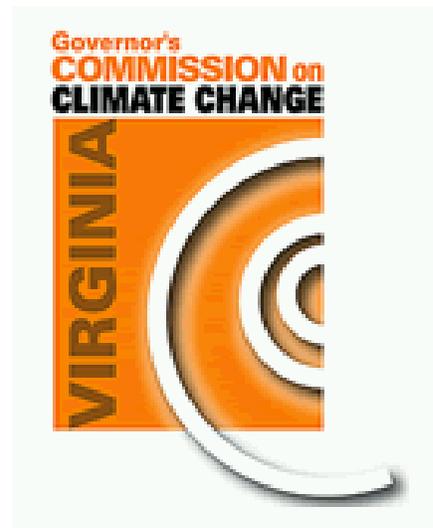


GOVERNOR'S COMMISSION ON CLIMATE CHANGE

Final Report: A Climate Change Action Plan



December 15, 2008

**The Honorable L. Preston Bryant, Jr.
Secretary of Natural Resources
Chair, Governor's Commission on Climate Change**

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APPENDIX A: Members of the Governor’s Commission on Climate Change

APPENDIX B: Interim Report

FINAL REPORT OF THE GOVERNOR'S COMMISSION ON CLIMATE CHANGE

A CLIMATE CHANGE ACTION PLAN

I. Introduction

In September 2007, Governor Timothy M. Kaine released the Virginia Energy Plan, an implementation document designed to demonstrate how the General Assembly-enacted state energy policy (SB-262; *Code of Virginia* § 67-100) could be executed. Included in the Virginia Energy Plan was the recommendation that the Governor create a commission to address climate change and its possible impacts on Virginia.

Governor Kaine responded by issuing Executive Order 59 (2007), establishing the "Governor's Commission on Climate Change." E.O.59 charged the Commission to create a Climate Change Action Plan that would do the following:

1. Inventory the amount of and contributors to Virginia's greenhouse gas emissions, and projections through 2025;
2. Evaluate expected impacts of climate change on Virginia's natural resources, the health of its citizens, and the economy, including the industries of agriculture, forestry, tourism, and insurance;
3. Identify what Virginia needs to do to prepare for the likely consequences of climate change;
4. Identify the actions (beyond those identified in the Energy Plan) that need to be taken to achieve the 30% reduction goal; and
5. Identify climate change approaches being pursued by other states, regions, and the federal government.

The Commission was comprised of more than 40 citizens of the Commonwealth, including scientists, economists, environmental advocates, and representatives from the energy, transportation, building, and manufacturing sectors. The Commission also included local government representatives and state lawmakers. The panel's members were broadly expert and philosophically diverse. The membership of the Commission is listed in Appendix A.

The Commission met in full 10 times over the course of 2008, starting in February and ending in December, when this Final Report was adopted. Meetings were held across the Commonwealth, often at the state's universities, which generally had facilities that could accommodate the anticipated number of interested citizens who would follow the Commission's work and want to offer comment.

The Commission's work was supported by professionals from the Department of Environmental Quality, the Department of Transportation, the Department of Conservation and Recreation, the Department of Health, the Department of Agriculture and Consumer Services, and the Department of Forestry. Other experts from various state institutions of higher

education, especially Virginia Tech and the University of Virginia, were called upon for advice or analysis.

The time committed to assessing climate change's possible impacts on Virginia, and developing strategies to mitigate and combat those impacts, by the Commission members and staff from many state agencies totaled nearly 2,000 hours. The work of the Governor's Commission on Climate Change represents the first comprehensive global warming climate change initiative undertaken by the Commonwealth to date.

Over a six-month period, the Commission heard testimony from a variety of experts on climate change and its impacts on the Commonwealth's natural resources, economy, and public health. The Commission also heard from those knowledgeable on emerging technologies and alternative fuels that represent both strategies to reduce greenhouse gas emissions as well as opportunities for inventors and investors.

The Commission issued an Interim Report in September 2008. The Interim Report provided an overview of the expert testimony presented to the Commission at the time of its writing. The Interim Report neither attempted to interpret testimony presented to the Commission nor draw any conclusions from testimony. Rather, the Interim Report sought to be an objective, "straight reporting" of the Commission's work to date. The Interim Report can be found in its entirety in Appendix B of this report.

Following the Commission's six months of foundational testimony, it deliberated over a set of findings: conclusions that the Commission had collectively drawn from the information it had gathered. The findings are contained in section III of this report.

To begin its consideration of possible recommendations, the Commission broke into four workgroups:

- Adaptation and Sequestration
- Built Environment
- Electric Generation and Other Stationary Sources
- Transportation and Land Use.

These workgroups were comprised of Commission members who had expertise relevant to the subject matter each workgroup was charged with studying. Each workgroup met several times, and each workgroup meeting ranged from three to five hours. A public comment period was held at each workgroup meeting, just as it was at each full Commission meeting. The workgroups developed reports explaining their recommendations; these reports were presented to the full Commission and are summarized in section V B of this report. The workgroups were the source of most of the more than 150 recommendation that the full Commission debated, accepted, amended, deleted, and/or adopted.

The final list of recommendations, as adopted by the full Commission, is provided in section IV of this report. The list of recommendations is divided into two groups. The first group consists of those recommendations that affect greenhouse gas (GHG) emissions. This first

group of recommendations thus addresses directly the Commission's fourth charge as outlined in Executive Order 59: Identify the actions (beyond those identified in the Energy Plan) that need to be taken to achieve the 30% reduction goal. After the first group of recommendations, the report provides estimates of the GHG reductions that will result from certain recommendations, as well as a discussion regarding the cost effectiveness of such recommendations. The second group of recommendations consists of strategies that will guide Virginia's response to climate change, including how the state should plan for and adapt to changes that are likely unavoidable. This second group addresses directly the Commission's third charge as outlined in Executive Order 59: Identify what Virginia needs to do to prepare for the likely consequences of climate change.

The time and energy put into the Commission's work has been considerable. Every effort was made to meet the Commission's charge as set forth in E.O. 59. The Commission's findings are clear. The Commission's recommendations themselves are numerous, some being general and flexible where necessary and others being much more specific.

The Commission appreciates Governor Kaine's decision to create this panel and charge it with conducting as in-depth an assessment as possible on climate change's impact on Virginia. We urge the Governor to act quickly on those recommendations with which he concurs and for which no other approval is required. We further ask the Governor to direct all agency heads to review the Commission's final report and immediately implement those for which sufficient authority and appropriations exist. A number of recommendations are significant and will require approval by the General Assembly. Legislation should be prepared for all significant recommendations for which executive branch authority does not exist.

The Commission further appreciates – and truly values – the great amount of input provided by the hundreds of citizens who routinely attended the panel's meetings or otherwise submitted comments for the public record. We hope this report provides significant value and insight to all who read it.

II. How to Interpret the Commission's Actions on this Report

This final report was adopted by the Commission on a unanimous vote. In adopting the report, Commission members endorsed the need to take actions to reduce greenhouse gas emissions and adapt to changes in Virginia's climate. However, that unanimous vote does not reflect unanimity among Commission members on every recommendation. Instead, it means that most Commission members agreed with most of what is in the document. Commission members' reservations reflect the complexity of the issues that the panel faced.

Testimony and presentations made before the Commission were from many perspectives. As is pointed out in the interim report, the information presented to the Commission was not necessarily endorsed by each Commission member.

Commission Action on the Findings

The Commission's findings were voted on as a set, and there was consensus support for their publication. Individual Commission members may have reservations about particular findings, but all members were comfortable enough with the findings to adopt them as a whole.

Commission Action on the Recommendations

The recommendations were voted on individually, not as a set. The majority received a unanimous vote. However, certain recommendations received great debate among Commission members. The report highlights those issues most intensely debated by the Commission in section V A.

Difficulty in Quantifying Costs and Benefits

It also should be noted that Commission members would have been more comfortable with the recommendations if more quantifiable information regarding costs and benefits had been available. Such analysis was not possible given the time and resource constraints on the Commission. As noted in section IV B of this report, additional analysis of cost issues will be part of the task of implementing the report.

Post-Commission Positions by Commission Members

As noted, most Commission members are in agreement on most of what is in this report. However, Commission members are free to rely on testimony, findings, and recommendations that they find most persuasive and credible, as they have been throughout the Commission's year-long deliberations. Now that the Commission's work is complete, members will remain free to express their own opinions on the report's findings and recommendations as they are debated in the future in various forums.

III. Findings

The Commission is mindful of Governor Kaine's charge to us, and we accept his views on certain foundational issues as our starting point. As Governor Kaine stated, the fact that global climate change is happening and is largely human-caused is now widely accepted.*

We have used the Intergovernmental Panel on Climate Change's (IPCC) Fourth Assessment Report as our primary reference point on the science of climate change. According to the IPCC, current climate models predict that global mean warming at the end of the 21st century (2090 - 2099) will range from 1.1°C to 6.4°C for various models and various scenarios, and the best estimate for one of the moderate emission scenarios (the so-called A1B scenario) is global warming of 2.8°C. Scientists from George Mason University and Center for Ocean-Land-Atmosphere Studies in Maryland have examined the original IPCC data for the moderate A1B

*While we have concluded that the overwhelming evidence supports these points, we have heard testimony providing contrary information during public comment periods at our meetings.

scenario for 15 global models and calculated the 21st century warming for Virginia and the adjoining areas (36.5°N-42°N; 73°W-84°W). They found that from 2000 to 2099 the average warming for Virginia and the adjoining areas would be 3.1°C (5.6°F) and that precipitation would increase by 11%. The warming would be higher for high emission scenarios. The IPCC projects that, to avoid catastrophic changes to the world's climate, greenhouse gas (GHG) emissions will need to be reduced by 25% below the 1990 level by 2020, and 80% below the 1990 level by 2050. While the IPCC predicts that overall changes to the world's climate will be extremely damaging, it also acknowledges that there may be some beneficial effects for some human endeavors (like the growing of certain agricultural crops in certain places).

As Governor Kaine noted, since climate change is a global problem, a national solution is needed in order to achieve the most significant reductions in GHG emissions. However, because the effects of climate change on Virginia will be profound, we cannot wait for the federal government to act. Moreover, many steps to reduce GHG emissions require state action.

We believe that the actions taken by U.S. states can have a significant effect on global GHG levels. The importance of the role of states in addressing climate change is illustrated by data from the World Resources Institute that shows the combined emissions of Virginia, North Carolina, and South Carolina are equivalent to those of South Korea. GHG emissions from just six southeastern states (Virginia, North Carolina, South Carolina, Georgia, Alabama, and Tennessee) are greater than all but six countries in the world.

