions	Year 2005 MMT Saved
Electricity from Microturbines in Industrial Operations	.77
Electricity from Fuel Cells in Industrial Operations (where security of supply adds value to investment)	1.13
Heat/Steam from Cogeneration for space heating or other use	.42
Sector Subtotal	2.32

IV. Commercial Buildings

There are several opportunities to employ emerging environmental technologies to improve energy efficiency and reduce carbon emissions. Support for these technologies would accomplish several ancillary public interest goals, including increased energy security, reduction in dependence on imported fuels and enhancement of local economic activity and employment. Incentives, both regulatory and financial, are necessary to implement some of these strategies. These measures include the following:

A. Microturbines

Placing smaller energy-generation systems closer to the customer reduces the 6-10% estimated transmission loss from centralized power systems. Installation of microturbines in commercial buildings would save in these losses and achieve an estimated 20% increase in efficiency.

B. Fuel Cells

Fuel cells produce electricity from natural gas through an electrochemical process at 45% efficiency, in contrast to combustion at 30% efficiency from conventional technologies. Fuel cells emit virtually no air pollution, are reliable and quiet and can be placed in or near buildings thereby eliminating transmission and distribution losses and problems. We estimate that if 10% of commercial buildings replace their current generation system with fuel cell technology by 2005, savings of more than 1.5 million tons of CO_2 equivalents would accrue.

C. Photovoltaics (PV)

Investment in clean energy technologies, such as photovoltaics, can provide energy for buildings that is cost-effective when environmental and energy costs associated with renovation or new construction of public buildings are considered. The recently adopted New Jersey energy deregulation bill established a renewable energy fund of $140 million over eight years to be jointly administered by the NJDEP and the NJBPU. PVs are one renewable technology the state is hoping to promote. Commercial energy consumers could install solar electric panels that would produce electricity when the sun is shining, a time that generally coincides with peak electric demand in the state. A building would use electricity from its panels and would buy from the utility only when its needs exceeded production. Excess electricity would flow into utility lines and in effect would cause the meter to "run backward". The high initial capital cost of photovoltaic panels limits New Jersey's ability to take advantage of this resource. Currently, photovoltaics produce electricity in the $.20/kwh range, several times the per kilowatt hour cost of delivered utility electricity.[21] The NJBPU expects the cost of PV-generated electricity to drop as a result of the energy portfolio requirements of the new deregulation legislation.

D. Geothermal Heat Pump Systems

Geothermal heat pump systems take advantage of the year-round containment of heat in the ground to provide heat and cooling for commercial buildings. The best application for this technology is in small buildings in remote locations. New Jersey's parks system has more than 100 buildings currently powered by oil combustion. Replacement of the combustion of fossil fuel with geothermal at these locations offers the dual benefits of saving GHG emissions and providing a prominent display of the advantages of this type of technology. The amount of savings from this action is not large enough to include in the state total.

The savings from applications of innovative technologies to commercial buildings is shown in Table 10 and 11 respectively.

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[21]United States Department of Energy, Energy Information Agency and New Jersey Board of Public Utilities, 1999.

Table 10
Potential New Jersey GHG Reductions from Innovative Technology in Year 2005
Measures for Commercial Buildings

Measures/Actions	Year 2005 MMT Saved
Electricity form Microturbines in Commercial Buildings	1.03
Electricity from Fuel Cells in Commercial Buildings (where security of supply adds value to investment)	1.51
Electricity from Photovoltaics for day time summer & winter peaking power	0.02
Heat/Steam from Cogeneration for space heating or other use	1.15
Sector Subtotal	3.71

Table 11
Potential New Jersey GHG Reductions from Innovative Technology in Year 2005
Measures for Residential Buildings

Measures/Actions	Year 2005 MMT Saved
Solar Domestic Hot Water Heating to replace Electric Resistance Water heating where natural gas in not available	.24
Electricity from Photovoltaics for day time summer & winter peaking power	0.01
Sector Subtotal	0.25

V. Issues for Implementation

Each strategy for GHG reduction in the buildings sector is technically feasible and can be implemented today. In order to achieve the amounts of reductions (scale of participation) that are proposed, energy efficient purchases and practices must occur at a much higher rate than they do now. To accomplish this goal, government must expand its partnerships with utilities and the private sector to increase industry and public awareness of the recommended GHG strategies and energy-efficient options. Government must also continue its work towards adjusting the existing regulatory framework to support energy-efficient practices, that in many instances will result in changes from standard business operations.

Use of innovative technologies on a larger scale will require other incentives. Tax credits, rebates or financing programs for PV could encourage utilization of this relatively reliable resource and decrease reliance on power imported from outside New Jersey. New Jersey could offer tax credits or rebate programs for large businesses that purchase fuel cells and exempt fuel cells from permitting legislation. Los Angeles, San Francisco and Massachusetts have exempted fuel cells from certain permitting requirements because they produce electricity with minimal air pollution. New Jersey has proposed exempting fuel cells of less than 500 mW. output from certain permits.

A careful evaluation of the best approaches to using these technologies in our state should be conducted.

A list of proposed demonstration projects is described in the research section of this report.

POLLUTION PREVENTION

New Jersey has been a pioneer in advancing the concept of pollution prevention, which serves to minimize the amount of hazardous materials being placed into the waste stream so that less has to be disposed. We are applying the same concept to energy management, realizing that there is a congruity between process changes and management strategies that reduce non-product output with those that can produce the same amount of product with less energy and therefore less emission of GHGs. The paradigm we are advancing is a combination of pollution prevention (P^2) and energy efficiency (E^2) that we call P^2-E^2.

One area for application of the P^2-E^2 approach is the handling of sulfur hexafluoride (SF_6), used as an insulator in electric equipment. SF_6 is a powerful greenhouse gas, having a global warming potential 23,900 times that of CO_2.[22] Much of New Jersey's inventory resides at the Princeton Plasma Physics Laboratory's Tokomak fusion reactor. The relatively low cost of SF_6 means that product replacement, rather than identification, fixing and exploration of alternative chemicals, has often been the chosen means for addressing leaks.

The NJDEP is contracting with Rutgers University to develop a self-audit for all companies to examine their energy and GHG management strategies. This approach will highlight important issues such as the need to fix SF_6 leaks and how its impacts reflect upon overall facility energy consumption and GHG emissions.

The amount of GHG benefit from addressing the issue of SF_6 leaks is shown in Table 6 (Energy Conservation - Industrial Operations).

Silver Track II Pilot Program

The Silver Track program links environmental performance with regulatory oversight. It is a voluntary program where a company commits to quantifiable improvements in its environmental performance This is similar to the commitments made by New Jersey corporate Climate Wise Partners. CO_2 is viewed as an "umbrella pollutant", reducing carbon dioxide also reduces air toxics. Good management practices such as energy conservation, recycling and waste management involve other relationships between the company and State regulatory agencies. It has been proposed that acceptance into the Silver Track II program be contingent upon the company initiating Climate Wise or equivalent measures to reduce GHG emissions.

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[22]Primer on Greenhouse Gases, D. Weubbles and J. Edmonds, Lewis Publishers, 1991

WASTE MANAGEMENT- RECYCLING SOLID WASTE

I. Introduction

Recycling is one environmental activity that involves all sectors of the economy throughout the life cycle of the material. Homeowners sort and segregate materials for collection. Local governments participate in the collection and processing of these items. Small businesses process recyclable materials into market-ready commodities. Large manufacturers use these recycled materials as raw materials in their production of renewed products. Consumers then complete the loop with their purchases of recycled products.

Recycling reduces the burden of the consumption of natural resources and realizes the subsequent avoided strain on disposal facilities. The environmental benefits of recycling have been qualitatively described for a long time, but the full environmental benefits of recycling have not been quantitatively detailed. Life cycle studies, such as the Tellus Institute report on the "Assessment of Impacts of Production and Disposal of Consumer Packaging on the Environment",[23] prepared for the NJDEP in 1992, attempted to quantify the broad range of environmental "costs" and benefits for some recyclable materials. This section includes a detailed component analysis for each material, including specific environmental impacts and benefits of avoided GHG emissions from municipal solid waste disposal and recycling.

Solid waste is broadly divided into two major components: Municipal Solid Waste (MSW) and Bulky/Industrial Solid Waste (BISW). MSW is generated by residential, commercial and institutional sources within a community. It includes MSW generated by industrial sources. BISW is solid waste that can not be compacted such as tree trunks, appliances, vehicles, scrap metals, construction/demolition waste and tires. It also includes residual waste such as petroleum contaminated solids, water treatment residues and ash streams. Table 12 is a listing of MSW and BISW components.

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[23] Assessment of Impacts of Production and Disposal of Consumer Packaging on the Environment, Report to the New Jersey Department of Environmental Protection by Tellus Institute, 1992.

Table 12

New Jersey Solid Waste Material MSW & BISW

Yard Waste*	Food Waste*
Newspaper*	Corrugated*
Office Paper*	Other Paper*
Plastic Containers*	Other Plastic Pkgs*
Other Plastic Scrap*	Glass Containers*
Other Glass*	Aluminum Cans*
Foils & Closures*	Other Aluminum Scrap
Vehicular Batteries	Other Non-ferrous Scrap
Tin & Bi-Metal Scrap	White Goods & Sheet Iron
Junked Autos	Heavy Iron
Wood Waste	Asphalt, Concrete & Masonary
Tires	Other Municipal & Vegetative
Other Bulky & Construct/Demo	Residual Waste

*collected and reported as MSW, the remaining categories are reported primarily as BISW.

This evaluation focused solely on MSW since the USEPA has developed GHG emission factors for only this portion of the solid waste stream. Given the significant recycling that occurs within the BISW stream, the resultant avoided GHG emissions obtained by recycling are likely to be greater than presented in this evaluation for only the MSW stream.

II. Recycling Calculation Methodology

Table 13 lists the quantity of MSW and total solid waste generated in 1985 through 1997 as well as the amounts of MSW and total solid waste recycled and disposed. For the solid waste disposed in the baseline year 1990, 83% was landfilled and 17% was incinerated. The amount of solid waste incinerated increased in successive years until 1995, when 77% was landfilled and 23% was incinerated. Some solid waste was imported into New Jersey for disposal from other states and some solid waste from New Jersey was exported for disposal in other states. However, for the purpose of this evaluation, the New Jersey avoided GHG emissions through MSW recycling were calculated based on the total MSW solid waste stream generated, recycled and disposal regardless of the locations.

Table 14 lists the 1990 recycling and disposal by component. The avoided GHG emissions by material can be calculated to determine the total annual avoided GHG emissions between 1990 and 1995. This evaluation utilizes the emission factors developed by the USEPA as listed in their report "Greenhouse Gas Emissions From Management of Selected Materials in Municipal Solid Waste", September 1998, as well as the methodology in that report to calculate GHG from MSW management including recycling, incineration and disposal. As noted by the USEPA in their report, source reduction provides a greater GHG reduction benefit over all other MSW management options. However, it is not currently possible to assign source reduction values per material in the MSW solid waste stream. NJDEP has very good data on the tonnage and percent of MSW and total solid waste disposed and recycled by material since 1990. NJDEP also has good data by general tonnage category since 1985 (and prior) when the mandatory source separation program was first implemented across New Jersey. Aside from the state specific tonnage values for MSW recycling and disposal by material, this evaluation utilized the national average conditions as referenced in the USEPA report. New Jersey specific conditions may result in slightly different values. The method utilizes the emissions counted from a raw material extraction reference point. Utilizing a waste generation reference point would result in different values for the total emissions with and without recycling; but, the quantity of the difference between these two reference points would have been relatively the same value.

Table 13

NEW JERSEY SOLID WASTE DATABASE TRENDS ANALYSIS
(1985 through 1997)

	GENERATION	RECYCLING				DISPOSAL					
								In-State		Out-Of-State	
Year		Total	% of	MSW	% of	Total	% of	Total	% of	Total	% of
	Total Tons	Tons	Total Tons	Tons	MSW Tons	Tons	Total Tons	Tons	Total Tons	Tons	Total Tons
1985 1)	11.4	0.9	8%	0.6	9%	10.5	92%	9.7	85%	0.8	7%
1986 1)	11.5	1.1	10%	0.7	12%	10.4	90%	9.6	83%	0.8	7%
1987 1)	12.4	1.8	15%	1.2	18%	10.6	85%	9.2	74%	1.4	11%
1988 2)	14.0	5.4	39%	1.5	23%	8.6	61%	4.6	33%	4.0	28%
1989 2)	14.3	6.1	43%	2.1	30%	8.2	57%	4.5	31%	3.7	26%
1990 2)	14.8	6.8	46%	2.5	34%	8.0	54%	4.8	32%	3.2	22%
1991 2)	14.3	7.2	50%	2.8	39%	7.1	50%	4.4	31%	2.7	19%
1992 3)	13.2	6.3	48%	3.1	42%	6.9	52%	4.3	33%	2.6	20%
1993 3)	14.8	7.8	53%	3.1	40%	7.0	47%	4.5	30%	2.5	17%
1994 4)	15.9	9.0	56%	3.3	42%	6.9	43%	4.7	30%	2.2	14%
1995 4)	16.8	10.1	60%	3.6	45%	6.6	40%	4.3	26%	2.3	14%
1996 5)	16.9	10.2	61%	3.3	42%	6.6	39%	4.3	25%	2.3	14%
1997 5)	16.9	10.3	61%	3.4	43%	6.6	39%	4.2	25%	2.4	14%

Note: All numbers are in millions of tons per year and have been rounded for presentation purposes.

1) Final statistics from 1985 through 1987 derived from O&D and tonnage grant figures reported to the Department.
2) Final statistics from 1988 through 1991 derived from O&D and tonnage grant reported figures as supplemented by industry survey.
3) Final statistics derived from O&D and tonnage grant reported figures and supplemented only by add-ons from the NJDOT.
4) Beginning with the 1994 recycling reporting period, industry documented tonnage's for other aluminum scrap, other non-ferrous scrap, white.
5) Recycling tonnage's for 1996 and 1997 do not include material from the 62 and 45 municipalities respectively which did not report those years.

Table 14

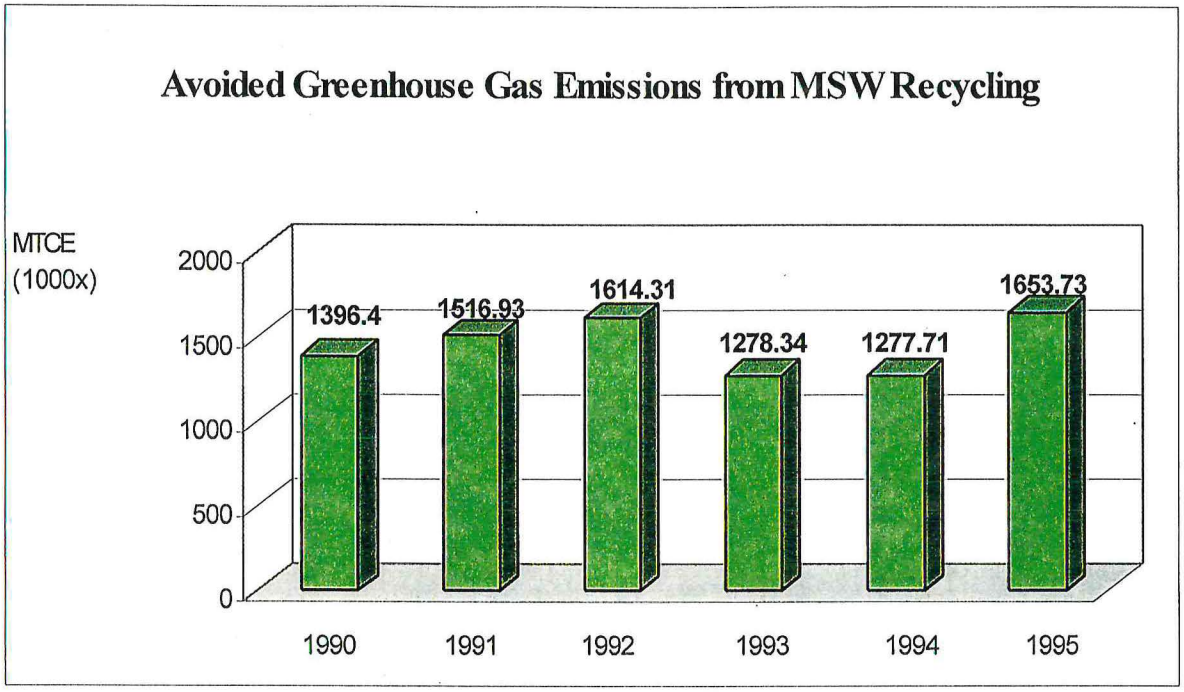
Statewide Recycling - 1990

Materials	% of Total Waste Stream	Total 1990 Generation	% Recycled	Tonnage Recycled
Yard Waste	10%	1,488	53%	782
Food Waste	5%	714	10%	71
Newspaper	5%	751	68%	510
Corrugated	6%	850	61%	517
Office Paper	3%	376	68%	256
Other Paper	11%	1,555	3%	41
Plastic Containers	1%	150	7%	10
Other Plastic Packaging	1%	157	0%	0
Other Plastic Scrap	4%	521	1%	6
Glass Containers	3%	383	68%	260
Other Glass	1%	83	0%	0
Aluminum Cans	0%	45	69%	31
Foils & Closures	0%	23	0%	0
Other Aluminum Scrap	1%	81	74%	60
Vehicular Batteries	0%	42	93%	39
Other Non-Ferrous Scrap	1%	80	76%	61
Tin & Bi Metal Cans	1%	128	22%	28
White Goods & Sheet Iron	3%	425	73%	311
Junked Autos	4%	625	99%	618
Heavy Iron	7%	1,037	99%	1,026
Wood Waste	8%	1,225	16%	202
Asphalt, Concrete & Masonry	15%	2,282	83%	1,885
Tires	1%	148	17%	25
Other Municipal & Vegetative	4%	661	4%	25
Other Bulky & Construct/Demo	6%	929	5%	48
TOTALS	**100%**	**14,757**	**46%**	**6,812**

III. Calculation of Emissions Savings from MSW Recycling

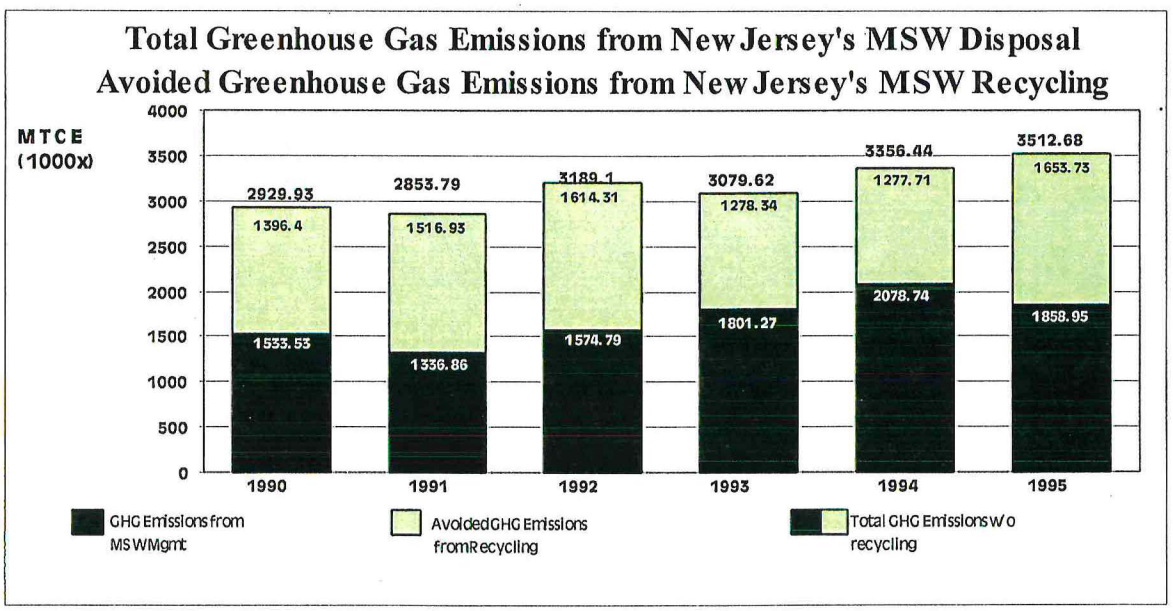
Figure 11 charts the avoided GHG emissions from MSW recycling from 1990 through 1995. Figure 12 charts the total GHG emissions from MSW management, the GHG emissions from MSW disposal and the avoided emissions resulting mainly from MSW recycling. As can be seen from the tables and figures, MSW recycling resulted in a range of approximately 4.8 to 6.2 million metric tons of CO_2 equivalents (1.3 to 1.7 MTCE) of avoided emission annually from 1990 through 1997.

Figure 11



* Calculated as Metric tons of Carbon Equivalent (MTCE) to convert to Metric tons of CO_2 equivalent to the MTCE value is multiplied by 3.67

Figure 12



* Calculated as Metric tons of Carbon Equivalent (MTCE) to convert to Metric tons of CO_2 equivalent to the MTCE value is multiplied by 3.67

From this data, an average GHG avoided emissions reduction per ton of MSW recycled can be calculated. On average, approximately 1.67 metric tons of CO_2 equivalents (0.46 MTCE) are avoided for every ton of MSW recycled. This is somewhat over-simplified since avoided GHG emissions are material specific; however, for projection purposes, this represents a reasonable assumption. The data also allows for an evaluation to prioritize materials to increase the avoided GHG emissions from MSW recycling. If New Jersey were to increase its MSW recycling in key components, such as plastics or other paper streams, a significant portion of the 3.5% NJDEP GHG reduction goal would be derived from MSW recycling. If the MSW recycling rate increased from 34% in 1990 (1995 MSW recycling rate is 45%) to 60% by the year 2005, this would result in a total of 7.7 million metric tons of CO_2 equivalents (2.1 MTCE) in avoided GHG emissions. This results in approximately 2.98 million metric tons of CO_2 (0.81 MTCE) equivalents of additional avoided GHG emissions from New Jersey recycling activities when compared to the 1990 levels. This represents approximately 15% of the total New Jersey GHG reduction plan. However, to be conservation only 30% of this value was included in the proposed CO_2 reduction by Market Sector (Table 1) for the overall reduction goal.

LANDFILL GAS RECYCLING

I. Introduction

Methane is a powerful GHG with a global warming potential 21 times greater than that of CO_2. It is a naturally occurring by-product of anaerobic decomposition of organic matter most notably from waste disposal, domesticated animals and manure. Methane emissions in New Jersey account for about 9% of the total CO_2 equivalent GHG emissions for base year 1990. We calculated this to be 18.6 million tons of CO_2 equivalents. Solid waste landfills are by far the largest anthropogenic source of methane emissions in this state, representing 72% (13.3 million tons) of CO_2 equivalents (.63 million tons of methane).

II. GHG Reductions

Of the 98 relatively large landfills in the State, 29 now capture some methane by flaring or through some type of recovery system. These facilities generate about 9.52 million tons of CO_2 equivalents. Adjusting for 75% recovery efficiency and 10% soil oxidation, about 7.4 million tons of CO_2 equivalents are presently being captured.

It has been determined that New Jersey could realistically capture and combust an additional 10% of available landfill methane beyond business as usual activities (see Table 15). This will be accomplished by Department funded closure and remediation of 12 priority sites. These sites have been selected on the basis of volume, watershed impact, availability of responsible party funding and the current level of environmental controls. Of those sites, funding to remediate eight of the sites will be through excess New Jersey Corporate Business Tax money, other public funds such as dredging funds, or infrastructure trust monies. The Hackensack Meadowlands Development Commission, as well as some private landfill entities, are expected to remediate the other sites. In all, remediation of the 12 sites will account for an additional savings of 0.68 million tons of CO_2 equivalents.

Table 15
Potential New Jersey GHG Reductions in Year 2005
Measures in Waste Management

Measures/Actions	Year 2005 MMT Saved
Recycling to keep organic material out of landfills and avoid CH_4 releases	1.62
Flare CH_4 to change CH_4 to CO_2	2.02
Sector Subtotal	3.64

Additional GHG savings should be realized through the installation of methane collection and combustion systems at certain landfills that are currently undergoing closure or other structurally-related construction activities, or present potentially cost-effective opportunities for such systems. There are ten such facilities that meet this criteria. Installation of collection and combustion systems at these landfills would account for an additional 0.64 million tons in CO_2 equivalent savings.

III. Issues for Implementation

The remaining 47 landfills, some open but most closed, account for about 35% of the total landfill methane (1.9 million tons of CO_2 equivalents) theoretically available for capture. Landfill gas collection can involve a significant expense and this realistically limits the opportunities for additional methane recovery. Furthermore, these facilities are not required, by either federal or state law, to install recovery systems. To require them to make considerable capital investment for nominal emissions reductions, can not be recommended.

However, it is important to note that new developments in methane capture and combustion may offer the possibility of lowering the costs of such efforts. One such option that is under consideration is the use of intermittent flares that could combust at least a portion of the gas vented by the 15 landfills with passive venting systems. It is estimated that there are about 34,000 tons of methane available for capture from these facilities (equivalent to 0.71 million tons of CO_2 equivalent). In contrast to an average $30,000 per acre for a landfill gas flaring system, stick flares run about $5,000 per acre. The major portion of the cost of a state-of-the-art flaring system is the flare and control units which are a fixed cost of $150,000 per site. The per acre cost, therefore, is higher and prohibitive for the smaller-sized facilities than those of the larger regional sites. Further evaluation of the economic versus the environmental benefits of this alternative method are required, in particular applicable air regulations and recovery efficiency.

Consideration of any of the following strategies could be beneficial in managing landfill methane and should be given further evaluation:

- Expedited permitting to qualifying gas recovery projects,
- Sales tax credits or exemptions for generating equipment,
- Use of landfill escrow accounts to finance recovery systems,
- Landfill Contingency Fund to fund recovery projects,

- Tax deductions (or credits) for use of generating equipment,
- Special consideration to companies that use recovered landfill gas (e.g. preference on state contracts),
- Explore opportunities for expanded use of lower cost alternate landfill cover materials such as paper mill sludge and dredge spoils; and,
- Authorize GHG trading credits for the flaring of methane at landfills that are not required to install collection systems and to those that use it for energy production.

NATURAL RESOURCES: OPEN SPACE INITIATIVE

I. Introduction

Approximately 46% of New Jersey's open land is forestland, over 1,800,000 acres. Additionally, it has been estimated that over four million trees occupy the space between the curb and sidewalk in our cities and towns. This natural resource provides a broad range of values and benefits to the natural systems they support, the citizens and industries that rely on them and the public and private ownerships to which they belong. The trees and forests help protect our watersheds, provide habitats for wildlife, recreation for our citizens, wood products for our economy, beauty to our landscapes and improvements to the air we breathe. These trees of both our rural and urban landscapes not only produce oxygen as a by-product of photosynthesis, but also consume CO_2 from the air in their life process. This CO_2 is naturally fixed within trees into carbon which makes up 49% of their biomass. Trees are CO_2 users and at the same time O_2 producers, they are nature's land based counterweight for CO_2 emissions.

The trees and forests of New Jersey are critical to our greenhouse gas plan since these resources not only sequester carbon but they also mitigate the production of CO_2 within our environment. Rural forests and urban trees in our state collectively absorb over 10 million tons of CO_2 from the air each year. This plan would increase the amount, growth and productivity of our forests and over this foundation provide greater CO_2 absorption from our air. Through sound and prudent management strategies our forests can continue to provide values to our society and environment as well as make significant improvements in carbon storage and CO_2 reductions.

These strategies can be divided into two general categories: management and technology.

A. Management

2. Afforestation of Marginal Cropland, Pasture and Riparian Zones

Increasing forestland acreage on open land not being productively utilized could provide substantial GHG benefits by planting trees on these properties. Tree species, particularly productive in sequestering carbon and/or fixing soil nitrogen, could be selected to obtain maximum GHG advantages per acre. Federal cost sharing funds are presently available, through Forest Service and Natural Resource Conservation Service (NRCS) cost-share programs that support the establishment of forest plantations. These funds could be utilized to support any GHG tree planting initiatives developed. A modest afforestation program of 550,000 trees would capture approximately 41,500 tons of CO_2 per year. Among these strategies are:

- Promote and develop a tree planting initiative for marginal crop, pastureland and riparian zones to achieve an additional 250,000 planted trees per year. Additional planting stock could be produced and provided from the existing state tree seedling nursery in Jackson.

- Encourage adherence to P.L. 1993, Chapter 106. This Act concerns the replacement of destroyed trees on certain forested areas owned or maintained by state entities commonly referred to as the "No Net Loss" Act.
- Update existing tree planting pamphlets and information to insure proper optimum spacing, species and positioning of tree plantations established to achieve maximum GHG advantages.
- Establish and maintain state and federal funding to support tree planting.
- Produce a New Jersey guide for reforesting riparian lands.

2. Tree Planting in Urban and Suburban Areas

Trees positively affect these areas by shading and cooling, reducing wind, capturing airborne particulates and mitigating GHG. Proper placement of trees and the use of correct tree species can substantially reduce energy needed to heat or cool urban environments as well as residential settings. The energy conservation planting of trees in urban and suburban settings not only reduce energy use, but also provides the positive $C/CO_2/O_2$ GHG effects. If only 1% of New Jersey residences utilized energy saving tree planting techniques to achieve a 10% reduction in their energy consumption, over 260,000 tons of CO_2 per year would be saved.

- Create energy conservation tree planting guidelines to provide homeowner, commercial and contractor advice for landscape plantings that will conserve energy.
- Generate funding support to encourage residential and commercial dwelling tree plantings consistent with energy conservation guidelines.
- Provide technical assistance to municipalities in the development of local tree management plans and develop guidelines for an "energy conservation" chapter within each plan.
- Increase community forestry tree planting "Green Communities" program funds presently available to support tree planting in urban environments.
- Increase Recycling of Urban Tree Removals.