In pursuing actions to combat climate change, Virginia is not acting in a vacuum. Indeed, we join 37 other states in preparing a climate change action plan. Based upon our review of information from other Mid-Atlantic states' climate change plans and what we have learned from the experts who have made presentations before the Commission, from our discussions, and from the many external documents we have shared with one another and posted on the Commission's website, we now make the following findings:

A. Effects on the Built Environment and Insurance

- Sea level rise is a major concern for coastal Virginia, particularly the highly populated Hampton Roads region. The Chesapeake Bay Program's Scientific and Technical Advisory Committee projects that sea levels in the Chesapeake Bay region will be 0.7-1.6 meters (2.3-5.2 feet) higher by 2100. Specific impacts will vary by location, depending on changes in land elevation.
- Based on an analysis by RMS (a catastrophe modeling company) that has been reviewed and approved by the Organization for Economic Cooperation and Development (OECD), the Virginia Beach-Norfolk Metropolitan Statistical Area ranks 10th in the world in value of assets exposed to increased flooding from sea level rise.

- Modeling and simulation tools already are being used to improve our understanding of how sea level rise and storm surge may affect certain areas of coastal Virginia. However, the fact that LiDAR (Light Detection and Ranging) elevation data does not exist for most of coastal Virginia is a major obstacle to the ability to plan effectively for these changes.
- Climate changes such as sea level rise pose serious and growing threats to Virginia's roads, railways, ports, utility systems, and other critical infrastructure.
- Climate change is widely viewed as a threat to national security. In Virginia, there are several major military installations located in low-lying areas that will be affected by sea level rise and storm surge.
- The continued affordability and availability of insurance for Virginia's landowners is a concern as our climate changes. These effects already are being felt in coastal Virginia. The frequency and severity of storms in the future are expected to exceed those of the past, and the insurance industry may not have the ability to handle several concurrent events. It also is important to make sure that federal flood insurance programs discourage development in sensitive coastal areas.

B. Effects on Natural Systems

- Climate change will have a significant impact on Virginia's ecosystems. At varying rates, vegetation ranges are moving from current locations to higher altitudes and latitudes. The effect of this will be that suitable habitat for some species will decline, other species will become extirpated, and others species will become extinct. Climate change also will exacerbate threats already faced by Virginia ecosystems, such as invasive species, pathogens, and pollution.
- The effects of climate change on many of Virginia's ecosystems and species will be better understood as more research becomes available. Research and conservation efforts will need to be increasingly focused on managing resources to maintain healthy, connected, and genetically diverse ecosystems, and plant, wildlife, and fisheries populations.
- Some of the Chesapeake Bay's "foundation species," such as blue crabs, eelgrass, and oysters, could decline or disappear as salinity and temperatures continue to increase and weather patterns continue to fluctuate widely from year to year. Because foundation species support many other species, these impacts would be felt throughout the ecosystem.
- Oxygen levels in the Chesapeake Bay are expected to decrease due to increasing temperatures and increasing storm runoff, which will have a negative impact on species like striped bass, blue crabs, and oysters. Acidification of the Bay and Atlantic Ocean also is a concern as waters absorb more carbon dioxide (CO₂).

- Coastal wetlands, a critical habitat for many of the Chesapeake Bay's plants and animals, are being lost as sea levels rise, and freshwater coastal wetlands are similarly threatened by saltwater intrusion.
- Virginia's agriculture and forestry industries, as well as commercial and sport fishing industries and park land, will be impacted by climate change. More research to determine specific effects is needed. The lack of specific information on the impacts hinders Virginia's ability to adapt and prepare for these changes.
- Virginia's forestlands sequester approximately 23 million metric tons of CO₂ per year. Unless current land conversion trends are reversed, however, this number will decline every year, as Virginia loses on average 27,000 acres of forestland annually to development. The loss of agricultural lands, which also can sequester CO₂, depending on the management practices applied, is an additional concern. In 2003, Virginia had 15.8 million acres of forestland, which represents a decline of 180,600 acres since 1992.

C. Effects on Human Health

- Climate change is likely to have wide-ranging and mostly adverse direct and indirect impacts on human health. Extreme weather events (e.g., floods, droughts, hurricanes or windstorms, wildfires, and heat waves) can directly affect health through injuries, drownings, or mental health problems, among other things. These extreme weather events could lead to compromised water and food supplies, resulting in increases in waterborne and food-borne illnesses. Climate change will lead to the alteration or disruption of natural systems, making it possible for vector-borne diseases (e.g., arthropod-borne diseases such as West Nile virus and Lyme disease) to spread or emerge in areas where they previously had been limited or non-existent. These alterations or disruptions also could result in the disappearance of some vector-borne diseases by making the environment less hospitable to the vector or pathogen. Climate change also is expected to increase the incidence of diseases associated with air pollutants and aeroallergens and exacerbate other respiratory and cardiovascular conditions.
- The Emergency Preparedness and Response Program for Virginia is available to address and mitigate the impacts of extreme weather events on human health and safety as well as on our buildings and infrastructure.
- Certain groups of people are recognized as being more vulnerable to the health impacts of climate change. These vulnerable populations include the following: children and the elderly, people of low socioeconomic status, members of racial and ethnic minorities, people living in coastal areas and flood plains, and people with pre-existing health conditions and disabilities.

D. General Principles Regarding Strategies

- It is not possible to effectively address the impacts of climate change without significant public and private investment. Either new funding sources, redirection of existing

resources, or both, will be required. Actions to combat climate change should be quantifiable or meaningful and chosen in a manner cognizant of their costs and benefits. State actions should be taken in the context of national goals and strategies.

- Strategies that are focused on conserving existing natural carbon sinks and increasing the capacity of those carbon sinks represent an important and cost-competitive strategy to decrease net GHG emissions. Some strategies, such as conserving land and planting trees and other vegetation, also produce a plethora of co-benefits like improving air and water quality, providing habitat for wildlife, assisting in stormwater management, minimizing impacts of sea level rise, producing food and fiber, reducing heat in urban areas, and providing recreational opportunities.
- The three largest sources of GHG emissions in Virginia are electricity generation, transportation, and non-utility uses of fuel in industrial, commercial, and residential facilities. Emissions from all of these sources must be addressed in order for our climate-change mitigation efforts to be successful and fair.
- The nation's movement toward a GHG emission-constrained economy represents an opportunity for Virginia researchers, inventors, and investors to accelerate and deploy technologies in the areas of energy efficiency, indigenous renewable and low-emission energy, and carbon capture and storage.
- Fossil fuels are a significant part of Virginia's current fuel mix. Carbon capture and storage technology offers the potential to reduce GHG emissions while continuing to produce energy from fossil fuels, but this technology is still in development and is not expected to be commercially available within the next ten years. In addition, its cost, especially with regard to coal-fired electric generation, has yet to be determined.
- As stated in the Virginia Energy Plan, energy efficiency and conservation provide the least costly and most readily deployable energy resource options available to Virginia. It is essential to identify and remove fiscal, regulatory, and other barriers to investments in energy efficiency and conservation. Many of the technologies needed to reduce emissions already are available and are becoming more affordable every day.
- According to the U.S. Energy Information Administration, annual per capita energy consumption in Virginia (345 million BTU/capita, 2005 data) far exceeds European countries like the United Kingdom (165 million BTU), Germany (176 million BTU), France (182 million BTU), and Italy (138 million BTU). The annual per capita energy consumption for the United States was 1.7 percent lower than in Virginia in 2005 (339 million BTU/capita). Virginia ranks 27th highest of the states and District of Columbia. States ranged from 1,194 million BTUs/capita in Alaska and 912 million BTUs/capita in Wyoming, down to 217 million BTUs/capita in New York and 213 million BTUs/capita in Rhode Island.
- Based on 2008 load forecast projections from the PJM Interconnection, the organization that manages the regional power grid of which Virginia is a member, electricity demand

is projected to grow by 26.8% in the part of Virginia served by Dominion Virginia Power and 14.7% in the part of Virginia served by Appalachian Power over the next 15 years. (See table below.)

In calculations completed during development of the Virginia Energy Plan, the Virginia Department of Mines, Minerals and Energy (DMME) projected that natural gas consumption will grow 3.6% from 2007 through 2016 under a business as usual scenario. Natural gas increasingly is being used for electric generation because it is the cleanest of the fossil fuels. This may cause an increase in demand for natural gas supply above this BAU projection.

The Virginia Energy Plan states that efficiency and conservation efforts should be accelerated to reduce these projected growth rate increases. The Plan further states that, even with increased conservation, new electricity generation capacity will be needed. How Virginia supplies this electricity will have a bearing on the Commonwealth’s GHG emissions.

| 15-Year Growth Rate Projection | kWH | Summer kW Peak | Winter kW Peak | |
|--------------------------------|-------|----------------|----------------|---------|
| Dominion | 1.6% | 1.6% | 1.3% | Annual |
| | 26.8% | 27.8% | 21.6% | 15-Year |
| AEP | 0.9% | 1.0% | 0.7% | Annual |
| | 14.7% | 16.0% | 11.3% | 15-Year |

- While recently-enacted federal fuel efficiency standards will reduce the level of GHGs that otherwise would be emitted by automobiles, if there is a significant increase in vehicle miles traveled (VMT), that would mean that transportation emissions still would grow over time. Regardless of the rate of VMT change in the future, near-term improvements in fuel efficiency, increased fuel costs and concomitant changes in driver behavior can significantly reduce emissions generated from driving.
- Areas with compact development patterns and readily available transit services have lower vehicle miles traveled per capita than areas with sprawling development and limited transit, and allow for conservation of more fields, forests, and farmlands. Indeed, areas of compact development generally have lower per-capita energy consumption overall.
- Local governments are the Commonwealth’s critical partners in both reducing the level of GHGs and addressing the impacts of climate change. Localities have authority over land use, zoning, and development decisions; the maintenance and operation of local infrastructure and vehicle fleets; and the enforcement of building codes. The response to climate change will be most effective if the mechanisms that are in place properly coordinate between state and local levels of government. Planning district commissions (PDCs) may be a useful mechanism for this coordination.

- Virginia currently does not have an institutional infrastructure to monitor impacts of climate change on Virginia, the effects of efforts to reduce GHG emissions, or to make Virginia-specific predictions of the future climate and its impacts.
- Although national, state, and local actions can make a significant difference, climate change is a global problem that requires a global solution. That global solution is only achievable if the U.S. demonstrates a commitment to reducing emissions and exerts sustained public policy, political, diplomatic, business, and technological leadership.
- The Commission anticipates that Congress will enact a cap-and-trade program within the next four years. The development of new technology will be accelerated by the market demand created by a cap on GHG emissions.

E. Greenhouse Gas Reduction Goals

The Governor’s Executive Order 59 (2007) set a greenhouse gas emission target of 30% below the business-as-usual projection of emissions by 2025. This will require a reduction of 69 million metric tons of carbon dioxide equivalent (MMte) CO₂, reducing Virginia emissions to 161 MMte CO₂. This is slightly below Virginia’s 2000 emission level of 163 MMte CO₂. The target set in Executive Order 59 (2007) differs from the IPCC recommendations as well as federal, state and regional goals. See the table below.

| Location | Goal |
|--|---|
| <i>International</i> | |
| IPCC | 25% below the 1990 level by 2020, and 80% below the 1990 level by 2050 |
| <i>National</i> | |
| United States (as per EPA testimony before the Commission) | Reduce GHG intensity of the American economy by 18 percent from 2002 through 2012 |
| <i>Regional</i> | |
| Midwestern Regional GHG Reduction Accord | Long-term target of 60 to 80% below current emissions levels; multi-sector cap-and-trade system |
| Northeast Regional Greenhouse Gas Initiative (RGGI) | Caps power plant emissions at current levels in 2009, and then reducing emissions 10% by 2019; trading from all sources |
| Western Climate Initiative | 15% below 2005 levels by 2020, or approximately 33% below business-as-usual levels |
| <i>State</i> | |
| Arizona (Executive Order) | 2000 levels by 2020, and 50% below 2000 levels by 2040 |
| California (Executive Order and Legislation) | EO: 2000 levels by 2010, 1990 levels by 2020, and 80% below 1990 levels by 2050 Legislation: 1990 levels by 2020, with enforceable penalties |
| Colorado (Executive Order) | 20% below 2005 levels by 2020 and 80% below 2005 levels by 2050 |

| Location | Goal |
|---|---|
| <i>State</i> | |
| Connecticut (Legislation) | 10% below 1990 levels by 2020. Barring intervention at the federal level or through the Regional Greenhouse Gas Initiative (RGGI), 80% GHG reduction below 2001 levels by 2050 |
| Florida (Executive Order) | 2000 levels by 2017, 1990 levels by 2025, and 80% below 1990 levels by 2050 |
| Illinois (Executive Action) | 1990 levels by 2020 and 60% below 1990 levels by 2050 |
| Maine (Legislation) | As part of the Climate Change Action Plan developed by the New England Governors and the Eastern Canadian Premiers, set goals of 1990 levels by 2010, 10 percent below 1990 levels by 2020, and 75-85 percent below 1990 levels in the long term. |
| Maryland (Commission Recommendation) | Based on 2006 base year, 10% below by 2012, 15% below by 2015, 25 to 50% reduction by 2020, and 90% reduction by 2050 |
| Massachusetts (Legislation) | 80% reduction in greenhouse gas emissions below 1990 levels by 2050. The Secretary of Energy and Environmental Affairs is to set an interim target of between 10 and 25% below 1990 levels by 2020, as well as targets for 2030 and 2040 (Legislation) |
| Minnesota (Legislation) | 15% by 2015, 30% by 2025, and 80% by 2050, based on 2005 levels |
| New Hampshire (Executive Action) | As part of the Climate Change Action Plan developed by the New England Governors and the Eastern Canadian Premiers, set goals of 1990 levels by 2010, 10 percent below 1990 levels by 2020, and 75-85 percent below 1990 levels in the long term. |
| New Jersey (Legislation) | 1990 levels by 2020 and to 80% below 2006 levels by 2050 |
| New Mexico (Executive Order) | 2000 emission levels by 2012, 10% below 2000 levels by 2020, and 75 percent below 2000 emission levels by 2050 |
| New York (Executive Action) | 5% below 1990 levels by 2010, and 10% below 1990 levels by 2020 |
| North Carolina (Commission Recommendation) | Climate Change Commission report does not set goals. Full implementation of all recommendations would reduce gross greenhouse gas emissions by 47% or to within 1% of 1990 levels |
| Oregon (Legislation) | Stop the growth of greenhouse gas emissions by 2010, 10% below 1990 levels by 2020, and to 75% below 1990 levels by 2050 |
| Rhode Island (Executive Action) | As part of the Climate Change Action Plan developed by the New England Governors and the Eastern Canadian Premiers, set goals of 1990 levels by 2010, 10 percent below 1990 levels by 2020, and 75-85 percent below 1990 levels in the long term. |

| Location | Goal |
|--|---|
| <i>State</i> | |
| South Carolina (Commission Recommendation) | 5% below 1990 levels by 2020. |
| Utah (Executive Action) | 2005 levels by 2020 (Estimated to be 28% below BAU) |
| Vermont (Executive Action) | As part of the Climate Change Action Plan developed by the New England Governors and the Eastern Canadian Premiers, set goals of 1990 levels by 2010, 10 percent below 1990 levels by 2020, and 75-85 percent below 1990 levels in the long term. |
| Virginia (Executive Order) | 30% reduction from BAU by 2025 (equivalent to 2000 emission level) |
| Washington (Legislation) | 1990 levels by 2020, 25% below 1990 levels by 2035, and 50% below 1990 levels by 2050 |
| <i>Local</i> | |
| Cool Cities | Meet or exceed Kyoto protocol targets of 7% below 1990 levels by 2012 |
| Cool Counties | 80% below current levels by 2050, by stopping increases by 2010 and achieving a 10% reduction every 5 years thereafter through 2050 |
| Metropolitan Washington Council of Governments | 10% below business as usual by 2012, 20% below 2005 levels by 2020, and 80% below 2005 by 2050 |

IV. Recommendations

A. Recommendations that affect GHG emissions.

1. *Virginia will reduce GHG emissions by increasing energy efficiency and conservation.*

1A. The General Assembly should enact legislation to encourage development of utility conservation programs. Such legislation should provide for the timely recovery of (i) prudent electric utility operational expenditures for energy efficiency and demand management actions, and (ii) prudent electric utility capital investments in energy efficiency, which should be subject to the same enhanced return as clean energy supply options (200 basis points above the approved electric utility-wide allowable rate of return). The legislation also should require utilities, subject to State Corporation Commission review and approval, to achieve reductions in electricity consumption through a mandatory energy efficiency standard equivalent to the medium case of the American Council for an Energy Efficiency Economy report “Energizing Virginia: Efficiency First” (19% of projected electricity needs by 2025).

1B. The General Assembly should enact legislation setting out state policy, to be implemented by the State Corporation Commission, that supports and encourages investments in advanced metering infrastructure across the electric transmission and distribution systems that

serve the Commonwealth. These policies are to promote increased energy conservation and efficiency in system operations and through customer actions.

1C. DMME and the Virginia Resources Authority should work with localities to establish a central, publicly-administered capital fund for energy efficiency investments in residential and small commercial markets. The agency, Authority, and localities should work with local community groups and businesses to establish one-stop, local energy efficiency service providers. DMME also should work with energy savings performance companies as well as commercial and industrial consumers to expand the use of Energy Savings Performance Contracts in new markets.

1D. The General Assembly should direct the Board of Housing and Community Development to phase in requirements that all new commercial buildings will meet Leadership in Energy and Environmental Design (LEED) energy standards or equivalent standards. Virginia should harmonize the standards with neighboring jurisdictions and standards established by the International Code Council.

1E. The General Assembly should ensure stable funding for an expanded Weatherization Assistance Program. Congress has increased funding for the program, which will result in approximately a tripling of funding from last year, allowing additional homes to be weatherized. If the increased amount of funding is not maintained in future years, state funds will be needed to backfill the program's budget to provide for a stable program. The General Assembly should consider expanding the program beyond the 2008 federal increase.

1F. Business-specific educational and technical assistance efforts, such as industrial efficiency programs, energy auditor training, and voluntary farm energy audits, should be more widely implemented in Virginia. These efforts could be funded from sources with a nexus to the target audience. For example, an effort targeted to fuel oil users or transportation efficiency could be funded through a small increase in the fee that now supports the state's underground storage tank program.

1G. The State Corporation Commission has been charged with implementing an energy efficiency consumer education program. The State Corporation Commission should implement this through multiple partners and should include funding that is sustainable over time. A key component of the program should be explaining the benefits of purchasing and using higher-efficiency appliances.

1H. The General Assembly should require the state's electric utilities to pilot voluntary real-time rates to residential and commercial customers to understand the effect such rates would have on their cost structure and ensure costs are not shifted between time-of-use and other customers. The utilities, to the fullest extent justified by cost structures, also should modify rate schedules to provide for inclining rate schedules for general service customers to encourage high-using customers to use less power. After successful testing in pilots, utilities should be required to make these rates available to all residential and commercial customers.

1I. The General Assembly should provide capital funds or tax credits to commercial and industrial businesses to expand implementation of energy conservation and efficiency in their operations.

1J. The Department of Housing and Community Development should work with stakeholders to incorporate increased energy efficiency requirements into the 2009 and 2012 uniform statewide building codes, so that by 2012, the resulting codes are at least 30% more efficient than the 2006 code.

2. *Virginia will advocate for federal actions that will reduce net GHG emissions.*

2A. The Governor should ask Congress to act as soon as possible to pass comprehensive climate change legislation that includes the following key provisions:

- Establishes a mandatory economy-wide cap and trade program to reduce greenhouse gas emissions;
- Achieves at least a 25% reduction in greenhouse gases by 2020 and an 80% reduction below 1990 levels by 2050;
- Reduces economic impacts by providing assistance to key industries, communities, and consumers to facilitate transition to a low emission economy; developing new technologies to control, capture, and sequester emissions; and reducing residential, commercial, and transportation energy use and costs;
- Allows use of certified high quality offsets that are real, verified, and permanent, from inside and outside the United States, including those generated through avoided deforestation, restoration of forests and other ecosystems, and management of agricultural and forestry operations that result in emission reductions or carbon storage that otherwise would not have occurred;
- Establishes, through a combination of free and auctioned allowances, a financial incentive to reduce carbon emissions, with revenues to be used for actions to mitigate and adapt to climate change; and
- Includes incentives to preserve and enhance natural carbon sequestration by forestland, farmland, wetlands, and other open space.

2B. The Governor should ask Congress to fund research for carbon capture and sequestration, energy conservation and efficiency, and renewable energy. As part of the assessment of carbon capture and sequestration potential, the Department of Mines, Minerals and Energy (DMME) should assess Virginia-specific technical, legal, and other related issues in conjunction with the Interstate Oil and Gas Compact Commission's study on carbon sequestration. This should include assessing issues such as availability of lands for carbon sequestration, ownership of voids used for carbon sequestration, conflicting property rights

related to surface and mineral owners of lands used for carbon sequestration, long-term liability for sequestered carbon, and permits required to inject carbon underground.

2C. The Governor should ask Congress to support the accelerated establishment of Corporate Average Fuel Economy (CAFE) standards for heavy trucks (which currently have no fuel economy standards) and stronger CAFE standards for passenger vehicles. The Governor may wish to suggest, for example, nationwide fuel economy standards that would achieve GHG emissions reductions similar to those that would be achieved under the California Low-Emission Vehicle (CALEV) requirements.