3. Increase Recycling of Urban Tree Removals

Urban tree removals can be utilized by sawmills that process logs into a broad range of wood products. These urban source trees which at times require removal due to disease, death, roadway construction and hazard reduction can, through their utilization as sawlogs, lessen the demand for logs produced from forest grown trees. Urban log use in this fashion can sequester the carbon stored within the tree's wood for a longer period of time as a useful and economical wood product. This conservation and recycling strategy can generate GHG advantages by displacing some forest log source demand with urban tree removal supplies. A recent New Jersey survey conducted by the New Jersey Forest Service has found that 37 million board feet of urban/suburban trees are presently classified as dead and dying and as such are removal candidates. If only 500,000 broad feet (BF) of this volume were recycled into lawn products, over 31,000 tons of CO_2 would be saved.

- Reprint the "Guidebook for Recycling Municipal Tree Removals" and distribute to all New Jersey municipalities, shade tree commissions and tree service companies.
- Continue direct service and assistance in the area of recycling municipal trees providing marketing guidance, product specifications and process recommendations to entities interested in the opportunities of municipal tree removal.

4. Reduce Forest Loss to Non-Forest Use

Conversion of forestland to non-forest use usually means permanent loss of all or a substantial part of live biomass and an organic matter loss in soils and the forest floor. When these acreages are lost as O_2 producers and CO_2 consumers, negative GHG scenarios result. Protecting and conserving forests by controlling their loss to non-forest use can have a positive result in the sequestration of carbon, absorption of CO_2 and production of oxygen within this natural system. Five thousand five hundred tons of CO_2 emissions per year could be saved if only 1,000 acres of forest were saved from conversion to non-forest use.

- As in the afforestation segment, encourage adherence to existing P.L. 1993, Chapter 106, No Net Loss Act on state-owned lands.
- Increase the existing amount of state-owned forestland through purchase and acquisition by insuring the availability of funds to at least double the acreage of forestland in state government ownership.
- Encourage the retention of privately owned forestland by providing tax-related incentives.

5. Improved Forest Management

Professional management of forestland can result in maximum stocking and productivity of forestland acreage in our state. This increased productivity can maximize the GHG benefits that forestland is capable of producing. Silvicultural practices to increase tree growth, adjust species composition and insure optimum stocking will yield beneficial GHG ratios on existing forestland resources of our state. CO_2 benefits from improved forest productivity through forest management could yield over 10,000 tons of CO_2 savings per year.

- Promote and develop increased guidance of forest management on privately owned woodlands provided by certified professional foresters.
- Insure the application and use of best management practices for forestry on any woodland properties where the harvesting or felling is a recommendation in management.
- Increase the amount and use of federal cost-sharing funds available to support timber stand improvement practices.
- Increase resources available for the preparation and implementation of Forest Stewardship plans on private and public forestlands in New Jersey.

6. Reduction of Waste in Wood Processing

Maximize the efficiency and utilization of wood as it is processed into products. Every tree, log, board and product if utilized properly during its processing can by virtue of efficiency of conversion provide a conservative effect on our forest resources. Waste reduction techniques in processing are available throughout all steps of primary and secondary processing. The application and use of these techniques can help conserve forests as well as reduce energy consumption in the conversion of raw wood into products needed. GHG advantages can be an added value. Only 3% improvements in primary and secondary wood processing yields would produce approximately 5,000 tons of CO_2 savings per year.

- Conduct training programs for loggers concerning improved felling and backing techniques to minimize loss and insure maximum utilization of harvested trees.
- Provide program of services to sawmills and secondary wood processors analyzing existing milling practices and providing improvement recommendations tailored to company equipment and personnel capabilities.

B. Technology

1. Substitute Renewable Biomass for Fossil Fuel Energy

Increased use of renewable sources of "green energy" can reduce the use of fossil fuels. Highly efficient and clean systems of residential, industrial and commercial scale wood energy technology exist and have found increasing use throughout the country. When biomass is grown sustainably and used to displace fossil fuels, net carbon emissions are avoided since the CO_2 released in converting biomass to energy is sequestered within the regrowing biomass through photosynthesis. There is no such advantage with fossil fuel energy since the fuels – coal, oil and natural gas, the residuals of evolution – only make a net carbon increase to the greenhouse gas equation.

- Provide a program of service in New Jersey in cooperation with the Coalition of Northeastern Governors Regional Biomass Program to support and develop in-state biomass energy opportunities. These biomass energy services encompass residential, industrial, transportation and commercial sectors. Conservatively, three million tons of CO_2 emissions from fossil fuels per year could be replaced with targeted use of biomass energy technology in residential and selected commercial energy applications.
- Encourage the application of sustainable biomass energy technology within state-owned facilities and institutions.

- Support large-scale commercial biomass energy production technology, including cofiring of wood with coal at existing coal fired power plants.

2. Increase Paper and Wood Recycling

Recycling wood fiber and wood products may reduce CO_2 emissions in two ways – by reducing the area harvested to provide virgin fiber and also by using less energy to convert recycled products versus growing, harvesting and processing virgin fiber. Wood fiber and wood products are remarkably recyclable. Paper can be reused to remanufacture paper as well as many other reprocessed and composite products. Wood which has outlived its usefulness as a particular product can be remanufactured to other reconstituted products. This extended useful life through recycling has significant greenhouse gas benefits and can be accomplished by:

- Improve mixed paper recycling and increase recycling programs available for small businesses.
- Renew funding support for state recycling efforts and increase the use of recycled wood products at state institutions and agencies.

Anticipated savings are shown in Table 16.

Table 16
Potential New Jersey GHG Reductions in Year 2005
Measures in Natural Resources Management

Measures/Actions	Year 2005 MMT Saved
Increase New Woody Tree Growth	0.52
Sector Subtotal	0.52

II. Open Space Initiative: Governor Whitman's Program to protect 1 Million Acres of Open Space

Open space preservation helps to protect New Jersey's rich natural, historic, and cultural heritage. It ensures that animal and plant habitats are protected and that areas of scenic beauty and agricultural importance are preserved. It safeguards streams and water supplies and provides opportunities to enjoy the outdoors. Open space preservation lies at the core of the quality of life of New Jersey's communities. In addition, open space, especially forested land, acts as carbon sink where CO_2 is absorbed and O_2 is released.

In November 1998, New Jersey voters endorsed the million-acre goal by constitutionally dedicating funds for open space preservation. The constitutional amendment allows New Jersey to set aside $98 million per year for ten years of state sales tax revenues and to allocate up to $1.0 billion in bond proceeds to preserve open space and historic resources.

In addition, nearly $100 million a year is expected to be spent by local governments for similar preservation activities. The bulk of these local dollars will be raised as the result of voter approved dedicated tax revenues.

The long-range vision for open space in New Jersey is an extensive, interconnected system of public and private preserved lands, linked together by greenways. Most of the land will be preserved forever through public ownership and management. Other open lands (farmlands in particular) will be protected by the purchase of conservation easements; the land will remain in private hands, but be safe from the threat of development.

Half of the one million acres, or 500,000 acres, will be farmland. The other 500,000 acres will include lands preserved as open space for ecological, recreational, watershed protection, and historical purposes.

RESEARCH

There are several areas where additional research in terms of data gathering or analysis is required for New Jersey to meet the NJDEP goal of reducing our State's GHG emissions 3.5% below 1990 levels by 2005:

I. Data Accumulation

The problem of controlling GHG emissions is different from most other pollution-control problems. This is because the chief GHG, CO_2, is the end product of complete combustion of fuels, and so cannot be controlled with end-of-the-pipe treatment. The only way to control anthropogenic CO_2 emissions is to control the ultimate source of the emissions, which is the original fuel use. This follows the same overall strategy that has been successfully employed by the DEPs Pollution Prevention program.

As is true with other pollution prevention initiatives, an accurate materials accounting is the necessary first step in developing a pollution prevention plan that can achieve its goals. There must be a good understanding of the inputs and outputs of a process if that process is to be managed rationally and fine-tuned to minimize the overall creation of pollution. This is clearly the case with CO_2 emissions. If their release is to be minimized in a manner that is optimal economically, a good picture of the inputs of fuels and the outputs of useful energy must exist. This knowledge base must contain enough detail so that various energy-saving and fuel use reduction options can be compared and costs and benefits assigned unambiguously.

Unfortunately, our present understanding of fuel use and CO_2 emissions is not specific enough for rational management of the sort embodied in a pollution prevention plan. Virtually all existing data on fuel use (including some data used in this report) are obtained from the USDOE Energy Information Administration (EIA) reports. These data are broad-based accountings of fuel uses, by type, across entire sectors and are based on surveys conducted by the EIA, not on direct reports of CO_2 emissions. It is unlikely that the EIA data is sufficiently accurate to be capable of determining whether the present goals of CO_2 reduction could actually be reached. It is equally clear the EIA data does not contain enough detail to direct the development of incentives and cost-effective control options for many specific end-uses of fuels.

Better data on CO_2 emissions and fuel uses must be obtained. The State of New Jersey must play a key role in advancing efforts at controlling GHG emissions by expanding its capabilities to understand the actual flow of fuels and energy in New Jersey. This could be accomplished by augmenting existing reporting mechanisms and by finding ways to utilize and make more available existing energy-related data. Specific suggestions include:

- Expand existing Right-to-Know reporting to include greenhouse gas emissions.
- Expand existing Emission Statement requirements to include GHG emissions. This program already collects information on fuel use by covered

facilities; making CO_2 emissions factors available to these facilities might make CO_2 emissions reporting relatively easy.

- Explore ways to make data collected by utilities on end uses of electricity and natural gas more available.

The increased and approved availability and accuracy of data on fuel use, energy consumption and carbon dioxide emissions will benefit other efforts such as the assessment of the economic impacts of GHG reduction strategies and the design of a carbon emissions trading program.

The NJDEP has re-allocated $75,000 from its FY'98 NEPPS Performance Partnership Grant (PPG) with the USEPA to begin the evaluation of such issues. Current plans are to seek the voluntary assistance of major pharmaceutical manufacturers to explore how more accurate and more readily available data can be obtained.

II. Econometric and Environmental Modeling, Assessment and Evaluation

There are two aspects to any assessment of potential impacts of policy options to reduce GHGs in New Jersey. One is the actual reductions in emissions that can be anticipated; when and how much. The second is the economic consequences, pro and con, of any proposal.

Efforts to quantify the economic and environmental impacts of various GHG reduction strategies is needed to optimize choices and develop programs with maximum effectiveness. Making such choices and decisions would be greatly helped by the application of a computer-driven, interative approach to options analysis, herein referred to as modeling. There are two approaches to the application of economic and environmental modeling. The "top-down" approach emphasizes the net expenses and damage to the economy. The "bottom-up" approach examines efficiency-enhancing, money-savings measures and technologies to explore potential economic benefits. Existing models, including the very powerful Markal-Macro model and similar computer programs used and proposed by scientists throughout the world, are capable of providing deep insight into the most cost-effective approaches to GHG emissions control. However, these models are only as effective as are the accuracy of their base of data and the ability to delineate a specified scope of application.

Faculty from Rutgers University have proposed a two-stage process to develop such a tool with specific application to the issue of GHG reductions in New Jersey. Stage one of the project would be the development of an integrated "bottom-up/top-down" framework that combines detailed analysis of policy options with an assessment of their economy-wide impacts on New Jersey. One potentially environmentally and economically beneficial strategy in each of the transportation, residential and commercial buildings, landfills and industrial operations sectors would be selected and used in the model to describe the following impacts:

- GHG emissions reductions
- energy savings

- economic impacts
- ancillary costs and benefits
- key uncertainties

Once the initial set of analyses are completed, stage two of this project would involve additional steps to provide the following enhancements:

- expand the model to include more sectoral detail
- include additional "what-if" scenario examinations
- assess a larger number of strategies
- evaluate the cross-sectorial impacts of various strategies

The first year cost of this project is estimated at $90,000.

III. Carbon Emissions Trading Program

The NJDEP, in collaboration with the Center for Clean Air Policy (CCAP), has received a grant from the USEPA to design a carbon emissions trading, or "banking" system for carbon emissions reductions credits that could operate on a national or international scale. Efforts to develop the design of such a GHG trading bank have focused on the following key elements:

- methods of recording and certifying credits generated
- methods of recording and certifying credits used
- methods of recording and tracking credits banked
- establishing baselines for credit generation
- encouragement of innovative technologies that generate energy with lower GHG emissions
- ensuring public availability information
- ensuring accuracy of all records and transactions
- procedures to enforce compliance
- government oversight of operations and quality assurance auditing

The design of the trading system was completed and proposed in the September 30, 1999 New Jersey Register. Collaborators in the project design team include staff from the NJDEP, NJ Board of Public Utilities, USEPA Office of State and Local Climate Programs and the Center for Clean Air Policy.

IV. Methane Quantification Project

A grant from the USEPA has been received to develop methodologies to quantify GHG emissions reductions resulting from solid waste management options, including the use of landfill gases and recycling. This is a gas with a more selected list of potential sources than CO_2. Proposed solutions could include capturing flared emissions from landfills and using them for power generation. Once quantified, such reductions could be banked and traded along with other GHGs.

V. Research on Public Beliefs, Attitudes and Behaviors

For New Jersey to reach the Department's goal, the public must gain a greater understanding of the societal impacts of climate change and their ability to effect changes in GHG emissions. It is equally important that policy makers understand the public beliefs, attitudes and behaviors on this subject. Without such information, public agencies would be guessing about the kinds of messages that would *effectively* inform and motivate changes in behavior that would lead to reduced energy consumption and lower GHG emissions. Research can help formulate appropriate messages and methods of transmittal and enable an assessment of the effectiveness of proposed policy options. Proposed research through contract with Rutgers University would:

- Review existing literature on public understanding of climate change,
- Combine results with plausible lay behaviors that reduce GHG emissions (automobile driving, consumer purchases, etc.) to generate a variety of outreach/education messages,
- Test relative impacts of these messages on public awareness, credibility, commitment to solving and willingness to change behavior, through focus groups and mail surveys,
- Develop a baseline statewide random survey of New Jersey citizen's beliefs and preferences on GHGs and mitigation options, and
- Conduct a follow-up survey to assess the impacts of these initiatives.

VI. Research on Innovative Technologies

The NJDEP has received several research proposals involving the evaluation of innovative technologies such as photovoltaics, fuel cells and geothermal applications. Each proposed project has State-specific applications but also can be applied in other areas. The list of proposed projects, collaborators and required funding is shown below:

A brief summary of each proposed project is shown in Appendix I.

OUTREACH AND EDUCATION

New Jersey's strategy to achieve reductions of GHG emissions will involve the promotion of voluntarily actions designed to achieve publicized public policy goals. Government, industry and the public will all need to make informed choices that will result in beneficial environmental outputs. There are two related aspects to implementing a GHG reduction strategy: *education*, to ensure a uniform, scientifically sound knowledge base, and *outreach*, to inform the diverse constituencies that affect and are affected by, proposed mitigation options.

There are a number of issues, obstacles and misconceptions that must be recognized if a public information campaign on GHG reduction measures is to be successful. These include:

- Opinions that climate change is a global issue that cannot be addressed by individual, local actions.
- Scientific debate about the timing and consequences of global warming is taken by some to mean a lack of credibility about the seriousness of the issue.
- The use of models to predict climate change impacts rather than empirical evidence suggests to some the problem is theoretical.
- Many of the most serious effects of global warming will not be seen for 50-100 years. It is difficult to focus the public attention on a problem and potential solutions that are so far in the future.
- The diversity of stakeholders in GHG emissions reductions programs includes virtually every organization and individual in the State, each with an individualized vested interest (either for or against).
- Economic and societal growth patterns within the State have in the past been based on the utilization of large amounts of fossil fuels. Change to this pattern is therefore threatening to many.
- Most people are fearful of change in any form, especially if it is designed to address issues that are not immediately threatening.
- Many people fear government is already overly intrusive in their personal lives and lifestyle choices.