2D. The Governor should ask Congress, as part of its renewable energy policies, to consider long-term, reasonable, predictable, and sustainable financial incentives like tax credits and/or federal loan guarantees to encourage development of carbon-free renewable energy projects.

2E. The Secretary of Transportation should work with stakeholders to develop specific goals and priority measures for the coming reauthorization of the federal surface transportation act that will reduce the GHG emissions from transportation. The Governor should ask Congress to incorporate these goals and measures into the transportation reauthorization legislation.

3. *Virginia will reduce GHG emissions related to vehicle miles traveled through expanded commuter choice, improved transportation system efficiency, and improved community designs.*

3A. The General Assembly should amend current law pertaining to the Statewide Transportation Plan to require that the Plan include coordination of transportation and land use as a key policy goal and to require the Plan to include quantifiable measures (including those called for in HB3202 (2007) and in the Final Report of the Transportation Accountability Commission, dated October 2007) and achievable goals relating to greenhouse gas reduction. Suggested goals include reduction of GHG emissions from the transportation sector, transit riders per mile of transit infrastructure, percentage of Virginians who walk or bike to work, and percentage of freight carried by rail. Progress towards the goals should be monitored through the annual Transportation Performance Report. Nothing in these recommendations is intended to limit the authority of local governments for land use decisions.

3B. The Virginia Department of Human Resource Management should continue to promote its telework and flextime standards for eligible state employees and should recommend that local governments and private businesses adopt these voluntary standards. All state agencies should increase opportunities for citizens to engage in electronic transactions with the state rather than having to drive to state offices. The Virginia Department of Rail and Public Transit should expand the Telework!Va program and encourage private employers to adopt these standards and should consider rewarding high-performing public and private employers who use telework well. The effectiveness of these transportation demand management measures should be compared to that of providing access to transit for workers and those doing business with the Commonwealth.

3C. State and local transit and rail funding should be increased, first to maintain existing infrastructure and services, second, to meet increasing demand by expanding the frequency and scope of transit and rail services across the Commonwealth, and, third, to encourage local and regional land use patterns which minimize GHG emissions. With regard to local transit funding, the General Assembly should extend the regional revenue source for transit that exists in Northern Virginia throughout the Commonwealth, because the current structure for funding regional transit operations is an impediment to sustaining and growing transit operations. The General Assembly should analyze the sufficiency of this source and ensure that the source is sufficient to provide for no less than a transit level of service “B” as defined by the Transit Capacity and Quality of Service Manual. With regard to rail funding, the General Assembly should improve and expand funding for passenger and freight rail service, including substantially increasing funding for the Virginia Rail Enhancement Fund. The draft Statewide Rail Plan, for example, identifies a number of projects offering significant GHG reductions. The movement of freight via rail instead of over-the-road is typically three times more fuel-efficient. A ton of freight moved via rail will generate one-third the carbon footprint of the same or equivalent movement over the road via truck.

3D. Within its allocation formula and funding decisions, the Commonwealth Transportation Board (CTB) should target available transportation funds towards existing communities and designated urban development areas and promote compact, walkable, transit-oriented development areas. The Virginia Department of Transportation (VDOT) and natural resources agencies should provide technical assistance, funding, and authority to localities to amend comprehensive plans and zoning ordinances to promote compact, walkable, transit-oriented development areas and to guide development to such areas.

3E. The Commonwealth Transportation Board should study and evaluate the impact of High Occupancy Toll (HOT) lane networks on greenhouse gas emissions. This should be considered as one factor in deciding whether to expand HOT lane networks.

3F. The State Corporation Commission should encourage insurance companies to offer pay-as-you-drive insurance as an option to motorists (which already is permissible, but not currently offered, in Virginia).

3G. Virginia should require that environmental analysis and review of major transportation projects/networks should include projections of the resulting GHG emissions. Virginia’s metropolitan planning organizations (MPOs) should include consideration of GHG emissions in their regional transportation analyses and seek outcomes that help reduce GHG emissions. The Commonwealth Transportation Board should use such analyses in its consideration of project selection.

3H. The Secretary of Transportation should explore ways to send consumers better, more accurate signals of the costs of transportation. Pricing transportation on miles driven and on the timing and congestion of the trips taken can do much to reduce and consolidate discretionary travel (as much as 40% of all trips and 54% of trips during peak periods). Our highway system must move toward greater use of pricing mechanisms that will charge for actual usage reflective of supply and demand (as virtually all other goods and services are priced).

3I. The Commonwealth should fund and support, through VDOT and other agencies, such as the Virginia Department of Housing and Community Development, the Virginia Housing Development Authority, the Department of Rail and Public Transportation, and the Department of Mines, Minerals and Energy, working with Planning District Commissions, MPOs, and local governments, a set of statewide region-by-region scenario analyses of local transportation and land use planning. This effort will model and compare the differences in transportation and infrastructure costs, land used, environmental impacts, housing availability, energy, water, fuel used, and GHG emissions of compact vs. sprawling land use patterns. The preferred scenario should be incorporated into local and regional plans and the Statewide Transportation Plan and used to guide transportation, infrastructure, housing, and natural resource system investments and future land use decisions.

3J. The Secretary of Transportation should evaluate the costs/benefits of a commuter tax credit, offering businesses tax savings for providing their employees with transportation benefits that provide an alternative to single occupancy vehicle commuting, such as transit passes, vanpool expenses, and cash in lieu of parking.

3K. The CTB has amended its road construction standards to make new or upgraded roads more pedestrian- and bike-friendly. The CTB should ensure that funding is available for localities to implement these standards, develop and provide funding and technical assistance to encourage local governments to construct pedestrian and bicycle improvements, and compile and coordinate local and regional plans to develop a pedestrian and bicycle network.

3L. The VRA should continue to promote the expansion of broadband access to our homes and businesses, a key to trip avoidance.

3M. The General Assembly should authorize and encourage cities, towns, and older suburbs to adopt the split rate property tax that applies a lower tax rate to buildings than on land to encourage redevelopment where there is existing infrastructure.

3N. The Commonwealth should work with lenders to provide and promote location efficient mortgages, which promote the purchase of homes in compact, mixed-use areas where there is less need to drive and therefore more discretionary income.

3O. VDOT should amend its corridor analysis and project analysis process, required under many federal provisions such as environmental statutes, to make sure that transit, freight and passenger rail, and other transportation modes are included in every analysis. Access management also should be considered as a design alternative for all major road projects to evaluate the cost effectiveness of various design options. VDOT should develop and implement access management plans to preserve new transportation corridors and to help restore the capacity of existing roads.

3P. VDOT should adopt a “complete streets” policy to design and operate roadways to allow safe, attractive, and comfortable travel for all users.

3Q. Local governments should enhance the convenience of using transit compared to driving. VDOT should develop and provide funding and technical assistance to local governments to amend zoning codes that currently establish excessive minimum parking space standards and encourage local governments to apply parking maximums, market pricing of parking, shared parking, and other tools. Virginia's Public-Private Transportation Act (PPTA) can be used for the development of privately funded parking facilities that can enhance the desirability and accessibility of using mass transit.

3R. VDOT should work with regional and local governments to harmonize the state transportation plans and local land use plans on the same five-year schedules.

3S. The General Assembly should expand local governments' current ability to flex secondary and urban road funds to provide the most efficient GHG emissions option.

4. *Virginia will reduce GHG emissions from automobiles and trucks by increasing efficiency of the transportation fleet and use of alternative fuels.*

4A. The General Assembly should enact state incentives for the purchase of fuel-efficient vehicles, regardless of energy source. Incentives could include tax credits, reduced sales tax, reduced car tax, or lower registration fees or other incentives. The public policy goal is to accelerate the rate of fleet turnover, with a particular emphasis on the introduction of ever more fuel efficient vehicles.

4B. Virginia should become a leader in promoting low-carbon fuel options, such as low-carbon gasoline blends, biodiesel, natural gas, plug-in hybrids, hydrogen, and other alternative fuel technologies. VDOT should promote and support siting of refueling and recharging stations for low-carbon fueling stations on state- and local government-owned land, including interstate highways, rest stops, and truck stops. VDOT should assess the feasibility and benefits of vehicles that can plug into the electric grid and identify and enhance plug-in charging areas and services to make and market Virginia as "hybrid friendly." VDOT should work with alternative fuels providers to enable convenient location of alternative fuels infrastructure and with equipment and vehicle manufacturers to support a vibrant alternative energy market in Virginia.

4C. The General Assembly should seek to reduce emissions from older diesel engines (e.g., trucks, school buses) through the establishment of a retrofit or retirement program, including incentives to encourage retrofits. The Secretary of Transportation should investigate the availability of existing funds to support such a program.

4D. The General Assembly should provide funding for increased enforcement of existing speed limits.

4E. The General Assembly should increase enforcement of the state anti-idling statute and evaluate the cost effectiveness of providing state funding to accelerate the electrification of truck stops and the adoption of idling avoidance technology. The Secretary of Transportation should investigate the availability of existing funds to support such efforts.

Where feasible, use of renewable energy to support truck stop electrification should be considered.

4F. The Secretary of Transportation should promote efforts to educate all drivers, including those taking driver education, about behavioral changes that can significantly boost energy efficiency, including considering participating with other states in EcoDrivingUSA.

4G. The CTB should create signalization standards to improve the timing and the intelligence of traffic signalization across the Commonwealth in order to support improved traffic flow, transit preference and priority, and improved pedestrian access. The CTB has established roundabouts as the preferred alternative for projects involving reconstruction of intersections or new intersections, when roundabouts are determined to be feasible. The CTB should establish simple criteria to make roundabouts easier to build.

5. *Virginia will reduce GHG emissions through accelerated research and development.*

5A. The Commonwealth should create a new entity or empower an existing entity, such as the Center for Innovative Technology, to increase clean energy and climate change related technology research through increased funding and collaboration among Virginia's research universities and private companies.

5B. The Commonwealth should promote research at Virginia's colleges and universities on alternative fuels, particularly those that provide multiple benefits, and vehicle efficiency. The General Assembly should create a pool of research funds to reward and stimulate low-carbon fuel and battery research and ask scientists at its universities to study the GHG impact of cellulose-based ethanol and of other biofuels. The Governor should ask Congress to expand federal appropriations for such research. Virginia Tech's pyrolysis and switch grass research and Old Dominion University's algal biofuels work are excellent examples of the productive work being accomplished in Virginia today. Virginia should canvass existing federal and independent research on measures that can improve vehicle fuel efficiency, such as improving the aerodynamics of larger vehicles (especially tractor-trailers) to reduce the turbulence of their wake and reduced rolling resistance in tires.

5C. The Commonwealth should sponsor research to assess, from a Virginia perspective, the relative costs, benefits, and effectiveness of various mechanisms to place a price on carbon emissions through a cap-and-trade or a pollution tax on GHG emissions that is linked to reduction of other taxes.

6. *Virginia will reduce GHG emissions by increasing the proportion of energy demands that are met by renewable sources.*

6A. Landfills generate significant amounts of methane from the degradation of putrescible wastes. Methane is more than 20 times more effective at trapping heat than carbon dioxide. Emphasis should be placed on recycling reusable material and diverting putrescible wastes for composting or cogeneration of electricity and thermal energy. Using the waste for direct energy generation causes less net GHG emissions than long-term decomposition in

landfills. The General Assembly should amend the statutory recycling requirements to establish a statewide average waste diversion goal of 50% and to establish waste diversion requirements for localities that will ensure that the Commonwealth achieves this statewide goal.

6B. Both of the major utilities in Virginia, Dominion and AEP, have publicly committed to meet the voluntary Renewable Portfolio Standard (RPS) by 2022 and the Commission should account for the GHG emissions avoided through 2025 resulting from those commitments. This voluntary RPS should be increased beyond 2022 so that utilities would be required to achieve a 15% RPS by 2025 to continue receiving the statutory incentives for meeting the RPS.

6C. The State Corporation Commission should encourage the development and use of renewable forms of energy by

- Developing standardized interconnection rules in order to simplify the process and reduce costs for renewable energy and combined heat and power generators to connect to utility systems. Through this process, consideration should be given to adjustment of the existing kilowatt load requirements and the extent to which any subsidies or tariffs should be modified;
- Ensuring that net metering customers generating renewable energy are credited for production back onto the grid at the same rate the utility charges customers under the 100% green power tariff, not under the standard tariff rate. Net metering generation in excess of a customer's use would be paid at a utility's purchased cost of green power;
- Studying the feasibility of a feed-in tariff for Virginia. As part of this study, the SCC should consider the feed-in tariffs proposed in other states; and
- Studying, in association with other agencies such as DMME and the Department of Environmental Quality (DEQ), innovative ways to provide incentives for and expand use of combined heat and power applications in Virginia.

6D. The SCC should work with utilities and non-governmental organizations (NGOs) should work together to publicize the availability of options for retail electric customers to purchase renewable energy products through their electric utilities.

6E. The Virginia Economic Development Partnership should promote Virginia as a green industry center for excellence by expanding its economic development marketing efforts to focus on green industries such as renewable energy providers, alternative fuel companies, energy audit and retrofit organizations, green building contractors, carbon sequestration entities, and research and development firms and identifying potential incentives for green business to locate in Virginia. The Secretaries of Education and Commerce and Trade should promote partnerships with Virginia colleges and universities – including community colleges – to create education and training programs to insure that green jobs can be filled by Virginia citizens.

6F. VDOT should, in cooperation with local governments, allow its rights-of-way to be used for connection of renewable power projects, such as from solar and wind sources, or combined heat and power projects to the power grid.

6G. As an additional incentive to implement distributed renewable systems, the General Assembly should expand the Energy Star sales tax credit to cover certified renewable energy equipment.

7. Virginia will reduce GHG emissions by increasing the proportion of electricity generation provided by emissions-free sources of energy.

7A. The General Assembly should adopt a statement of policy supporting nuclear energy and encouraging the development of additional nuclear energy capacity in Virginia. This policy should include a statement recommending that the Virginia delegation to Congress encourage the federal government to address treatment of spent nuclear fuel by providing for safe, long-term storage coupled with nuclear fuel reprocessing. Such a program should recognize the paramount importance of safety, security, and environmental protection in spent fuel storage and reprocessing. This policy also should recommend that the Virginia delegation to Congress support extension of the federal loan guarantees for new nuclear power plants.

7B. The General Assembly should adopt a policy statement supporting and encouraging the development of emissions-free renewable electricity generation (such as solar and wind). Such generation should be applied to meet new electrical generation needs when its overall economic performance becomes cost effective, taking into account factors such as comparative advantage to provide base, intermediate, and peaking power.

7C. The State Corporation Commission should include in its review of applications for certificates of public convenience and necessity, for new generation projects and high-voltage transmission lines greater than 250 kilovolts in capacity, an analysis of the greenhouse gas emissions and climate change impacts of the project. The Commission also should include as part of its evaluation, the effect of existing or anticipated programs that would result in a reduction of greenhouse gas emission on the assumptions used to justify the project.

8. Virginia will reduce net GHG emissions by protecting/enhancing natural carbon sequestration capacity and researching/promoting carbon capture and storage technology.

8A. The General Assembly should provide funding for research at Virginia universities on carbon capture and sequestration, including research to determine the commercial viability of carbon capture and sequestration technology and the potential for its development and deployment in Virginia. Universities also should seek federal dollars to support this research. Research also should be conducted on emissions-free energy sources and advanced clean coal technology.

8B. Farmland, managed using best practices, can make a significant contribution to natural carbon sequestration, yet thousands of acres of farmland are lost to development every

year due to the difficulty of keeping farms economically viable. Virginia should improve the economic viability of farming by capitalizing on Virginia's natural resources and advanced renewable fuel technologies. Virginia should proactively seek companies to demonstrate and evaluate start-up energy production systems that ideally achieve multiple goals, including water quality and rural economic development goals. Virginia economic development organizations should particularly target companies that use agricultural and silvicultural resources as an energy source. In addition, current efforts to promote consumption of agricultural products grown in Virginia, such as the Virginia Farm Bureau Federation's "Save Our Food" campaign, should be sustained and expanded. These efforts are necessary to support the economic viability of Virginia's farms and help preserve farmland for carbon sequestration.

8C. Recognizing that enhanced land management activities can both decrease emissions associated with certain agricultural practices and increase the sequestration capacities of agricultural lands, the Department of Conservation and Recreation (DCR) should continue to work with local Soil and Water Conservation Districts to vigorously promote increased adoption of high-priority agricultural best management practices that reduce agriculture's fuel and fertilizer consumption and associated greenhouse gas emissions and that provide methods for increasing carbon sequestration on Virginia's agricultural lands. The General Assembly should provide adequate and consistent funding to appropriate agencies to implement this recommendation.

8D. The General Assembly should provide funding for the acquisition of high resolution statewide land cover data to accurately assess the land use status over time. This data is critical to quantify Virginia's land cover categories and to identify large natural sequestration areas (forests, wetlands, agricultural lands, parks, and other open space, etc.) in Virginia and monitor their change over time. Collection and compilation of this statewide land cover data should be completed by January 13, 2010, and a comprehensive survey should be conducted every four years to validate the accuracy of the inventory. In particular, wetlands inventory data for Virginia is outdated and needs to be updated.

8E. Virginia should establish a no net loss goal for natural carbon sequestration areas based on the 2010 baseline. In order to achieve progress on a goal of no net loss of natural carbon sinks, the Commonwealth should set ambitious goals to protect, in separate categories, forests, wetlands, and farmland to maximize protection of natural carbon sinks. Particular focus should be given to large blocks of functional forest, wetlands, and farmland that not only sequester carbon but also demonstrate multiple economic and ecologic benefits. (Note that recommendation 14D also contains goals for protecting lands that provide particular ecologic benefits.) Existing federal, state, and local government programs for protection of forests, farmland, wetlands, and open space, including grant programs and tax incentives, should be used to the maximum extent possible in implementing this no net loss goal. Implementation of this recommendation should rely on incentive-based programs, not regulatory requirements.

8F. Virginia, like all states, is struggling with estimates of natural carbon sequestration rates and sources, and, as a result, the current GHG emissions inventory does not account for the carbon currently sequestered in Virginia's forests, farmland, wetlands, or long-lived farm and forest products. Virginia's universities should supply the research that is

necessary to incorporate this information into the next iteration of the GHG emissions inventory. This research will provide a quantitative basis to recognize emission reduction benefits associated with land conservation and management policies and to further the development of best practices.

8G. The Commonwealth should develop a natural sequestration carbon crediting and debiting system for carbon storage and sequestration projects (including wetland protection, restoration and creation; forest conservation, afforestation, and reforestation; and other working forest and agricultural lands management). Additionally, the Commonwealth should seek certification for such a system by the Voluntary Carbon Standard or a similar program. Lastly, the Commonwealth should pursue integration of its own natural sequestration carbon crediting system with current or future programs of this nature at the federal or regional levels.

8H. The General Assembly should encourage local governments to establish tree canopy preservation goals through incentives and ordinances and provide technical assistance to localities seeking to establish such goals. A specific statewide goal should be developed for 2025 or another target year.

8I. Reduce the loss of critical natural habitats and native species by incorporating data from the Virginia Natural Heritage program and the Department of Game and Inland Fisheries (DGIF) as well as other information as appropriate as a factor to consider in biomass conversion incentive programs for agricultural- and forestry-based biomass production and alternative energy facility development planning.

8J. VDOT should amend its landscaping standards to minimize mowing, support tree preservation, and increase carbon retention.

9. The Commonwealth and local governments will lead by example by implementing practices that will reduce GHG emissions.

9A. The Governor and General Assembly should require all new and substantially renovated public buildings to meet LEED or equivalent standards for energy efficiency. All future federal buildings and substantial renovations already are required to meet LEED or equivalent standards.

9B. The Department of General Services (DGS) should set minimum miles-per-gallon standards for the fleet owned or leased by the Commonwealth as well as standards for the appropriate class of rental vehicles requested by state employees in the transaction of state business. These standards should be phased in to allow effective implementation and should include achieving the 2025 CAFE standard by 2015. In addition, DGS policies for purchasing and leasing vehicles should give a preference for the most fuel-efficient vehicles available. Virginia should recommend such standards for local government-owned fleets (especially school buses and transit vehicles), non-governmental organizations, and private businesses and provide incentives to groups that adopt the suggested minimum standards. For example, the state should provide a higher rate of matching funds to localities that adopt the standards. Virginia also

should develop technical assistance capacity to help inform local governments about their range of vehicle choice, costs, and benefits.

9C. The Commonwealth should lead the Atlantic and Southeast Regions in establishing one standard for diesel biofuel (e.g., B15) for state-owned equipment and school buses and work with our neighboring states to adopt this same standard. In cooperation with adjacent states and the federal government, VDOT, DGS, and the Department of Education, working with other agencies such as the DEQ and DMME, should implement standards for government use of alternative transportation fuels (such as biodiesel or low-carbon fuels), equipment, and vehicles – all of which reduce GHG emissions compared with traditional fuels, equipment, or vehicles.

9D. All state agencies and institutions and local governments should take necessary actions to minimize vehicle miles traveled related to state and local operations. Virginia agencies and institutions should implement programs to promote alternatives to driving, including creating new or expanded benefits for state workers who take transit, walk, or bike to work, and create program examples for local governments and private businesses. These benefits should be equal to or greater than those provided for state employees to park their personal automobiles at work. All office buildings owned or rented by the Commonwealth should provide bike racks. Where possible, all office buildings owned or rented by the Commonwealth should be located near transit facilities.