Specific action items in education and outreach must be directed at addressing these concerns.

I. Training Modules for Primary and Secondary Education

The success of several environmental initiatives, such as recycling, is in part attributable to the introduction of the concept at the primary school level. This resulted in a commitment to and involvement in the issue at the individual level, which spread to families and then to communities.

- Provide resource support for classroom instruction on these subjects.
- Develop a module on GHG reductions and energy conservation as part of the New Jersey Department of Education's Science core curriculum standards.

II. Assistance to Local and County Planners

Issues such as land use and zoning have a critical connection to how much energy will be used and how much GHGs will be emitted. Subjects such as population density for proposed new development, incorporation of energy efficiency into building codes, placement of roads and associated traffic patterns are among the issues that fall within the purview of local and county planners.

- Hold seminars for local and county planners through the auspice of oversight organization, such as the Association of New Jersey Environmental Commissions (ANJEC), on the importance of GHG reduction measure.
- Organize and conduct training seminars that can be delegated to ANJEC officials for their outreach meetings with their regional organizations.

III. Involvement of Civic and Religious Organizations

Consciousness on environmental issues exists within many civic and religious organizations. A program to educate the leaders of these organizations about impacts and potential remedies for transmittal to their constituents or congregants would be beneficial in reaching an educated and involved audience.

IV. State Support to Publicize and Extend Successful Voluntary Industry Initiatives

The Federal government supports voluntary activities to reduce energy and GHGs through programs such as GreenLights, Climate Wise and Energy Star Buildings. New Jersey has more than 15 industrial participants in Climate Wise, including large firms such as AT&T, Johnson & Johnson and Lucent. The State must take a leadership role in promoting these environmentally beneficial programs and work with trade associations and individual companies to seek their voluntary participation. The State should develop a mentoring program where Climate Wise companies counsel other firms in their immediate area on how to reduce energy consumption and GHG emissions. This can be accomplished through a series of seminars held for interested companies in counties where Climate Wise partners are active.

V. Publicize and Extend Successful Voluntary Government Initiatives

The Department of Treasury is responsible for managing operations and energy use at State facilities which occupy 24 million cubic feet of space. Actions such as fuel switching, conversion to more effective means of heating and cooling and increased efficiency in lighting has saved 46 million pounds of CO_2 from electrical retrofits and reduced NO_x emissions by 75%. These are success stories that must be better publicized and extended to similar operations in both the public and private sectors.

VI. Develop Print Media to Reinforce Message

Getting the message that GHG reductions are a serious issue requiring individual action to the public is a large task. To maximize the effectiveness of the delivery and to engage the public in a dialog, we propose to prepare a series of fact sheets and pamphlets describing the issue and how personal action can contribute to reducing GHGs.

VII. Sea Level Rise and the New Jersey Shore

With the level of the sea rising one inch every six years along the New Jersey shore, beach areas are eroding and low-lying coastal areas are more vulnerable to flooding and storm damage. For storm hazard mitigation strategies to be accepted and implemented at the local level, the public must be made aware of their vulnerability to storms and potential means and costs for minimizing storm damage. Develop a public information/education program for distribution to:

- coastal residents
- municipal officials
- municipal planning boards
- environmental commissions
- beach and public interest associations

APPENDICES

Appendix A

STATE OF NEW JERSEY
EXECUTIVE DEPARTMENT

EXECUTIVE ORDER NO. 96

WHEREAS, the State of New Jersey is committed to protecting the resources we have today to ensure that the New Jersey we pass on to our descendants will be healthy, efficient and just; and

WHEREAS, the State of New Jersey is at the forefront of becoming a "sustainable" state by encouraging economic, social and environmental goals that meet the needs of the present without compromising the ability of future generations to meet their own needs; and

WHEREAS, in 1995, in partnership with the Governor's Office, the nonprofit New Jersey Future engaged in a wide-ranging community dialogue aimed at identifying long-term goals intended to enhance the quality of life for all residents of New Jersey, now and in the future, and identifying important economic, environmental and social indicators which could be utilized to measure our progress toward achieving these goals; and

WHEREAS, the results of New Jersey Future's findings have recently been compiled in the first-ever Sustainable State Report, "Living with the Future in Mind", which sets 11 goals, concerning economic vitality, transportation and land use efficiency, public health, equity, education quality, natural resource protection, ecological integrity, pollution prevention, housing, good government, and strong communities, culture and recreation, as well as indicators to measure our progress toward these goals; and

WHEREAS, the goals and indicators outlined in the New Jersey Future report offer valuable practical guidance to the State of New Jersey in our efforts to achieve long-term sustainability for the benefit of current and future generations;

NOW, THEREFORE, I, CHRISTINE TODD WHITMAN, Governor of the State of New Jersey, by virtue of the authority vested in me by the Constitution and by the Statutes of this State, do hereby ORDER and DIRECT:

1. All State Departments and agencies shall:

   a. Pursue, as appropriate, policies which comport with the 11 sustainability goals outlined in New Jersey Future's "Living With the Future in Mind" report.

   b. Collaborate in the exchange of information among departments and agencies, and establish institutional mechanisms to encourage and facilitate achievement of these goals.

   c. Report to the Governor on June 1, 2000, and every year

thereafter, on their progress toward goal attainment.

2. This Order shall take effect immediately.

GIVEN, under my hand and seal
this 20th day of May
in the Year of Our Lord, One
Thousand Nine Hundred and
Ninety Nine, and of the
Independence of the United
States, the Two Hundred and
Twenty-Third.

/s/ Christine Todd Whitman
Governor

[seal]

Attest:
/s/ John J. Farmer, Jr.
Chief Counsel to the Governor

Appendix B

State of New Jersey

Department of Environmental Protection

Christine Todd Whitman
Governor

Robert C. Shinn, Jr.
Commissioner

June 16, 1997

TO: Management Team

FROM: Robert C. Shinn, Jr, Commissioner

SUBJECT: New Jersey Global Climate Change Work Group

The issue of global climate change and the need to reduce emissions of greenhouse gases (GHGs), which include carbon dioxide, methane, nitrogen dioxide and chlorofluorocarbons (CFC)s, has become an important new focus of discussion in the states and at ECOS (Environmental Council of States). As you recall, ECOS recently spoke out publicly for the first time on this issue by passing a resolution at our spring meeting in Arizona, which I have attached for your information; the ECOS membership also highlighted an interest in collaborating with the National Association of State Energy Officials (NASEO) to ensure closer coordination between state energy planners and environmental commissioners.

The purpose of this memorandum is to update you on New Jersey's activities related to global climate change and to advise you about the formation of the New Jersey Global Climate Change Work Group. The group's primary task will be to work with external stakeholders to develop a State Action Plan in response to global climate change. The US EPA awarded a grant to NJDEP to develop this plan and we are expected to complete it by September 30; we are among 20 other states that are developing similar plans. In the longer term, the group will identify, coordinate and track the various New Jersey activities and accomplishments related to reduced greenhouse gas emissions or mitigation efforts, and will work with other New Jersey state agencies to do the same.

Since sea level rise and global climate change are discussed in our National Environmental Performance Partnership System (NEPPS) agreement, the work group is responsible for working with the various DEP program offices to develop goals and milestones and indicators to measure our progress.

I've asked Dona deLeon of my staff to chair the group; she will assist the group's coordination of intra-state policy issues as well as those with ECOS, USEPA, and other states and stakeholders. Project managers and Co-chairs of the NJDEP work group are Stuart Nagourney, NJDEP Division of Science and Research and Dr.

Cameron Johnson of the Board of Public Utilities. Given the important link between rising CO2 emissions and energy planning issues, I'm pleased that the BPU has agreed to co-chair this important effort with us. Participation will also be requested from the NJ Departments of Transportation, Treasury (Office of Energy and Utility Management that oversees energy use in state operations), Commerce, and the State Planning Commission. A representative from DEP's Division of Parks and Forestry will also be added.

The activities related to the impact of global climate change that New Jersey is currently working on is included in the attached fact sheet. Attached for your information is a one page overview New Jersey's 1990 Greenhouse Gas Emission Inventory as preparation for the state action plan. The inventory was also prepared by funding from an EPA grant finalized earlier this year. Congratulations to Dr. Cam Johnson and Dr. Mike Aucott of the DEP's Office of Pollution Prevention for a job well done! Clearly, the sources of greenhouse gas emissions will be key to identifying cost effective strategies to further reduce emissions. Early indications of emissions trends is also attached and shows that from 1991 through 1994 emissions have remained within 2.2% of NJ 1990 levels.

The core members of the Global Climate Change Work Group include the following DEP staff:

Dr. Mike Aucott, Office of Pollution Prevention: as co-author of the 1990 GHG emissions inventory, Mike will work with staff to continue to refine the data and will follow and analyze research related to weather patterns, increased number and intensity of storms as a result of climate change and reactions by the Insurance Industry.

Mike Winka, Office of Innovative Technology and Market Development, is responsible for identifying and reporting on NJ companies or projects that are researching, demonstrating or manufacturing innovative technologies for GHG reduction and coordinating this work with the appropriate state offices.

Mary Anne Goldman, Bureau of Landfill & Recycling Management Recovery, will focus on the use of methane and other landfill gases in the generation of energy. Existing incentive programs such as the Recycling Tax Credit program and Pollution control Equipment Sales Tax Exemption will be continued. New initiatives such as the use of excrow accounts and tax incentives will be explored, as will beapplication of specific pilot projects that result in the creation of energy concurrently with reduced GHG emissions.

Frank Gollatz, Bureau of Air Regulation Development, is responsible for coordinating all on-going air quality related issues with the office of air planning, including coordination of the newly formed global climate change committee in STAPPA-ALLAPCO (state/local air director assoc.) And NJDEP's pending proposal to USEPA on development of a CO2 bank.

Dr. Peter Sugarman, NJ Geological Survey and Mark Mauriello, Bureau of Coastal Regulation, will collaborate on compiling existing information on sea level rise

and develop outreach programs and information packages to better inform the public and affected communities about recent findings. The scientific causes of sea level rise, the relationship between greenhouse gas emissions and sea level rise and options available to impacted communities will be emphasized.

Matt Polsky, Bureau of Risk Analysis, will conduct or research existing economic cost-benefit analyses of possible GHG reduction strategies.

This group will continue to keep the Management Team and I apprised of their work. Please offer your assistance and support to members of this group as they work within the Department and outside it to pursue ways to address this important environmental issue. Share this information with staff; questions may be directed to Dona deLeon or Stu Nagourney.

NEW JERSEY EFFORTS
TO REDUCE GREENHOUSE GAS EMISSIONS
AND MITIGATE POSSIBLE FUTURE IMPACTS

- **Development of New Jersey Greenhouse Gas (GHG) Inventory :** New Jersey's Greenhouse Gas Emissions Inventory was completed in March, 1997 with funding from the US EPA. This report quantifies the amount of GHGs emitted in New Jersey in 1990, and shows that the Garden State produces approximately 2.2% of the US GHG emissions, a low value considering we represent 3.1% of the US population. About 81% of our GHGs are CO2 emissions, consistent with the overall US contribution. Methane makes up 9% of our baseline inventory. Of the state CO2 emissions, 38% is from transportation fuel combustion, 24% from residential buildings, 22% from commercial buildings, and 16% from industry.

- **Sea Level Rise:** In April, 1997 NJDEP released, the "NJ Coastal Report: A Framework for a Coastal Management Partnership" to serve as a discussion piece for renewed cooperation among those who have an interest in protecting New Jersey's coast. The document discusses sea level rise, the causes and related science to global climate change and the implications for coastal beach replenishment and hazard mitigation. A public discussion of this and related issues will continue.

- **Greenhouse Gas (GHG) Action Plan:** The DEP has received a grant from USEPA to develop an action plan as the follow-up to the recently-completed GHG inventory. This plan will identify cost-effective strategies to reduce the amount of GHGs generated within the state as well as potential mitigation and adaptation strategies. The work group will look for cost effective ways to reduce or eliminate barriers that impede our progress. The plan's development will be aided by the creation of a public advisory committee and will be completed by Fall, 1997.

- **GHG Emissions Bank:** In collaboration with the Center for Clean Air Policy, we have submitted a grant proposal to EPA to develop a banking system for carbon dioxide (CO_2) emissions, which represents more than 82% of the state's GHG inventory. We anticipate that the development of this bank will lead to further voluntary reductions of significant contributors to global warming and could serve as the model for future initiatives on a national level. Grantees will be notified by July, 1997.

- **Voluntary CO_2 Emission Reductions by NJ business and industry :** Many New Jersey companies/businesses, including Public Service Electric and Gas, Atlantic Electric Co., General Public Utilities, Johnson & Johnson, Bristol-Myers Squibb Co., Lucent Technologies, Schering Plough Corp., Roche Vitamins & Fine Chemicals, Homasote Co., Cosmair, Inc., Pathmark Stores, St Barnabas Medical Center and Holy Name Hospital have recognized the importance of voluntary reductions of CO_2 emissions by participating in the DOE Climate Challenge Programs and the EPA Climate Wise Program. We will seek to expand private sector participation in these

activities through a program of outreach and education and the opportunity for interested parties to join an advisory committee to work with us.

- **Increased Energy Efficiency in NJ State Buildings:** The NJ Department of Treasury is implementing programs targeted at energy efficiency in the operation and maintenance of public buildings. Many of these actions have the added environmental benefit of reducing GHGs. We will seek the assistance of Mr. Joseph Sullivan, Director of the Energy and Utility Management in developing pilot programs to quantify and expand energy management practices.

- **Methane Reduction**: The DEP is preparing regulations to control greenhouse gas emissions from 19 landfills in New Jersey. Methane from New Jersey's landfills account for 9.2% of the state's total greenhouse gas inventory. USEPA has also developed a Landfill Methane Outreach Program (LMOP) to require landfill operators to asses landfill gas emissions and the potential for cost-effective recovery to use the energy from the gas, which New Jersey will implement. This rulemaking will also reduce volatile organic compounds (VOCs) which contribute to the formation of ozone and hazardous air pollutants.

- **Research and Development of Innovative Technologies**: DEP and the New Jersey Center for Advanced Technology (NJCAT) are working cooperatively to promote development and export of clean technologies to developing countries, whose contributions to CO2 emissions are expected to rise significantly over the coming years. An example is Hydrocarbon Technologies, Inc. (HTI), an employee-owned Research & Development company/process licensor in Lawrenceville, NJ. This company will work with the Chinese government and the Chinese Central Coal Mining Research Institute over the next 6 years to commercialize a coal liquefaction plant in China using HTI's coal liquefaction technology. China is one of the largest contributors to world-wide CO2 emissions and their contribution is expected to double by 2010.

The U.S. Department of Defense (DOD) has chosen the U.S. Army's Picatinny Arsenal in New Jersey to administer a $14 million grant program to assist fuel cell buyers as part of a broader government effort to reduce greenhouse gas emissions. This Climate Change Fuel Cell Program promotes commercialization of stationary fuel cells by stimulating use by electric utilities and DOD power generators, thereby stimulating production volume by U.S. fuel cell manufacturers. Funding can cover as many as 60 projects nation-side. Proposals are due May 1.

- **Alternative Fueled Vehicles:** Governor Whitman has recommended appropriations in her proposed 1998 budget for a NJ Transit Alternatively Fueled Bus Program that will significantly improve NJ's air quality and reduce CO2 emissions. The program includes building a state-of-the-art terminal facility dedicated to compressed natural gas and fuel cell powered buses. This NJ Transit program complements NJDEP's Clean Fleets Program, which encourages public and private fleet operators in New Jersey to utilize clean burning alternative fuels whenever possible. By the year 2005, the State Fleet is projected to have over 2,000 propane or CNG fueled vehicles under this program.

Appendix C

State of New Jersey
Department of Environmental Protection
CN 402
Trenton, NJ 08625-0402

*stine Todd Whitman
*ernor

Robert C. Shinn, Jr.
Commissioner
Tel. # (609) 292-2885
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ADMINISTRATIVE ORDER 1998-09

I, Robert C. Shinn, Jr., Commissioner of the New Jersey Department of Environmental Protection, pursuant to the authority of N.J.S.A. 13:1B-3 declare the following as policy goals of the Department of Environmental Protection:

STATEMENT

A scientific consensus exists that the unabated atmospheric accumulation of greenhouse gases threatens potential calamitous consequences world wide. There is a developing consensus that levels of certain greenhouse gas emissions, most notably carbon dioxide, are increasing at substantial rates in part as a result of human activity.

These world wide concerns have led to the third international convention on climate change in Kyoto, Japan in December of 1997, from which the "Kyoto Protocol" resulted.

This treaty, not yet ratified by the United States Senate proposes global reductions of six greenhouse gases to at least 5% below 1990 levels by the years 2008-2012. Reductions of emissions by individual countries varies, however the U. S. target is 7% below emissions levels in 1990.

The Whitman Administration has adopted a broad range of environmental initiatives which are having direct impact on the quality of the air we breath. These initiatives, include the Ozone Transport Assessment Group (OTAG) NOx transport agreement, adoption of the national low emission vehicle (NLEV), a 90% NOx reduction from instate coal power plants, emission-based fees for air permits, emission trading, the DOT purchase of fuel cell technology, and the immanent implementation of enhanced vehicle inspection as a few examples.

The Department of Environmental Protection plays a key and indispensable role in the planning and implementation of strategies to control the emission of greenhouse gases and shall continue to do so.

POLICY GOALS

To the extent permitted by law, it shall be the policy goals of the New Jersey Department of Environmental Protection in the spirit of creating a sustainable environment, to support and advocate for legislation both state and federal which has as its goal the reduction of greenhouse gases, and the protection of our coast line from sea level rise, which is one direct result of climate change.

The Department shall coordinate with other agencies of state government on the implementation of emission reduction strategies in support of the protocols established at Kyoto.

The Department shall enhance its efforts to design and implement an emissions banking system so as to quantify and credit certain voluntary greenhouse gas emissions reduction by New Jersey companies. In doing so the department shall work in cooperation with international bodies, and countries, such as the Netherlands to explore emission banking concepts and goals which we have in common.

The Department shall provide its assistance and expertise in cooperation with the Department of Transportation and New Jersey Transit for the development of clean fuel fleets both in the public and private sectors.

It shall be the goal of this Department to reduce the level of emissions of the six major greenhouse gases i.e. carbon dioxide, methane, nitrous oxide, sulfur hexafluoride, hydroflurocarbons and fully fluorinated compounds, to 3.5% below 1990 emission levels by the year 2005.

The Department shall coordinate with the Board of Public Utilities to find new energy conservation measures and to the monitoring of green house gases.

I am directing the Department's Greenhouse Gas Workgroup to focus its efforts on the policies set forth herein and to coordinate the resources of the department to effectuate the goals outlined above. I am directing further that all offices of the department cooperate and make available resources as needed by the workgroup to perform these tasks.

This ORDER shall take effect immediately, and shall be published in the New Jersey Register on the next available publication date.

Dated: March 17, 1998

Robert C. Shinn, Jr.
Commissioner

Appendix D

Letter of Intent
Between
The Ministry of Housing, Spatial Planning and The Environment,
The Netherlands
and
The Department of Environmental Protection,
The State of New Jersey

This Letter of Intent conveys the understanding of the Signatories of their intention to cooperate in addressing the challenges posed by the prospect of climate change. The premise for this document includes the following points of common understanding:

A. The Signatories are aware that the 1992 Declaration of the United Nations Conference on Environment and Development states that States and people shall cooperate in good spirit of partnership. (Principle 27);

B. The Signatories acknowledge that the global nature of climate change calls for the widest possible cooperation by all countries and participation in an effective and appropriate international response, in accordance with the countries' common but differentiated responsibilities and respective capabilities and their social and economic conditions. (Preamble United Nations Framework Convention on Climate Change);

C. The Signatories are desirous of expressing their joint concern with the potential environmental damages which may result from the consequences of climate change, including sea level rise, health and economic impacts, and irreversible changes to ecosystems and weather patterns;

D. The Signatories recognize the spirit of the principles of the United Nations Framework Convention on Climate Change which states inter alia that Parties should take into account that policies and measures relevant to climate change should be cost effective so as to ensure global benefits at the lowest possible costs and that efforts to address climate change may be carried out cooperatively by interested parties. (Article 3, paragraph 3 of the United Nations Framework Convention on Climate Change);

E. The Signatories are aware that Annex I Parties have commited themselves to "adopt national policies and take corresponding measures on the mitigation of climate change, by limiting its anthropogenic emissions of greenhouse gases and protecting and enhancing its greenhouse sinks and reservoirs." (Article 4.2a of the United Nations Framework Convention on Climate Change) and further are aware that these parties may implement such policies and measures jointly with other Parties. (Article 4.2a of the United Nations Framework Convention on Climate Change);

F. The Signatories are aware that each Party of the Kyoto Protocol included in Annex 1 in achieving its quantified emission limitation and reduction commitments under Article 3 of the Protocol, in order to promote sustainable development, shall cooperate with other such Parties to enhance the individual and combined effectiveness of their policies and measures adopted under this Article, pursuant to Article 4, paragraph 2(e)(I), of the United Nations Framework Convention on Climate Change. To this end, these Parties shall take steps to share their experience and exchange information on such policies and measures, including developing ways of improving their comparability, transparency and effectiveness (Article 2 of the Kyoto Protocol);

G. The Signatories are aware that the Conference of the Parties to the United Nations Framework Convention on Climate Change shall define the relevant principles, modalities, rules and guidelines, in particular for verification, reporting and accountability for emission trading. Under Article 17 (of the Kyoto Protocol), the Parties included in Annex B may participate in emissions trading for the purposes of fulfilling their commitments under Article 3 (of the Kyoto Protocol);

H. The Signatories herein express the need to collect practical experiences in several ways to gain better insight into the Kyoto Protocol such as emissions trading, joint implementation, and the use of policies and measures.

The Undersigned Signatories in order to effectuate the stated principles of intent set forth herein shall establish a standing committee of representatives of the Ministry of Housing, Spatial Planning and the Environment of The Netherlands, and the Department of Environmental Protection of the State of New Jersey, together with representatives from the Center for Clean Air Policy, Washington D.C.

The purpose of the Committee shall be to develop a plan of action for the implementation of this Letter of Intent.

The Signatories further agree to undertake cooperation in, inter alia, the following areas of endeavor:

- Identify trading mechanisms and identify and design a prototype greenhouse gas emissions trade;
- Undertake joint research into the possibilities of development and implementation of Long Term (Voluntary) Agreements with industry;
- Undertake joint elaboration of the concept of "Benchmarking" of energy-intensive industry;
- Collaborate on the design and implementation of an emission banking system;
- Work together to enhance the individual and combined effectiveness of policies and measures;
- Share information about successful practices that have been implemented within the respective jurisdictions of the Signatories, including the development of innovative technologies.

The Signatories conclude that this Letter of Intent represents a sound first step toward gaining "early experiences" in emission trading, joint implementation and policies and measures, and believe that it will provide a sound basis for future cooperation between the Netherlands and the State of New Jersey in the effective implementation of international environmental conventions.

It is agreed by the Signatories that this Letter of Intention is an expression of good will, and does not bind either signatory, to the commitments herein, or to providing financial resources. This Letter of Intent may be dissolved by either signatory at any time by written notice to the other.

It is on the 5th day of June, 1998 that this Letter of Intent prepared in the English language has been signed in Trenton, New Jersey, by the Signatories and witnessed by the Executive Director of the Center for Clean Air Policy.

Robert C. Shinn, Jr.
Commissioner
New Jersey Department of
Environmental Protection

Margaretha de Boer
Minister of Housing, Spatial Planning
and the Environment of the Netherlands

Edward A. Helme

Witness:
Edward A. Helme, Executive Director
Center for Clean Air Policy

Appendix E

STATE OF NEW JERSEY
EXECUTIVE DEPARTMENT

EXECUTIVE ORDER NO. 94

WHEREAS, the State of New Jersey is committed to leadership in advancing technologies for cleaner and more fuel-efficient automobiles that utilize alternative fuels; and

WHEREAS, the use of advanced technology vehicles ("ATVs") and alternate fuel vehicles ("AFVs") can play an important role in achieving the goals of clean air, conservation of finite energy resources, and reduced greenhouse gas emissions; and

WHEREAS, the State of New Jersey is committed to achieving improvements in air quality mandated by the federal Clean Air Act; and

WHEREAS, the State of New Jersey is committed to complying with the alternative fuel vehicle requirements of the federal Energy Policy Act of 1992 ("EPAct"); and

WHEREAS, AFVs are defined as motor vehicles that operate primarily on non-petroleum fuels such as natural gas, propane, electricity, hydrogen and biodiesel; and

WHEREAS, ATVs are defined as motor vehicles that operate primarily on alternative fuels and that meet or exceed California Air Resources Board ("CARB") ultra-low emission vehicles ("ULEV") standards for the applicable model year, and hybrid-electric or fuel cell vehicles powered by conventional or alternative fuels that meet or exceed CARB ULEV standards for the applicable model year; and

WHEREAS, the development and manufacture of ATVs and AFVs and the development of support industries present potential employment opportunities for New Jersey residents; and

WHEREAS, life-cycle cost analysis can be a useful tool in determining the actual costs to the State of acquiring and operating new motor vehicles;

NOW, THEREFORE, I, CHRISTINE TODD WHITMAN, Governor of the State of New Jersey, by virtue of the authority vested in me by the Constitution and the Statutes of this State, do hereby ORDER and DIRECT:

1. There is hereby created the New Jersey Advanced Technology Vehicle Task Force ("Task Force").

2. The Task Force shall be composed of 7 members as follows:

(a) the President of the Board of Public Utilities ("BPU"), c his designee;

(b) the Chief Executive Officer and Secretary of the Commerce and Economic Growth Commission, or his designee;

(c) the Commissioner of the Department of Environmental Protection, or his designee;

(d) the Commissioner of the Department of Transportation, or his designee;

(e) the State Treasurer, or his designee;

(f) the Attorney General, or his designee; and

(g) the Executive Director of the New Jersey Economic Development Authority ("EDA"), or her designee.

3. The Governor shall designate a chair and vice-chair of the Task Force from among the foregoing members.

4. The Task Force shall:

(a) assist the Department of the Treasury ("Treasury") in developing and coordinating ATV and AFV acquisition plans and vehicle placement for State agencies;

(b) create and implement a compliance monitoring program to ensure that State fleet vehicles with bi-fuel capabilities operate utilizing an alternative fuel to the maximum extent practicable;

(c) work with individual State agencies to remove regulatory and other non-economic barriers to increase the use of ATVs and AFVs in public and private fleets throughout New Jersey;

(d) assist Treasury in establishing life-cycle cost analysis guidelines for the purchase, lease and use of vehicles by State agencies;

(e) administer an annual Clean Fleets Partner Award to public and private fleets demonstrating outstanding leadership in ATV acquisition and use;

(f) assist the EDA in reviewing requests for financial assistance from companies that wish to purchase ATVs;

(g) assist Treasury in preparing a plan for developing the refueling/recharging infrastructure necessary to support the anticipated level of AFV and ATV use by the State motor vehicle fleet; and

(h) assist Treasury in creating an incentive program for other public entities to defray the incremental costs of converting vehicles to alternative fuel use or of acquiring ATVs.

5. The Task Force shall issue a report to the Governor no later than one year from the date that the Task Force convenes, and annually thereafter, on the State's progress in increasing the acquisition and use of AFVs and ATVs by the State motor vehicle fleet.

6. The State of New Jersey and all State agencies shall exercise leadership in the acquisition and use of ATVs and AFVs. The State shall exceed the EPAct AFV acquisition requirements for State government fleets by 5 percentage points for each model year. In Model Years 1999 and 2000, those additional vehicles

acquired to fulfill this enhanced commitment shall meet or exceed CARB low emission vehicle ("LEV") standards in effect for those model years. In Model Year 2001, and thereafter, those additional vehicles acquired to fulfill this enhanced commitment shall meet or exceed CARB ULEV standards in effect for those model years.

7. Treasury shall, in consultation with the Task Force, work with individual State agencies to develop and implement a five-year plan for the integration of ATVs into the State motor vehicle fleet.

8. The EDA shall provide financial assistance in the form of low-interest loans and loan guarantees to qualifying New Jersey companies for projects for the voluntary purchase of ATVs, consistent with N.J.S.A. 34:1B-1 et seq.

9. The New Jersey Department of Transportation, Division of Motor Vehicles, is directed to develop an ATV and AFV school bus inspection program, so that school districts interested in utilizing advanced technology or alternative fuel school buses may do so.

10. Treasury shall take into consideration life-cycle costs when reviewing individual State agency requests for motor vehicle acquisitions.

11. To the extent allowed under law, Treasury shall negotiate reciprocal agreements with other public entities, including educational institutions and municipal and county governments, allowing for the shared use of the existing and planned refueling/recharging infrastructure. To the extent allowed under law, Treasury shall negotiate agreements with the private sector to refuel/recharge the State's ATVs and AFVs.

12. The Task Force is authorized to call upon any department, office, division or agency of State government to provide such data, information, personnel and assistance as deemed necessary to discharge its responsibilities under this Order. Each department, office, division and agency of this State is hereby required, to the extent not inconsistent with law, to cooperate with the Task Force and to furnish it with such information, personnel and assistance as is necessary to accomplish the purpose of this Order.

13. This Order shall take effect immediately.

GIVEN, under my hand and seal
this 16th day of April
in the Year of Our Lord, One
Thousand Nine Hundred and
Ninety Nine, and of the
Independence of the United
States, the Two Hundred and
Twenty-Third.

/s/ Christine Todd Whitman
Governor

New Jersey Geological Survey
Information Circular

Sea Level Rise in New Jersey

Introduction

Along coastal regions, where the ocean meets the land, the forces of nature have always challenged human activities. This is especially true along the heavily populated New Jersey shoreline, where increased erosion, flooding, loss of wetlands, and salinity of surface and ground waters are environmental factors which have major impacts on heavily developed communities. These environmental problems are in part the result of rising global sea level. Sea-level has been rising due to melting of major ice sheets after the last major glaciation 20,000 years ago and thermal expansion of the oceans. The rate of sea-level rise, however, may be exacerbated by human-induced climate change from the production of greenhouse gases. This information circular surveys current scientific understanding about recent sea level changes as well as variations that occurred in the distant geologic past.