B. GHG Reductions and Cost Effectiveness

Executive Order 59 directed the Commission on Climate Change to formulate a plan to reduce greenhouse gas emissions in Virginia by 30 percent of business-as-usual (BAU) emissions by 2025. Meeting this goal would require a reduction from the BAU scenario of 230 million metric tons per year down to an emissions level of 163 million metric tons per year. This section lists actions which, together, have been calculated to reduce greenhouse gas emissions to 154 million metric tons per year – a greater level of savings than necessary to reach the 30% goal. This section also discusses the relative cost effectiveness of those actions.

Implementing the Commission’s recommendations will require investments in energy conservation and efficiency, efforts to eliminate or minimize the creation of greenhouse gases in energy production or other processes, and efforts to sequester greenhouse gas emissions in terrestrial and geologic sinks. Other investments will be needed to adapt to the expected impacts of climate change. Some investments will be “paid back” through savings from reduced operating costs, typically from reduced energy costs. Others will cause a net increase in expenditures. These costs will be passed along to citizens and businesses through higher utility bills, higher infrastructure costs, and higher consumer prices for products affected by climate change. Care should be taken to minimize the financial burden such higher costs may impose on moderate and low-income families.

It is important to recognize that a failure to reduce emissions and invest in adaptation measures also would lead to significant costs to Virginians. Sea level rise, increased frequency and severity of storms, problems related to higher temperatures, and human health effects of

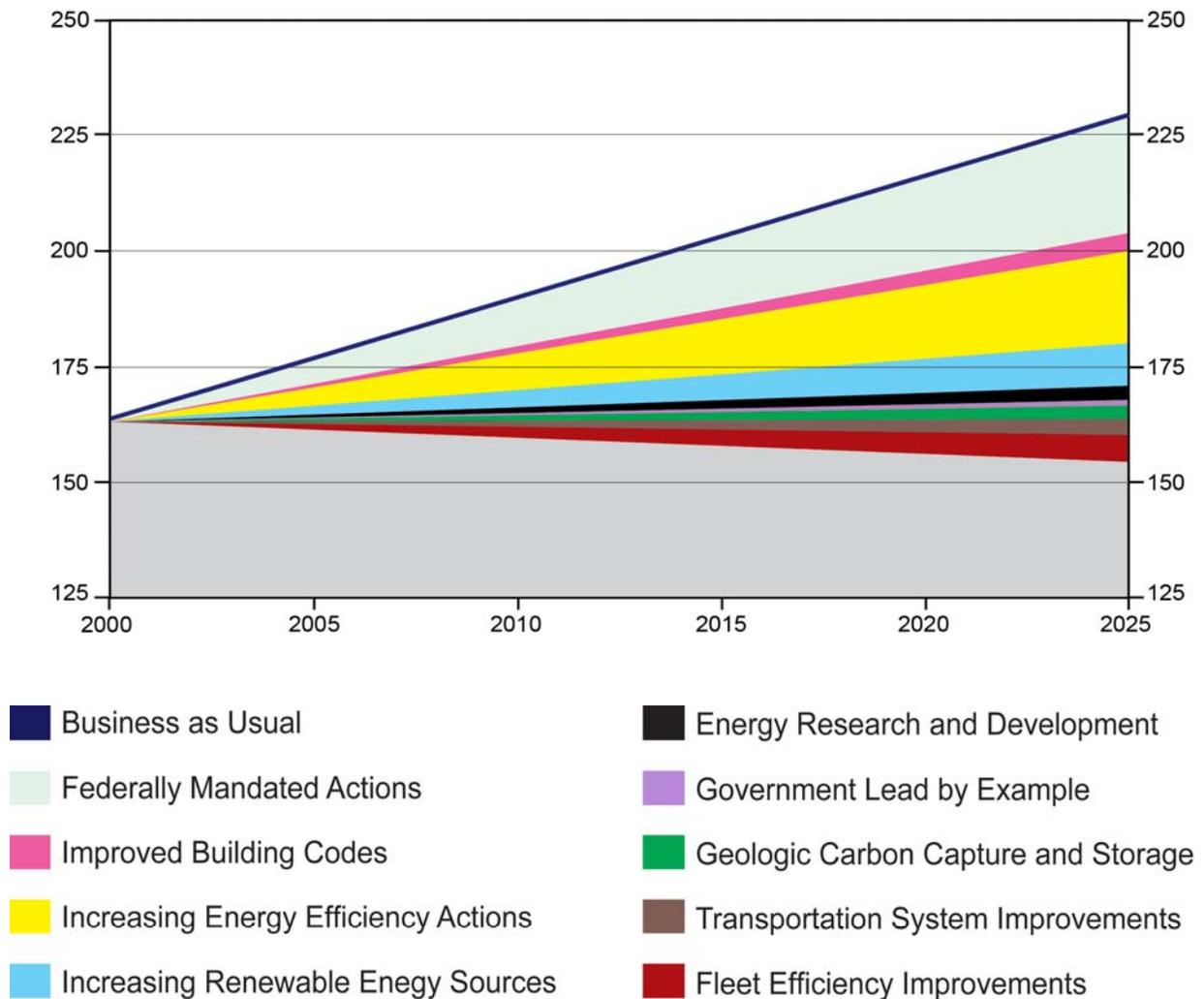
climate change will all create enormous burdens on both the private and public sector. While some of these costs are unavoidable, they will be minimized if efforts to reduce emissions are sufficiently aggressive.

The cost effectiveness of various recommendations can be compared by assessing the cost per ton of CO₂ emission reduced. Understanding the costs of inaction and the cost effectiveness of actions to reduce greenhouse gas emissions will allow the Commonwealth and its citizens to maximize the value of these investments.

Calculating Greenhouse Gas Emission Reductions

Reductions in greenhouse gas emissions have been estimated for eight sets of actions, and the savings attributable to each of these actions are shown in the following wedge diagram.

Greenhouse Gas Emission Reduction Strategies
MMt CO₂e



The following table shows the savings attributable to each set of actions.

| Action | Emission Reductions (metric tons CO ₂ e) |
|---|--|
| Federally mandated actions* | 26 million |
| Improved state building codes | 4 million |
| Recommendations increasing implementation of energy conservation and efficiency | 20 million |
| Recommendations increasing use of renewable resources | 9 million |
| Recommendations to increase energy efficiency and clean energy research and development | 5 million |
| Recommendations for governments to lead by example | Less than 1 million |
| Recommendations for implementing carbon capture and geologic sequestration | 2 million |
| Recommendations for transportation system improvements | 6 million |
| Recommendations for increasing fleet efficiency and use of alternate fuels | 4 million |
| Total | 76 million metric tons CO₂e |

*Note: Savings attributable to federally mandated actions reflect the passage of the Energy Independence and Security Act of 2007 (EISA2007). The specific EISA2007 provisions included in this analysis are: updates to the renewable fuel standard and the corporate average fuel economy (CAFE) standard for new light-duty vehicles; updated and new appliance energy efficiency standards for boilers, dehumidifiers, dish-washers, clothes washers, and commercial walk-in refrigerators and freezers; lighting energy efficiency standards; provisions to reduce energy consumption in Federal buildings; and efficiency standards for industrial electric motors.

Co-benefits of Measures to Reduce Greenhouse Gas Emissions

It is important to recognize that many actions that will reduce greenhouse gas emissions also will deliver co-benefits to Virginia. For example, many energy efficiency recommendations will result in lower energy bills for Virginia’s households and businesses. These benefits can help offset the costs of projects to reduce greenhouse gas emissions, and are reflected in negative costs per ton of CO₂e reductions.

Many recommendations will provide ancillary environmental benefits. For example, growing cellulosic energy crops or algae for biodiesel can result in reduced nutrient runoff into the Chesapeake Bay and other waters. Other actions can reduce emissions of regulated air pollutants such as sulfur dioxide, nitrogen oxides and toxics, while others will minimize the amount of waste placed in landfills. Also, efforts to conserve land so as to protect existing carbon sinks in forests, farmlands, and wetlands helps advance the Commonwealth’s longstanding land conservation goals to preserve habitat, support key industries, and provide clean water.

Actions to reduce greenhouse gas emissions also can have co-benefits for agriculture and silviculture. Use of winter cover crops for biofuel production can provide an additional source of income to farmers. Crop and tree farmers undertaking terrestrial carbon sequestration actions will be able to receive financial benefits under cap-and-trade systems.

Some of the Commission's recommendations will result in new green jobs being created to manufacture and install renewable energy systems, to install energy efficiency improvements, and take adaptation actions. If Virginia produces more of its energy from indigenous sources, income will stay in the state, expanding the state's economy.

Some measures Virginia may implement to mitigate climate change may reduce required investments and costs in other areas. For example, actions that result in compact development can result in lower costs for utilities, roads, and other infrastructure. Residents of such developments will have lower transportation costs to the extent the new developments are located in urban development districts or nearby existing built-up areas.

Climate Change and the Cost of Inaction

Virginians will face increased costs related to climate change. While these costs are difficult to calculate with any level of certainty, it is certain that Virginia residents, governments, and businesses will face increased costs to adapt to the effects of climate change. For example, as sea level rises, businesses as well as federal, state, and local governments will be forced to move or raise the elevation of public works and build protective barriers to protect existing infrastructure. The Hampton Roads area is particularly vulnerable due to the low elevation of the land and the existence of civilian and military ports, buildings, and infrastructure. Stormwater systems will need to be designed to handle larger flows with increased storm intensity. Utility infrastructure will need to be constructed to withstand greater natural forces.

Businesses and homeowners are already facing increasing costs and decreasing availability of property casualty insurance in coastal areas of the Commonwealth. Businesses providing services internationally will face increased risk due to political unrest if, for example, a region's food supplies are interrupted. These risks have been outlined in presentations to the Commission addressing national security consequences of climate changes.

Climate change can raise input costs for agricultural and silvicultural activities if new actions are needed to control invasive species or diseases. Temperature changes will likely cause a change in forest species composition. If existing species die before new replacement species can move into the environment, there could be a substantial disruption to the state's forest products industry and ecosystems.

Virginia would be faced with increased public health response costs if climate change causes new disease vectors to come to Virginia. Increased heat waves would cause increased public health problems and costs, particularly for lower income and elderly households.

Costs Effectiveness of Climate Change Mitigation Recommendations

The Climate Change Commission is making recommendations for many actions that will need to be implemented over the coming years and decades. An understanding of the relative cost effectiveness of these actions will help Virginians make investments in a wise manner. It also is important to recognize that ultimately, once a national GHG cap-and-trade program has been established, the associated carbon market will largely determine which measures are most cost effective and these will generally be implemented first.

The Commonwealth will need to ensure the existence of policies that will allow cap-and-trade markets to work efficiently in the state. Market rules should be set so that the markets are transparent and market participants have equal access to data. Markets should be structured so that small consumers will not be closed out due to their size. State actions to govern carbon markets should work within national market rules.