There have been many significant changes in sea level over the course of Earth's history. During the geologic past there is evidence of repeated variations of more than 100 m (330 ft) from present sea level. These have occurred both during times of intense glaciation and when the Earth was completely ice-free. Sea-level variations are well documented for the past few hundred thousand years, but are less well-known before then. In the most recent glacial event approximately 20,000 years ago, global sea level was more than 100 m lower than at present (fig. 1).

During the past 42 million years, the Earth has operated as an "icehouse" world where global changes in sea level resulted from the successive formation and melting of continental ice sheets. When ice sheets melt, water is returned to the ocean and sea level rises. When ice sheets expand, water is withdrawn from the ocean and sea level falls.

During earlier times in Earth's history, warmer climates inhibited the formation of large ice sheets, resulting in a period when the Earth operated as a "greenhouse" world. Between 50 and 65 million years ago, the world was intermittently ice free. During the Mesozoic Era (the age of dinosaurs, 65 to 250 million years ago), continental ice was seemingly absent. Consequently, sea level was higher during the Mesozoic, and was at its highest (over 200 m above the present level) 100 million years ago

Glacial History

Water is found in the oceans, locked in ice sheets and mountain glaciers, underground, on the surface as lakes and rivers, and in the atmosphere. By far the greatest volume of

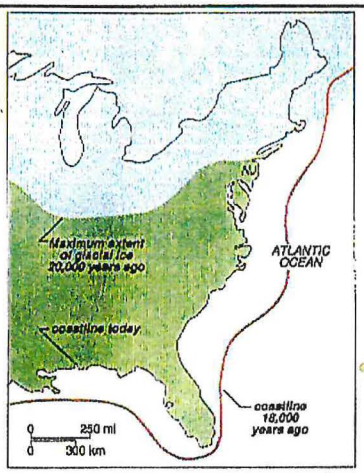

Figure 1. Maximum extent of northern ice sheet during most recent glaciation 20,000 years before present. Global sea level was more than 100 m (approximately 330 feet) lower, resulting in a shoreline extending to the edge of the continental shelf.

water, approximately 97 percent, is stored in the world's oceans. Ice sheets and glaciers account for approximately 2 percent, leaving less than 1 percent in ground and surface waters, and the atmosphere.

During the last several million years vast amounts of liquid water have changed to ice and back again, having a profound effect on sea level. Indeed, sea-level change within the next few thousand years will probably be dominated by water stored in glaciers and by ice sheet dynamics. Therefore, it is important to have an understanding of glacial history and the Ice Age to appreciate the relationship between climate change, the buildup of glaciers, and sea level variations.

The Ice Age began two to three million years ago. There were multiple periods of glacial advance during the Ice Age, with warmer intervals (interglacial periods) between them. During advances, glaciers were far more extensive than they are today.

The best evidence of glacial control on eustatic (worldwide) sea level comes from marine records from seafloor sediments. Glacial/interglacial cycles occurred approximately every 100,000 years during the Ice Age, resulting in about 20 cycles of cooling (glacials) and warming (interglacials). These climatic cycles and corresponding sea-level events are best determined from changes in the ratio between two isotopes of oxygen (O): O^{16} which is the more common and lighter form, and the heavier O^{18}. By measuring O^{18}/O^{16} ratios in the calcium carbonate shells of small marine organisms (foraminifera) retrieved from the sea floor, scientists can determine climatic conditions that existed in the past. When ocean water evaporates, O^{16} is concentrated in water vapor and eventually falls as snow on the surface of an ice sheet. The remaining sea water is thus enriched in O^{18}. When deglaciation occurs, glacial meltwater enriched in O^{16} returns to the ocean, and a corresponding O^{16} spike is recorded in foraminifera from ocean sediments. In looking at the past trend of O^{18}/O^{16} glacial/interglacial (cold/warm) cycles, each cycle lasted about 40,000 years from 2.75 million years to 900,000 years ago; since then, these cycles have lasted about 100,000 years each.

Most Recent Glacial Period

During the Ice Age, New Jersey underwent at least three glaciations. The last glaciation is known as the late Wisconsinan Glaciation. During this period, huge continental ice sheets covered most of Canada, parts of the northern United States, Greenland, northwestern Europe and Antarctica. In New Jersey, the furthest advance of the Wisconsinan ice sheet is marked by a poorly sorted mixture of sand, clay and boulders called the Terminal Moraine.

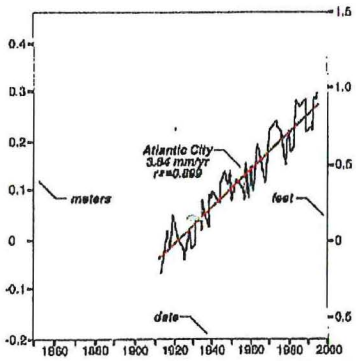

Figure 2. Tide gauge records for Atlantic City and Sandy Hook, New Jersey (modified from Pauty and Collins, 1996).

During the late Wisconsinan glaciation, global sea level was more than 100 m lower than it is today, and both the Hudson and Delaware Rivers cut canyons deep into the continental shelf. As sea level rose, these canyons were drowned, creating the present Hudson and Delaware estuaries. The ice began to melt back from its

maximum position around 20,000 years ago (fig. 1).

The ice sheets in North America and Europe began to melt more rapidly about 15,000 years ago. The meltwater returned to the ocean basins and sea level rose. The rapid melting of the northern continental ice sheets between 15,000 - 7,000 years ago probably accounted for most of the rise of the sea to its present level. During most of this time, the average rise in sea level was 12.5 mm/yr (0.5 in/yr). In New Jersey, from 7,500 to 2,500 years ago, there was a steady rate of sea level rise of approximately 2.0 mm per year (0.1 in/year). Sea-level rise slowed to a rate of approximately 0.8 mm (0.03 in/year) between 2,500 to 1,000 years ago. During the last 1,000 years it has accelerated again to a rate of 4 mm/yr (0.16 in/yr).

Historical Shoreline Change in Response to Sea Level Rise (recent to past 100 years)

Worldwide relative sea level has risen by an estimated 1 - 2 mm/yr (0.04 - 0.08 in/yr) over the past 80 years. This was determined by using data from key tide-gauge stations and a grouping of records from different regions. In New Jersey, sea-level rise has been measured at approximately 3.8 mm/yr (0.15 in/yr at Atlantic City)

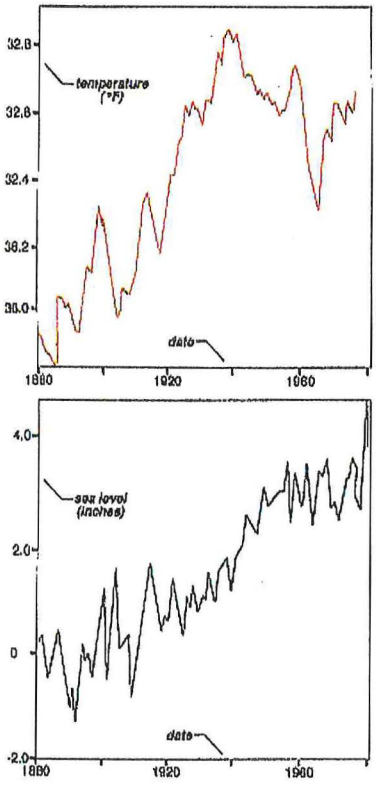

Figure 3. Correlation between global temperature and sea-level rise during the last century (from Intergovernmental Panel on Climate Change, 1990).

using tide gauges (fig. 2), or about twice the world rate. This may be the result of land subsidence along the coast due to sediment compaction. Global sea level has risen up to 15 cm (6 inches) in the past 100 years (fig. 3); much of this rise may be related to the increase of global mean temperature (fig. 3). Indeed, sea-level change during the next few thousand years will probably be controlled by water within the global ice budget and by ice sheet dynamics. If the polar ice sheets were to completely melt, sea level would rise by 70 m (over 200 ft). The Statue of Liberty would just be visible in New York Bay (fig. 4).

Figure 4. View of the Statue of Liberty if the Antarctic and Greenland ice sheets were to completely melt (from K. Miller, Rutgers University).

Causes of Sea Level Rise: Natural and Anthropogenic

Global warming of the atmosphere and ocean resulting from increasing concentrations of carbon dioxide and greenhouse gases (greenhouse gas warming) will control the rise of global sea level during the next 100 years by:

1) thermal expansion of ocean waters as they become warmer (termed steric volume change); and 2) changes in the mass of land ice in both continental ice sheets and mountain glaciers from increased snow and ice melting.

There is a close correlation between sea-level rise and global mean temperature for the past 100 years (fig. 3). One future projection of sea-level rise due to global warming, based only on the steric volume component, is shown on Figure 5. This projection does not include the effect of melting continental ice sheets, which may cause the amount of sea-level rise to be significantly higher.

A difficult question which cannot be answered is how much of the global warming observed during the last decade is attributable to the natural fluctuations of climate, and how much to emissions of heat-trapping greenhouse gases produced by the burning of coal, oil, and natural gases. The prevailing scientific view is that continued and increased emissions of greenhouse gases will disrupt the Earth's climate in the foreseeable future.

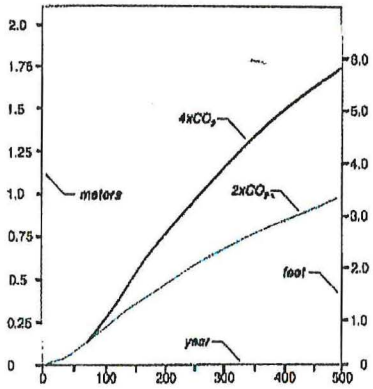

Figure 5. Sea-level rise projections based on a model of projected CO_2 increases of 2x and 4x present levels (Manabe and Stouffer, 1994). These projections only include thermal expansion of ocean waters and do not take into consideration melting continental ice sheets.

The forces of nature can be severe along coastlines. As sea level rises, coastal storms penetrate farther inland, increasing the vulnerability of these areas through the loss of wetlands, increased flooding, and the increase of salt-water intrusion into major aquifers and estuaries. This reality must be accepted and planned for to ensure a secure future for New Jersey.

Sources of Information

Intergovernmental Panel on Climate Change (IPCC), 1990, Scientific Assessment of Climate Change, Working Group I., WMO-UNEP, Geneva, Switzerland.

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Prepared by Peter Sugarman

October, 1998

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This information circular is available upon written request or by downloading a copy from the NJGS web site.

Appendix G

United States Environmental Protection Agency | Office of Policy, Planning and Evaluation (2111) | EPA 230-F-97-008dd September 1997

EPA Climate Change And New Jersey

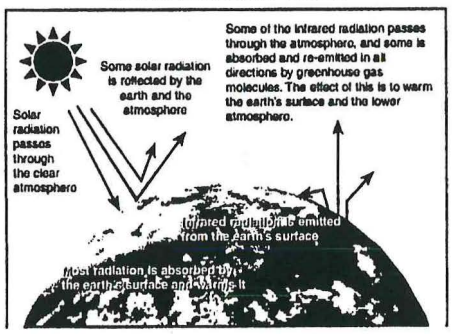
The earth's climate is predicted to change because human activities are altering the chemical composition of the atmosphere through the buildup of greenhouse gases — primarily carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons. The heat-trapping property of these greenhouse gases is undisputed. Although there is uncertainty about exactly how and when the earth's climate will respond to enhanced concentrations of greenhouse gases, observations indicate that detectable changes are under way. There most likely will be increases in temperature and changes in precipitation, soil moisture, and sea level, which could have adverse effects on many ecological systems, as well as on human health and the economy.

The Climate System

Energy from the sun drives the earth's weather and climate. Atmospheric greenhouse gases (water vapor, carbon dioxide, and other gases) trap some of the energy from the sun, creating a natural "greenhouse effect." Without this effect, temperatures would be much lower than they are now, and life as known today would not be possible. Instead, thanks to greenhouse gases, the earth's average temperature is a more hospitable 60°F. However, problems arise when the greenhouse effect is ***enhanced*** by human-generated emissions of greenhouse gases.

Global warming would do more than add a few degrees to today's average temperatures. Cold spells still would occur in winter, but heat waves would be more common. Some places would be drier, others wetter. Perhaps more important, more precipitation may come in short, intense bursts (e.g., more than 2 inches of rain in a day), which could lead to more flooding. Sea levels would be higher than they would have been without global warming, although the actual changes may vary from place to place because coastal lands are themselves sinking or rising.

The Greenhouse Effect



Source: U.S. Department of State (1992)

Emissions Of Greenhouse Gases

Since the beginning of the industrial revolution, human activities have been adding measurably to natural background levels of greenhouse gases. The burning of fossil fuels — coal, oil, and natural gas — for energy is the primary source of emissions. Energy burned to run cars and trucks, heat homes and businesses, and power factories is responsible for about 80% of global carbon dioxide emissions, about 25% of U.S. methane emissions, and about 20% of global nitrous oxide emissions. Increased agriculture and deforestation, landfills, and industrial production and mining also contribute a significant share of emissions. In 1994, the United States emitted about one-fifth of total global greenhouse gases.

Concentrations Of Greenhouse Gases

Since the pre-industrial era, atmospheric concentrations of carbon dioxide have increased nearly 30%, methane concentrations have more than doubled, and nitrous oxide concentrations have risen by about 15%. These increases have enhanced the heat-trapping capability of the earth's atmosphere. Sulfate aerosols, a common air pollutant, cool the atmosphere by reflecting incoming solar radiation. However, sulfates are short-lived and vary regionally, so they do not offset greenhouse gas warming.

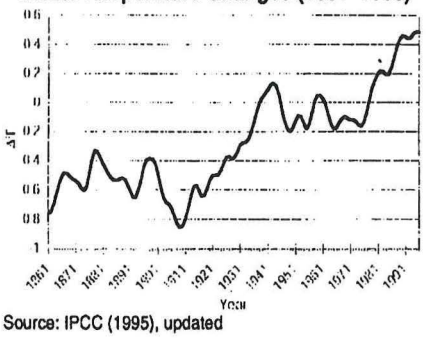
Although many greenhouse gases already are present in the atmosphere, oceans, and vegetation, their concentrations in the future will depend in part on present and future emissions. Estimating future emissions is difficult, because they will depend on demographic, economic, technological, policy, and institutional developments. Several emissions scenarios have been developed based on differing projections of these underlying factors. For example, by 2100, in the absence of emissions control policies, carbon dioxide concentrations are projected to be 30-150% higher than today's levels.

Current Climatic Changes

Global mean surface temperatures have increased 0.6-1.2°F since the late 19th century. The 9 warmest years in this century all have occurred in the last 14 years.

Several pieces of additional evidence consistent with warming, such as a decrease in Northern Hemisphere snow cover, a decrease in Arctic Sea ice, and continued melting of alpine glaciers, have been corroborated. Globally, sea levels have risen 4-10 inches over the past century, and precipitation over land has increased slightly. The frequency of extreme rainfall events also has increased throughout much of the United States.

Global Temperature Changes (1861–1996)



Source: IPCC (1995), updated

A new international scientific assessment by the Intergovernmental Panel on Climate Change recently concluded that ***"the balance of evidence suggests a discernible human influence on global climate."***

Future Climatic Changes

For a given concentration of greenhouse gases, the resulting increase in the atmosphere's heat-trapping ability can be predicted with precision, but the resulting impact on climate is more uncertain. The climate system is complex and dynamic, with constant interaction between the atmosphere, land, ice, and oceans. Further, humans have never experienced such a rapid rise in greenhouse gases. In effect, a large and uncontrolled planet-wide experiment is being conducted.

General circulation models are complex computer simulations that describe the circulation of air and ocean currents and how energy is transported within the climate system. While uncertainties remain, these models are a powerful tool for studying climate. Scientists are reasonably confident about the ability of models to characterize future climate at continental scales.

Recent model calculations suggest that the global surface temperature could increase an average of 1.6-6.3°F by 2100, with significant regional variation. These temperature changes would be far greater than recent natural fluctuations, and they would occur significantly faster than any known changes in the last 10,000 years. The United States is projected to warm more than the global average, especially as fewer sulfate aerosols are produced.

The models suggest that the rate of evaporation will increase as the climate warms, which will increase average global precipitation. They also suggest increased frequency of intense rainfall as well as a marked decrease in soil moisture over some mid-continental regions during the summer. Sea level is projected to increase by 6-38 inches by 2100.

Calculations of regional climate change are much less reliable than global ones, and it is unclear whether regional climate will become more variable. The frequency and intensity of some extreme weather of critical importance to ecological systems (droughts, floods, frosts, cloudiness, the frequency of hot or cold spells, and the intensity of associated fire and pest outbreaks) could increase.

Local Climate Changes

Over the last century, the average temperature in New Brunswick, New Jersey, has increased from 50.4°F (1889-1918 average) to 52.2°F (1966-1995 average), and precipitation in some locations in the state has increased by 5-10%.

Over the next century, New Jersey's climate may change even more. Based on projections given by the Intergovernmental Panel on Climate Change and results from the United Kingdom Hadley Centre's climate model (HadCM2), a model that accounts for both greenhouse gases and aerosols, by 2100 temperatures in New Jersey could increase about 4°F (with a range of 2-8°F) in winter and spring, and slightly more in summer and fall, if greenhouse-gas emissions are not controlled. Precipitation is projected to increase by 10-20% (with a range of 0-40%), with slightly less change in spring and slightly more in winter.

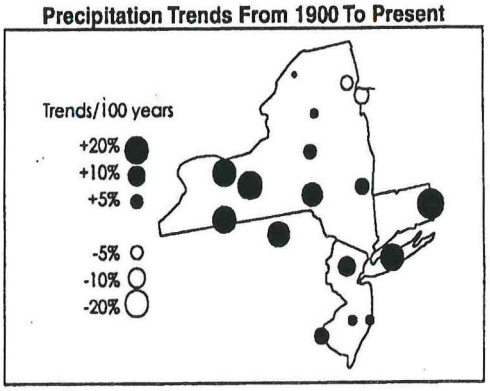
The amount of precipitation on extreme wet (or snowy) days most likely would increase, but changes in the lengths of wet or dry spells are not clear. The frequency of extreme hot days in summer is expected to increase along with the general warming trend. It is not clear how severe storms such as hurricanes would change.

Climate Change Impacts

Global climate change poses risks to human health and to terrestrial and aquatic ecosystems. Important economic resources such as agriculture, forestry, fisheries, and water resources also may be affected. Warmer temperatures, more severe droughts and floods, and sea level rise could have a wide range of impacts. All these stresses can add to existing stresses on resources caused by other influences such as population growth, land-use changes, and pollution.

Similar temperature changes have occurred in the past, but the previous changes took place over centuries or millennia instead of decades. The ability of some plants and animals to migrate and adapt appears to be much slower than the predicted rate of climate change.

Precipitation Trends From 1900 To Present



Source: Karl et al. (1996)

Human Health

Higher temperatures and increased frequency of heat waves may increase the number of heat-related deaths and the incidence of heat-related illnesses. New Jersey, with its irregular, intense heat waves, seems very susceptible.

In Newark, one study projects that a 2-3°F warming could increase heat-related deaths during a typical summer fivefold, from about 25 today to near 125 (although increased air conditioning use may not have been fully accounted for). Decreases in winter mortality probably would be less than the summer mortality increases if the climate warms. The elderly, particularly those living alone, are at greatest risk.

There is concern that climate change could increase ozone levels. For example, high temperatures, strong sunlight, and stable air masses tend to increase urban ozone levels. Furthermore, air pollution also is made worse because natural hydrocarbons emissions increase during hot weather. If a warmed climate causes increased use of air conditioners, air pollutant emissions from power plants also will increase.

A 4°F warming in New York City, with no other change in weather or emissions, could increase concentrations of ozone, a major component of smog, by 4%. Similar increases also could occur in New Jersey. Current ozone concentrations exceed the national health standards for ozone throughout the state. Virtually all of New Jersey is classified as an "extreme and severe" nonattainment area for ozone. Ground-level ozone has been shown to aggravate existing respiratory illnesses such as asthma, reduce lung function, and induce respiratory inflammation. In addition, ambient ozone reduces agricultural crop yields and impairs ecosystem health.

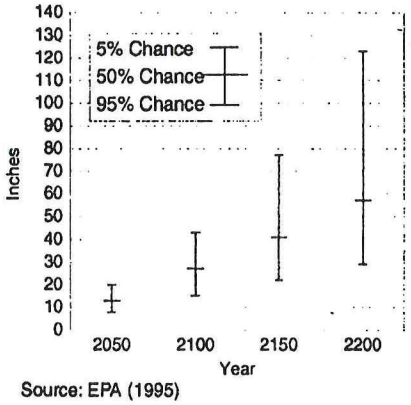
Warming and other climate changes could expand the habitat and infectivity of disease-carrying insects, thus increasing the potential for transmission of diseases such as malaria and dengue ("break bone") fever. Mosquitos flourish in some areas around New Jersey. Some can carry malaria, while others can carry Eastern equine encephalitis, which can be lethal or cause neurological damage. Lyme disease, which is carried by ticks, has increased in the Northeast. If conditions become warmer and wetter, mosquito and tick populations could increase, thereby increasing the risk of transmission of these diseases.

In addition, warmer seas could contribute to the increased intensity, duration, and extent of harmful algal blooms. These blooms can damage habitat and shellfish nurseries, can be toxic to humans, and can carry bacteria like those causing cholera. Brown algal tides and toxic algal blooms already are prevalent in the Atlantic. Warmer ocean waters could increase their occurrence and persistence.

Coastal Areas

Sea level rise could lead to flooding of low-lying property, loss of coastal wetlands, erosion of beaches, saltwater contamination of drinking water, and decreased longevity of low-lying roads, causeways, and bridges. In addition, sea level rise could increase the vulnerability of coastal areas to storms and associated flooding.

Future Sea Level Rise At Atlantic City



Source: EPA (1995)

Along much of New Jersey's coast, sea level already is rising by 15 inches per century, and it is likely to rise another 27 inches by 2100. A large portion of New Jersey's 130-mile coastline is vulnerable to extensive erosion and flooding from sea level rise and storms. The New Jersey coastline is made up primarily of long narrow barrier islands, low-lying salt marshes, and tidal flats. Because of this topography, sea level rise could inflict extensive damage on New Jersey's valuable, high-density coastal real estate and recreational beaches. Rising seas also would inundate many acres of New Jersey's remaining coastal salt marshes and tidal flats that provide flood protection, water quality benefits, and habitat for native species, as marsh plants die or recede to higher elevations.

Protecting New Jersey's coast would require significant resources and planning. For example, estimates of the cost of protecting Long Beach Island with seawalls and more sand from a 1-3 foot increase in sea level over the next century are $100-$500 million. These costs could begin to accrue soon and continue to be incurred throughout the next century.

Water Resources

Water resources are affected by changes in precipitation as well as by temperature, humidity, wind, and sunshine. Changes in streamflow tend to magnify changes in precipitation. Water resources in drier climates tend to be more sensitive to climate changes. Because evaporation from streams and lakes is likely to increase with warmer climate, it could result in lower river flow and lower lake levels, particularly in the summer. In addition, more intense precipitation could increase flooding. If streamflow and lake levels drop, groundwater also could be reduced.

Ensuring the supply of high quality municipal and industrial water is the most critical water resource issue in New Jersey. About half the state's potable water comes from streams and rivers, primarily the Delaware, Raritan, and Passaic rivers, and numerous small streams. The other half comes from groundwater. Except

for that part of the Delaware River that flows from upper New York State, winter snow accumulation has only a modest effect on New Jersey streams. However, streamflow could decrease because of the increased evaporation that would accompany warmer temperatures. The mean annual flow of the Delaware River at Trenton could decrease about 15% if average temperatures warm 4.5°F and precipitation remains unchanged. Urbanization has lowered water quality and increased flooding in many small New Jersey rivers and streams, especially in the northern part of the state. Reduced flows, especially in summer, would exacerbate the decline in water quality. Many New Jersey aquifers also have been contaminated because of industrial and urban development. In the absence of increased precipitation, the amount of groundwater available to refill the aquifers could decrease.

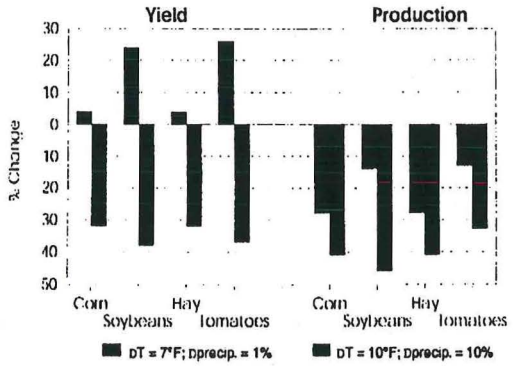
Agriculture

The mix of crop and livestock production in a state is influenced by climatic conditions and water availability. As climate warms, production patterns will shift northward. Increases in climate variability could make adaptation by farmers more difficult. Warmer climates and less soil moisture due to increased evaporation may increase the need for irrigation. However, these same conditions could decrease water supplies, which also may be needed by natural ecosystems, urban populations, and other economic sectors.

Understandably, most studies have not fully accounted for changes in climate variability, water availability, and imperfect responses by farmers to changing climate. Including these factors could substantially change modeling results. Analyses based on changes in average climate and which assume farmers effectively adapt suggest that aggregate U.S. food production will not be harmed, although there may be significant regional changes.

In New Jersey, agriculture is about a $0.7 billion annual industry, two-thirds of which comes from crops. About 6% of New Jersey's agricultural land is irrigated. The principal crops are hay, corn, soybeans, and some vegetables. Projections of changes in New Jersey yield are mixed; they could range from up by 25% to down by 38%. Climate change could lower total acres farmed and production, as well as farm income.

Changes In Agricultural Yield And Production



Source: Mendelsohn and Neumann (in press); McCarl (personal communication)

Forests

Trees and forests are adapted to specific climate conditions, and as climate warms, forests will change. These changes could include changes in species, geographic extent, and health and productivity. If conditions also become drier, the current range of forests could be reduced and replaced by grasslands and pasture. Even a warmer and wetter climate would lead to changes; trees that are better adapted to warmer conditions, such as southern pines, would prevail. Under these conditions, forests could become more dense. These changes could occur during the lifetimes of today's children, particularly if they are accelerated by other stresses such as fire, pests, and diseases. Some of these stresses would themselves be worsened by a warmer and drier climate.

With changes in climate, the extent and density of forested areas in New Jersey could change little or could decline by as much as 10-20%. However, wildfire frequency almost certainly would change with hotter and drier conditions. The types of trees dominating New Jersey forests are likely to change. The mixed forests, dominated by southern pines and oaks, would spread northward throughout the state. These forests would replace the predominantly hardwood forests currently found in the northern half of the state.

Ecosystems

The most important ecosystems of New Jersey that would be vulnerable to climate change are the coastal wetlands and the forested Pine Barrens. The Pine Barrens cover approximately 1 million acres of the Outer Coastal Plain in southern and central New Jersey. The Pine Barrens provide the habitat for rare and unusual species, including the pine barrens treefrog, which is protected by the Endangered Species Act. Because there are few natural corridors that would allow migration of species, their ability to adapt and migrate in response to climate change could be limited.

Plant and animal species near the borders of their ranges are likely to be most affected by climate change. Species better adapted for cool conditions would need to migrate northward, while southern species of plants and animals (including noxious weeds such as kudzu and insect pests such as fire ants) could spread into the state.

New Jersey's coastal wetlands are among the largest and most diverse in the mid-Atlantic region. Sea level rise would alter flooding and salinity, with substantial impacts on wildlife and fisheries. Losses of tidal freshwater wetlands would be especially harmful to foraging grounds for wading birds.

For further information about the potential impacts of climate change, contact the Climate and Policy Assessment Division (2174), U.S. EPA, 401 M Street SW, Washington, DC 20460.

Appendix H

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Appendix I

DESCRIPTION OF TABLE 4 THROUGH 11, 15 and 16 BY COLUMN

Column 1.	CO_2 or CO_2 Equivalent GHG emissions in million tons projected by 2005 by sector.
Column 2.	Short Description of Measure/Action and assumption mode.
Column 3.	Portion of sector 2005 emissions attributable to that subsector, expressed in million tons (MMT).
Column 4.	Portion of sector entities that might take action beyond "business as usual" in any year beyond an action incorporated in projection.
Column 5.	Amount of reduction attributable to measure per entity per year.
Column 6.	Number of years measure might be in effect by Year 2005.