From the very beginning of the Commission's work, Commission members recognized the need to determine to the extent possible the "costs" associated with any recommendations. Each member knew the importance of assessing – again, to the extent possible – not only the cost of certain strategies but, in some cases, the cost of not adopting certain strategies. Suffice it to say that, the expertise and resources being brought by the state to this question notwithstanding, determining such costs proved to be easier said than done.

The Commission settled on a specific method to determine costs – it wanted to assess various greenhouse gas-reduction strategies by placing a value on a ton of greenhouse gases avoided. This was a methodology adopted by numerous other states also engaged in developing Climate Change Action Plans, and it seemed appropriate for the Commission's Virginia-specific assessment. This method was unanimously adopted by the Commission.

As the Commission and staff developed strategies – actually, categories of strategies – staff found it difficult to assign a value to tons of greenhouse gases avoided to individual strategies. (Many other states likewise have found it difficult to provide a cost to specific strategies.)

However, it was less difficult to provide a general value to categories of strategies. Therefore, the estimated values of greenhouse gas emissions reductions in this report are based on overall analysis of each group of recommendations. For example, the adjustment for ongoing federal actions used the analysis by the federal Energy Information Administration of the reductions in greenhouse gas emissions attributable to enactment of the federal Energy Independence and Security Act of 2007 (EISA 2007). Estimates of greenhouse gas emission reductions from improved building codes are based on calculations of the reduced energy use due to more strict codes calculated over the total square feet of residential and commercial buildings constructed each year. Estimates of greenhouse gas emission reductions due to the state's renewable portfolio standard are calculated based on the total kWh to be produced from the renewable systems multiplied by the average greenhouse gas emission factor for electric generation in Virginia.

The cost and GHG reduction estimates provided in this report are only that – estimates. Some data needed to make the calculations are not available, while other data are based on many assumptions, lessening their precision. To provide a buffer against the uncertainty inherent in the calculations, every possible greenhouse gas emission reductions has not been included in the analysis.

It will take more detailed calculations than are possible within the scope of this report to quantify greenhouse gas emission reductions and costs for individual recommendations. Additional analysis of cost issues will be part of the task of implementing this Climate Change Action Plan.

To help assess the relative cost effectiveness of the Commission’s recommendations, the table below provides data from the McKinsey and Company report, *Reducing U.S. Greenhouse Gas Emissions: How Much at What Cost?*, and from climate commission reports in Maryland, North Carolina, and South Carolina. Negative costs indicate that direct and indirect savings will more than offset direct and indirect costs. Positive costs indicate direct and indirect costs outweigh direct and indirect savings.

| Virginia Recommendation | Corresponding McKinsey, Maryland, North Carolina, South Carolina Recommendation | Cost per Ton CO _{2e} Reduced |
|--|--|---|
| Improved state building codes | Maryland <ul style="list-style-type: none"> • RCI-1, Building and trade codes North Carolina <ul style="list-style-type: none"> • RCI-6, Building energy codes South Carolina <ul style="list-style-type: none"> • RCI-6, Incentives and policies for improving building efficiency, including building energy codes | -\$38 -\$17 -\$16 |
| Recommendations increasing implementation of energy conservation and efficiency <ul style="list-style-type: none"> • 1A. Mandated utility conservation programs • 1B. Support investments in advanced metering infrastructure • 1C. Establish locally-implemented energy efficiency services • 1D. Require commercial buildings to be LEED or equivalent | McKinsey <ul style="list-style-type: none"> • Residential/commercial electronics • Residential/commercial lighting • New shell improvements • Residential shell building retrofits • Industrial processes Maryland <ul style="list-style-type: none"> • RCI-2, Demand side management • RCI-7, RCI-11, RCI-3, Other energy efficiency programs • RCI-10, Energy efficiency resource standard | -\$95 -\$85 to -\$90 -\$55 to -\$75 +\$10 -\$15 -\$54 -\$45 to -\$54 -\$52 |

| Virginia Recommendation | Corresponding McKinsey, Maryland, North Carolina, South Carolina Recommendation | Cost per Ton CO ₂ e Reduced |
|--|--|--|
| <ul style="list-style-type: none"> 1E. Increase Weatherization Assistance Program funding | <p>North Carolina</p> <ul style="list-style-type: none"> RCI-1, DSM for residential, commercial, industrial sectors RCI-2, Expand energy efficiency funds RCI-7, Beyond code buildings <p>South Carolina</p> <ul style="list-style-type: none"> RCI-1, Energy efficiency programs, funds, goals ES-1a, 5% of energy met with energy efficiency RCI-2, DSM/energy efficiency programs for natural gas, propane, fuel oil | <ul style="list-style-type: none"> -\$25 -\$25 -\$14 -\$26 -\$26 -\$85 |
| <p>Recommendations increasing use of renewable resources</p> <ul style="list-style-type: none"> 6A. Increase waste to energy generation 6B. Meet a 15% renewable portfolio standard goal 6C. Increase use of net metering 6D. Increase purchases by consumers under green power tariff | <p>McKinsey</p> <ul style="list-style-type: none"> Distributed solar PV Solar <p>Maryland</p> <ul style="list-style-type: none"> ES-7, Renewable portfolio standard ES-1, Promotion of renewable energy <p>North Carolina</p> <ul style="list-style-type: none"> ES-3, Removing barriers to CHP and clean DG ES-8, Waste-to-energy ES-10, NC GreenPower renewable resource program <p>South Carolina</p> <ul style="list-style-type: none"> ES-1b, 5% energy served by new renewables ES-6, Green power purchases at 1% by 2012 ES-8, Distributed renewable energy incentives and barrier removals | <ul style="list-style-type: none"> +\$25 +\$26 +\$30 +\$6 -\$37 +\$37 +\$19 -\$27 +\$50 |
| <p>Recommendations to increase energy efficiency and clean energy research and development</p> <ul style="list-style-type: none"> 5A. Provide for long-term, sustainable clean technology R&D funding | <p>North Carolina</p> <ul style="list-style-type: none"> RCI-4, Market transformation and technology development programs | <ul style="list-style-type: none"> -\$32 |

| Virginia Recommendation | Corresponding McKinsey, Maryland, North Carolina, South Carolina Recommendation | Cost per Ton CO ₂ e Reduced |
|--|--|---|
| <p>Recommendations for governments to lead by example</p> <ul style="list-style-type: none"> 9A. Require all new and renovated public buildings to meet LEED energy requirements 9B. Require state and local fleets to meet federal CAFE standards by 2015 9C. Require state fleets to use B-15 (The Commonwealth recently implemented state-wide E-10 state bulk fuel purchases) | <p>McKinsey</p> <ul style="list-style-type: none"> Cellulosic Biofuels <p>Maryland</p> <ul style="list-style-type: none"> RCI-4, Lead-by-example <p>North Carolina</p> <ul style="list-style-type: none"> RCI-3, Energy efficiency requirements for government buildings <p>South Carolina</p> <ul style="list-style-type: none"> TLU-7, Diesel engine emission reductions – biodiesel TLU-12, Low GHG fuel standard | <p>-\$15</p> <p>-\$53</p> <p>-\$14</p> <p>-\$15 to +\$164</p> <p>+\$1 to +\$183</p> |
| <p>Recommendations for implementing carbon capture and geologic sequestration</p> <p>8A. Fund carbon capture and storage research and development in unminable coal seams and emission-free energy sources</p> | <p>McKinsey</p> <ul style="list-style-type: none"> Coal power plants – CCS rebuilds with EGR | <p>+\$35</p> |
| <p>Recommendations for transportation system improvements</p> <ul style="list-style-type: none"> 3A. Coordinate transportation and land use planning 3B. Expand use of telework 3C. Increase availability of transit and rail services 3D. Target transportation funding to built-up areas and urban development districts 3E. Expand HOT/HOV network, evaluating the impact of HOT lane networks on greenhouse gas emissions 3F. Expand use of pay-as-you-drive insurance | <p>Maryland</p> <ul style="list-style-type: none"> TLU-10 Transportation technologies <p>North Carolina</p> <ul style="list-style-type: none"> TLU-1a, Land development planning TLU-1b, Multi-modal transportation and promotion TLU-4, Truck stop electrification <p>South Carolina</p> <ul style="list-style-type: none"> TLU-2, Transportation system management TLU-4, Improve development patterns TLU-5, Transit & bike-pedestrian | <p>-\$200 to +\$1500</p> <p>Net savings</p> <p>-\$25</p> <p>Net savings</p> <p><\$0</p> <p><\$0</p> <p>-\$1</p> |

| Virginia Recommendation | Corresponding McKinsey, Maryland, North Carolina, South Carolina Recommendation | Cost per Ton CO ₂ e Reduced |
|---|---|---|
| Recommendations for increasing fleet efficiency and use of alternate fuels <ul style="list-style-type: none"> • 4A. Increase rate of fleet turnover to more efficient vehicles • 4B. Expand alternate fueling infrastructure • 4C. Support diesel vehicle retirement/retrofit • 4D. Increase speed limit enforcement • 4E. Implement anti-idling policies and incentives • 4F. Promote EchoDrivingUSA practices | North Carolina <ul style="list-style-type: none"> • TLU-9, Diesel retrofits • TLU-11, Pay-as-you-drive insurance South Carolina <ul style="list-style-type: none"> • TLU-6, Alternative-fuel infrastructure • TLU-7 Diesel engine emission reductions - efficiency improvements • TLU-8, Stricter enforcement of speed limits • TLU-10, Commuter choice and commuter benefit programs | Not quantified Expected net savings +\$70 -\$114 Not quantified -\$240 |

C. Recommendations that Address Steps Virginia Should Take to Plan For and Adapt to Climate Change Impacts that are Likely Unavoidable, Including Direct Adaptive Responses, Required Research, and Increased Capacity and Coordination Within State and Local Government

10. Virginia should consider a more aggressive GHG reduction goal.

10A. The Governor and General Assembly should consider adopting a more aggressive GHG reduction goal that more closely reflects the Intergovernmental Panel on Climate Change (IPCC) recommendations. The IPCC recommendations call for reducing GHG emissions by 25% below the 1990 level by 2020, and 80% below the 1990 level by 2050. This Climate Change Action Plan recommends actions needed to reduce near- and medium-term GHG emissions and meet the GHG emission reduction target of Executive Order 59. Virginia will need to take additional actions to achieve the long-term reductions recommended by the IPCC.

11. Virginia will focus and expand state capacity to ensure implementation of the Climate Change Action Plan.

11A. To ensure that the recommendations of the Commission are implemented, that Virginia meets its greenhouse reduction goals, and that the state’s response to climate change is refined and updated as more information becomes available, the Governor should establish a Sub-Cabinet on Climate Change Response. The Governor’s Sub-Cabinet on Climate Change Response should consist of the Secretaries of Agriculture and Forestry, Commerce and Trade, Finance, Health and Human Resources, Natural Resources, Public Safety, and Transportation.