Table 4

Potential New Jersey GHG Reductions From Energy Conservation in Year 2005						
Y2005 CO_2 MMT	**Measures for Residential Buildings - Assumptions**	PROJ Y2005 MMT	Chg. >>proj.	Chg. Per Unit/Yr	# yr.	Y2005 Saved MMT
	(a)x(b)x(c)x(d)=(e)	(a)	(b)	(c)	(d)	(e)
non electric 16.6	Increase rate of residental Non-electric Space Heating system upgrade. c. When non-electic space heating releases .67 of 16.6 MMT - 11.12 MMT. d. If 2% additional system Upgraded each year. (Base rate = 2.5% /y or 40yr system life) e. If upgrade raises average system from 65% to 80% efficiency - 23% improvement. f. If action taken for 6 years - 1999-2005	11.12	0.02	0.23	6	0.31
natural gas 15.6	Increase rate of residential natural gas Domestic Hot Water heater upgrade. A. When natural gas heaters release .22 of 15.6 MMt - 3.43 MMT B. If 5% (or half) of new water heaters are high efficiency, high recovery models. (Base rate - 10%/y or 10 year heater life). C. If each unit saves .5 therms/day (c. 50%) - 47% improvement. D. If action taken for 6 years - 1999 -2005	3.43	0.05	0.47	6	0.48
Electric .326 x (4.6 + 23.5) = 9.16	Increase rate of Refrigerator upgrade a. When electric generation for refrigerators releases .24 of 9.16 MMT electricity - 2.2 MMT b. If 5% (or half) of new water heaters are high efficiency, high recovery models. (Base rate = 5% replacement/year or 20 year life) c. If unit use down 67% (1500 to 500 kwh/y). d. If action taken for 6 years - 1999-2005	2.20	0.05	0.67	6	0.44
NET Non-electric and electric	Increase building efficiency through Update Building Codes a. Based on projected residential net MMT. b. If new housing is 0.19% of all units c. If 95CABO reduces energy use 10%/unit d. If action taken for 5 years - 2000-2005	24.53	0.00	0.10	5	0.02
	Increase building efficiency - Energy Star Buildings A. Based on projected residential net MMT B. If new housing is 0.19% of all units C. If 20% of new units reduce space conditioning MMT by overall 20%/unit D. If action taken for 5 years - 1999-2005	24.50	0.00	0.20	5	0.01
25.76	SECTOR SUB TOTAL	65.78	0.12	1.67	28	1.26

Table 5

Potential New Jersey GHG Reductions From Energy Conservation in Year 2005						
Y2005 CO_2 MMT	**Measures for Commercial Buildings - Assumptions**	PROJ Y2005 MMT	Chg. >>proj.	Chg. Per Unit/Yr	# yr.	Y2005 Saved MMT
	(a)x(b)x(c)x(d)=(e)	(a)	(b)	(c)	(d)	(e)
Non electric 14.5	Increase rate of Space heating system tune up and maintenance to reduce non-electric fuel use. a. When space heating systems release .7 of 14.5 MMT = 10.15MMT b. If 15% facilities above business as usual have annual HVAC tune up/maintenance. c. If tuneup saves 10% of CO_2/facility/year. d. If action taken for 6 years - 1999-2005	10.15	0.15	0.10	6	0.91
Electric: .433 (4.6+23.5) = 12.17	Increase rate of Lighting upgrade. a. When electric generation For lighting releases.44 of 12.17 MMT electric =5.35MMT b. If 15% facilities above business as usual upgrade to best management practices (=Energy Star/Greenlights Program level) c. If upgrade saves 40% of kwh/facility/yr. d. If action taken for 6 years - 1999-2005	5.35	0.15	0.40	6	1.93
	Increase rate of heating/cooling and distribution of system tune up/maintenance to reduce electric requirement. a. When eletric. Generation for HVAC releases .3 of 12.17 MMT = 3.65 MMT b. If 15% facilities above business as usual have HVAC tune up/maintenance c. If tuneup saves 25% of CO_2/facility/year d. If action taken for 6 years - 1999-2005	3.65	0.15	0.25	6	.82
	Increase rate of Office equipment upgrade to Energy Star level. a. Based on electric generation net MMT b. If 15% facilities above business as usual upgrade heavy use equipment (5+yr file) c. If Energy Star reduces electric by 30% d. If action taken for 6 years - 1999-2005	3.16	0.15	.30	6	.85
26.67	SECTOR SUBTOTAL	22.31	0.6	1.05	24	4.51

Table 6

Potential New Jersey GHG Reductions From Energy Conservation in Year 2005						
Y2005 CO_2 MMT	**Measures for Industrial Operations - Assumptions**	PROJ Y2005 MMT	Chg. >>proj.	Chg. Per Unit/Yr	# yr.	Y2005 Saved MMT
	(a)x(b)x(c)x(d)=(e)	(a)	(b)	(c)	(d)	(e)
non-electric 16.9	Increase rate of undertaking Steam distribution and trap repair programs a. When fuel input to steam averages 10% .1 x 16.9 non electric fuel = 1.69 MMT. b. If 10% more facilities above business as usual undertake program and c. Lower fuel required for steam by 10% on average. d. If action taken for 6 years - 1999-2005.	1.69	0.10	0.10	6	0.10
electric 239 (4.6+23.5)=6.72	Increase rate of undertaking ongoing repair and maintenance of Air compressor systems. a. When electric input to power air compressors averages 5% of facility kwh .05 x 6.72 electric MMT = 0.336 MMT b. If 10% more facilities above business as usual lower electric required to power air compression & reduce kwh 50% on average c. If action taken for 6 years - 1999-2005	0.34	0.10	0.50	6	0.10
	Increase rate of use of Variable Speed Drives for high use motors. a. When electric input to power motors averages 44% of net electric: .44 x net electric MMT = 2.91 MMT b. If 10% more facilities above business as usual lower electric required to power c. High use motors reduce motor kwh 10% on average d. If action taken for 6 years - 1999-2005	2.91	0.10	0.10	6	0.17
23.62	SECTOR SUBTOTAL	4.94	0.3	0.7	18	0.37

Table 7

Potential New Jersey GHG Reductions From Energy Conservation in Year 2005						
Y2005 CO_2 MMT	Measures for Transportation - Assumptions	PROJ Y2005 MMT	Chg. >>proj.	Chg. Per Unit/Yr	# yr.	Y2005 Saved MMT
	(a)x(b)x(c)x(d)=(e)	(a)	(b)	(c)	(d)	(e)
Motor gas 35.7	Implement an Inspection/Maintenance Program for New Jersey registered vehicles a. When all motor gas combustion releases 35.7 MMT. b. If Inspection/Maintenance (I/M) affects 4% more vehicle miles gallon c. 10% d. If action taken for 6 years 1999-2005	35.70	0.04	0.10	6	.86
	Increase Improvements to Mass Transit to reduce Trip to Work IV If trip work releases 35% of all motor gas MMT =.35x35.7 MMT = 12.5 MMT reduces by I/M savings = 11.64 MMT IV If project reduces MMT by 1% each year IV If each trip reduces MMT/trip by 90% IV If action taken for 6 years 1999-2005	11.64	0.01	0.90	6	0.63
	SECTOR SUBTOTAL	47.34	0.05	1	12	1.49

Table 8

Potential New Jersey GHG Reductions From Innovative Technology in Year 2005						
Y2005 CO_2 MMT	**Measures for Innovative Technology - Assumptions**	PROJ Y2005 MMT	Chg. >>proj.	Chg. Per Unit/Yr	# yr.	Y2005 Saved MMT
	(a)x(b)x(c)x(d)=(e)	(a)	(b)	(c)	(d)	(e)
Net of Motor Gas	Increase Mass Transit Ridership by adding to Electric Station Car Project: a. Add Employer provided electric cars at mass transit connection points. When trip to work fuel releases net MMT after energy conservation measures. b. If pgm lowers trip to work mileage 1% each year and c. electric car combined with substitution of mass transit reduces fuel combustion by 90% d. If action taken for 6years 1999-2005	11.01	0.01	0.90	6	0.24
	Substitute Electric & hybrid electric cars for Fossil Fuel powered cars 1) Based on net MMT after conservation and trip to work reduction of MMT. 2) Substitute for 3 % of vehicle miles traveled each year. 3) Replace 22 miles per gallon vehicles with 66 mpg eqivalent vehicles (based on mpg of only hybrid vehicle now in production - Toyota Prius) to reduce MMT 67% 4) If action taken for 3 years 2002-2005	33.62	0.03	0.67	3	0.24
	Replace Fossil with Biofuels made primarily from waste materials. a. Based on net MMT after conservation. b. Substitute biofuel for 2% of fossil fuel each year to reduce transportation fossil fuel releases. c. Create biofuels from waste organics (CO_2 reduction = 37%) d. If action taken for 3 years 2002-2005	10.77	0.02	0.37	3	0.24
	SECTOR SUBTOTAL	55.4	0.06	1.94	12	0.72

Table 9

Potential New Jersey GHG Reductions From Innovative Technology in Year 2005						
Y2005 CO_2 MMT	**Measures for Technology In Industrial Operations - Assumptions**	PROJ Y2005 MMT	Chg. >>proj.	Chg. Per Unit/Yr	# yr.	Y2005 Saved MMT
	(a)x(b)x(c)x(d)=(e)	(a)	(b)	(c)	(d)	(e)
New Electric	Electricity from Microturbines in Industrial Operations a. When net electric MMT after efficiency = 6.44 MMT b. If 10% more facilities above business as usual generate electricity c. At 20% less CO_2/kwh than utility generation. Note that microturbines generate at about the same CO_2/kwh as centralized generation but eliminate transmission and distribution losses and incredibility d. If action taken for 6 years 1999-2005	6.44	0.10	0.20	6	0.77
	Electricity from fuel cells in Industrial Operations (where security of supply adds value to investment) a. When net electric MMT = 5.67 MMT b. If 10% more facilitates above business as usual generate electricity c. At 40% less CO_2/kwh than utility generation d. If action taken for 5 years 2000-2005	5.67	0.10	0.40	5	1.13
Net Non-electric	Heat/Steam from Cogeneration for space heating or other use a. When net non-electric MMT=16.8 MMT b. If 2% more facilities above business as usual use heat from generating equipment. c. If cogeneration heat replaces 25% of fuel d. If action taken for 5years 2000-2005	16.80	0.02	0.25	5	0.42
	SECTOR SUBTOTAL	28.91	0.22	0.85	16	2.32

Table 10

Potential New Jersey GHG Reductions From Innovative Technology in Year 2005						
Y2005 CO_2 MMT	**Measures for Technology in Commercial Buildings - Assumptions**	PROJ Y2005 MMT	Chg. >>proj.	Chg. Per Unit/Yr	# yr.	Y2005 Saved MMT
	(a)x(b)x(c)x(d)=(e)	(a)	(b)	(c)	(d)	(e)
Net Electric	Electricity form Microturbines in Commercial Buildings a. When net electric MMT after efficiency = 8.57 MMT b. If 10% more facilities above business as usual generate electricity c. At 20% less CO_2/kwh than utility generation. Note that microturbines generate at about the same CO_2/kwh as centralized generation but eliminate transmission and distribution losses and incredibility d. If action taken for 6 years 1999-2005	8.57	0.10	0.20	6	1.03
	Electricity from fuel cells in Commercial Buildings (where security of supply adds value to investment) a. When net electric = 7.54 MMT b. If 10% more facilities above business as usual generate electricity c. At 40% less CO_2/kwh than utility generation d. If action taken for 5 years 2000-2005	7.54	0.10	0.40	5	1.51
	Electricity from Photovoltaics for day time summer & winter peaking power a. When net electricity MMT = 6.03 MMT b. If 1% of facilities install PV and generate c. 5% of required electricity at 0% CO_2/kwh	6.03	0.01	0.05	5	0.02
Net Non electric	Heat/Steam from Cogeneration for space heating or other use a. When net non-electric MMT = 9.24 MMT b. If 10% more facilities above business as usual use heat from generating equipment c. If cogenerated heat replaces 25% of fuel d. If action taken for 5 years 2000-2005	9.24	0.10	0.25	5	1.15
	SECTOR SUBTOTAL	31.38	0.31	0.9	21	3.71

Table 11

Potential New Jersey GHG Reductions From Innovative Technology in Year 2005						
Y2005 CO_2 MMT	Measures for Industrial Operations - Assumptions	PROJ Y2005 MMT	Chg. >>proj.	Chg. Per Unit/Yr	# yr.	Y2005 Saved MMT
	(a)x(b)x(c)x(d)=(e)	(a)	(b)	(c)	(d)	(e)
Net Electric	Solar Domestic Hot Water Heating to replace Electric Resistance Water heating where natural gas in not available a. When net electric MMT=MMT b. If 1% of facilities install PV and generate 5% of required electricity at 0% CO_2/kwh c. If action taken for 5 years 2000-2005	2.9	0.02	0.7	6	0.24
	Electricity from Photovoltaics for day time summer & winter peaking power a. When net electric MMT=MMT b. If 1% of facilities install PV and generate 5% of required electricity at 0% CO_2/kwh c. If action taken for 5 years 2000-2005	2.71	0.01	0.05	5	0.01
	SECTOR SUB TOTAL	5.61	0.03	0.75	11	0.25

Table 15

Potential New Jersey GHG Reductions From Energy Conservation in Year 2005						
Y2005 CO_2 MMT	Measures in Waste Management - Assumptions	PROJ Y2005 MMT	Chg. >>proj.	Chg. Per Unit/Yr	# yr.	Y2005 Saved MMT
	(a)x(b)x(c)x(d)=(e)	(a)	(b)	(c)	(d)	(e)
CH4 Prevent Waste Generation 7.5	Recycling to keep organic material out of landfills and avoid releases a. When CH4 releases = .358 million tons x 21 7.518 MT COE b. If 4% more Recycling of organic materials occurs and removes 100% of those organic materials c. If action taken for 5 years 2000-2005	7.52	0.04	1.00	5	1.62
CH4 Landfill Management 15.8	Flare CH4 t change CH4 to CO_2 a. When CH4 = net CH4 b. If 9% of CH4 released each year is flared more than business as usual c. Flaring reduces COE MMT by factor of 21 or 95% d. If action occurs over 4 years 2001-2005	5.90	0.09	0.95	4	2.02
13.3	SECTOR SUBTOTAL	13.42	0.13	1.95	9	3.64

Table 16

Potential New Jersey GHG Reductions From Energy Conservation in Year 2005						
Y2005 CO_2 MMT	**Measures in Natural Resources Management - Assumptions**	PROJ Y2005 MMT	Chg. >>proj.	Chg. Per Unit/Yr	# yr.	Y2005 Saved MMT
1.7	(a)x(b)x(c)x(d)=(e)	(a)	(b)	(c)	(d)	(e)
CO_2 LAND USE net 1.7	Increase new woody tree growth a. When CO_2 uptake by trees = 9.05 MMT b. If 1% more old growth wood is replaced with your rapidly growing trees each year. c. Increasing $C0_2$ up take by 95% d. If action taken for 6 years 1999-2005	9.05	0.01	0.95	6	0.52
	SECTOR SUBTOTAL	9.05	0.01	0.95	6	0.52

NJ GHG ACTION PLAN
PROJECTS FOR EXTERNAL FUNDING

Project	Working Organization	Funding
Outreach and Education		
Research on Public Beliefs, Attitudes and Behaviors	NJDEP/Contract	$ 50,000 (1st year)
Training Modules		
Schools, Civic Organizations	NJDEP	$ 50,000 (1st year)
Coastal Communities - SLR	NJDEP	NJDEP Funding
Assessment		
Econometric Modeling	Rutgers	$ 90,000 (1st year)
Carbon Emissions Trading Systems	Coopers and Lybrand	$ 25,000
Technology and Business Development		
Fuel Cells - Distib. Power & Co-gen.	Princeton/CEES	$108,000
Fuel Cell Vehicle Applications	Princeton/CEES	$ 62,000
Carbon Sequestration	Princeton/CEES	$ 86,000
Transport Fuels from MSW	Princeton/CEES	$110,000
Photovoltaics	Princeton/CEES	$100,000
Transport Fuels from Biomass	Princeton/PPPL	$ 83,100
Geothermal Applications	GPU, NJ Heat Pump Council, Conectiv	$ 75,000
Technology Assessments for Commercialization	Coopers and Lybrand	$ 25,000
Impacts		
Impacts of Climate Change in NJ	Rutgers University	$125,000
Natural Resources		
Urban Tree Planting	DEP-P&F	No Estimate - US Forest~~,~~ Service
Suburban Tree Planting	DEP-P&F/Commerce	No Estimate - US Forestry Service
Rural Forest Replenishment	DEP-P&F	No estimate - US Forestry Service