The Sub-Cabinet's core responsibilities should include coordinating the Commonwealth's response to climate change; disseminating critical information and data on climate change to elected officials, policy makers, and the general public; assessing progress toward implementation of recommendations in Virginia's Climate Action Plan; and providing an annual report on progress to the Governor, the General Assembly, and the public. Additionally, the Sub-Cabinet should evaluate the feasibility and desirability of the future creation of an Office of Climate Change Response, with its Director reporting to the Governor.

11B. Several of the Commission's recommended actions complement the Commonwealth's existing goals and commitments, such as those for land conservation and water quality. In order to maximize these complementary goals, the Governor and General Assembly should strive to utilize existing state programs to implement its recommendations in lieu of creating new state programs. This will, however, require ensuring that existing state programs are appropriately staffed and funded and that their authorities include consideration of climate change impacts.

11C. The Governor should continue working with neighboring states, especially in the southeast, to develop strategies for collaborative engagement in the national discussion on federal climate change legislation and to implement regional GHG emissions reduction and adaptation strategies complementary to such a federal system.

11D. The General Assembly should formalize the use of Planning District Commissions (PDCs) as a bridge between the state and local governments and encourage the PDCs to include climate change in their regional strategic plans.

12. Virginia will educate the public about climate change and the actions necessary to address it.

12A. The Commonwealth should, in collaboration with other public and private sector partners, develop an outreach and educational campaign to increase understanding of the causes and impacts of climate change and to build public support to implement the recommendations of the Climate Change Action Plan. It is critical to inform the public about the individual, business, and governmental actions needed to mitigate and to adapt to climate change. The campaign should focus first on no-cost and low-cost GHG reduction strategies and those with co-benefits and over time explain the need for long-term mitigation actions and those that may increase energy costs. The outreach and educational campaign should include information from the region-by-region scenario analyses of local transportation and land use planning about the transportation and infrastructure costs; land use and environmental impacts; housing availability; energy, water, and fuel use; and GHG emissions of compact and sprawling land use patterns.

12B. The Commonwealth's agencies, such as DEQ and DMME, the Cooperative Extension, and others should create a voluntary climate action plan for Virginia citizens: "Ten things we can do (and should not do) in our private lives to help achieve the 30% reduction goal."

12C. The Commonwealth's agencies, such as DEQ and the Virginia Department of Agriculture and Consumer Services, should work with retailers to eliminate the distribution of free plastic and paper bags in stores, provide programs for recycling plastic bags, and implement a public education program.

13. Virginia will continually monitor, track, and report on GHG emissions and the impacts of climate change.

13A. The General Assembly should provide funding to a network of scientific and technological institutions to regularly produce Virginia-specific predictions of climate change and to monitor and evaluate the impact of climate change on Virginia's agriculture, energy use, economy, health, and ecosystems; and to suggest optimal adaptation and mitigation strategies to the policy-makers.

13B. The General Assembly should establish a GHG reporting system, requiring all stationary sources of air pollution already required to report air emissions to include GHG emissions in these reports, requiring VDOT to report on transportation emissions, and requiring DEQ to prepare an annual report of emissions in Virginia. The reporting system should rely on federal reporting protocols once they are adopted at the federal level.

13C. DEQ should annually update and enhance GHG emissions inventories and forecasts, assess progress toward achieving GHG reduction goals at least once every five years, and report the results of this assessment to the public. These inventories and forecasts should account for natural terrestrial sequestration of carbon when possible. DEQ should, as part of this five-year assessment, consider the need to readjust GHG reduction goals that have been set and to adopt additional goals.

13D. VDH should monitor changes in harmful algal blooms (HABs) frequency, toxicity, and geography and any impacts on human health through the Harmful Algal Bloom Illness Surveillance System (HABISS), a surveillance database used for tracking illnesses related to HAB exposure.

13E. VDH should develop a system able to track changes in allergic or respiratory illnesses and cardiovascular disease that might be associated with increasing temperatures and/or air pollution.

14. Virginia state agencies and local governments will prepare for and adapt to the impacts of climate change that cannot be prevented.

14A. To allow for the potential migration of tidal wetlands inland and increase coastal resiliency, the Virginia Marine Resources Commission (VMRC) should adopt shoreline protection policies that emphasize the use of living shorelines and seek to avoid shoreline hardening (bulk heads, sea walls, rip rap) wherever feasible.

14B. The Secretary of Commerce and Trade should develop adaptation plans to minimize impacts of climate change on Virginia's economy, with special emphasis on those

industries and economic sectors most sensitive to changing climatic conditions (e.g., agriculture, fisheries, military installations, and ports).

14C. Local governments in the coastal area of Virginia should include projected climate change impacts, especially sea level rise and storm surge, in all planning efforts, including local government comprehensive plans and land use plans. Local governments should revise zoning and permitting ordinances to require projected climate change impacts be addressed in order to minimize threats to life, property, and public infrastructure and to ensure consistency with state and local climate change adaptation plans.

14D. Both DCR and DGIF have established planning documents (e.g., Natural Heritage Plan and Wildlife Action Plan) that identify important habitat types, specific habitat sites, areas important for maintaining biodiversity, and conservation actions needed to conserve all of Virginia's wildlife and native habitats. Using these plans to identify critical conservation areas, Virginia should implement a statewide effort to conserve 5% of these areas that are currently unprotected by 2015 and 20% of these areas that are currently unprotected by 2025. This effort should utilize an assortment of management tools including education, financial incentives, regulations, and additional state investments.

14E. The Secretary of Transportation should ensure that climate change impacts, particularly sea level rise and storm surge vulnerability in coastal areas of Virginia, are taken into account in all transportation planning, project design, and prioritization of projects for funding as well as transportation systems management, operations, and maintenance. Where existing transportation infrastructure already is vulnerable to sea level rise, more intense storm events and other climate change impacts, state, regional, and local transportation agencies should develop plans to minimize risks, move infrastructure from vulnerable areas when necessary and feasible, or otherwise reduce vulnerabilities.

14 F. State agencies and local governments should develop climate change adaptation plans for critical infrastructures for which they are responsible. Climate change impacts, particularly sea level rise and storm surge vulnerability in coastal areas of Virginia, should be taken into account in all critical infrastructure planning, project design, and prioritization of projects for funding, as well as infrastructure management, operations, and maintenance. VTRANS 2035, the Commonwealth's statewide long-range multimodal transportation plan, should include a complete reevaluation of the state's transportation plans, capital investment programming, and projects in light of climate change, higher energy prices, and changing demographics. Private sector owners of infrastructure should be encouraged to conduct a climate change vulnerability assessment and develop a climate change adaptation plan as a condition for approval of any required permits.

14G. All state discretionary funding programs should require that infrastructure projects receiving state funding are designed to be resistant to climate change impacts over the projected life of the project. Additionally, the Commonwealth should establish policies that discourage expenditure of public funds on development of public infrastructure in areas highly vulnerable to climate change effects, especially sea level rise and increased risk of flooding from intense precipitation events.

14H. DCR should revise the Virginia Floodplain Management Plan and update model floodplain management ordinances to address more specifically sea-level rise and increasing storm surge impacts due to climate change. Local governments should then be directed to update floodplain ordinances and maps to incorporate sea-level rise and increasing storm surge impacts where applicable.

14I. Based on the revised floodplain maps accounting for sea-level rise, increasing storm surge, and flooding from more intense rainfall events, the State Corporation Commission should work with the insurance industry and other partners as necessary to develop an analysis of the areas most vulnerable to insurances losses due to increased storm activities and inundation.

14J. Adaptation policies and programs for the built environment should take into consideration impacts on natural systems, particularly in coastal areas, and minimize negative impact on natural areas that are important for mitigating the impact of climate change. Adaptation policies and programs for the built environment should make use of nature-based strategies, such as natural shorelines, and should be coordinated with fish and wildlife adaptation strategies.

14K. The Secretary of Natural Resources should lead an inter-agency and intergovernmental effort to develop a Sea Level Rise Adaptation Strategy by January 1, 2011. The Sea Level Rise Adaptation Strategy should encompass the full range of policies, programs, and initiatives that will be required to adapt in the areas of natural resources, economy, and infrastructure and any other area impacted by sea level rise.

14L. DCR should assess the need to expand Virginia's Resources Protection Area buffer designations beyond the current 100-foot requirement to accommodate the impact of sea-level rise.

14M. The Assistant to the Governor for Commonwealth Preparedness should lead a state-wide assessment of the impact of climate change on emergency preparedness, response, and recovery plans and capacity in Virginia; coordinate a review of all state agency Continuity of Government and Continuity of Operations plans to ensure that they are adequate for projected climate change effects and develop recommendations for correcting weaknesses in those plans; and coordinate a review of the Virginia Homeland Security Exercise and Evaluation Program (HSEEP) and regional and local exercise and evaluation programs to ensure that they are adequate for projected climate change effects and develop recommendations for correcting weaknesses in those exercise and evaluation programs.

14N. The General Assembly should provide funding for the Virginia Geographic Information Network to acquire and process LiDAR data for the entire state. LiDAR data should be first acquired for the coastal zone, which will cost approximately \$6 million, and then for the rest of the state. The resulting data should be made available to all public agencies.

14O. DCR and DGIF should develop a process to document climate change impacts on native species and ecosystems and recommend ways to preserve Virginia native species when

feasible under conditions of climate change, while preventing the spread of invasive species. The Virginia Institute of Marine Science should assess the vulnerability of coastal and marine living resource restoration efforts to climate change, particularly those for oysters and submerged aquatic vegetation, to climate change and recommend specific steps to increase the likelihood of success under changing conditions.

14P. The Secretary of Natural Resources should direct state agencies and universities to work with federal partners (National Oceanic and Atmospheric Administration, U.S. Fish and Wildlife Service, U.S. Geological Survey, and U.S. Environmental Protection Agency), neighboring states, and regional non-profits to develop regional adaptive resource management plans that incorporate climate change impacts.

14Q. DCR should monitor available forecasting tools and amend its stormwater regulation as needed to ensure the implementation of stormwater management measures that will continue to function effectively in an altered precipitation regime.

14R. DCR should assess the consequences of climate change on the effectiveness of non-point source urban and agriculture best management practices.

14S. The Assistant to the Governor for Commonwealth Preparedness should coordinate with Department of Defense installations and facilities in the Commonwealth to explore ways the Commonwealth and Department of Defense can work together to address climate change impacts to critical military installations in Virginia.

14T. State and local agencies should establish policies such as rolling easements, tax incentives, or mandatory setbacks to discourage new development in vulnerable coastal areas. Persons purchasing or developing property in vulnerable coastal areas or floodplains should have ready access to accurate data on the current and potential future vulnerability of their property.

14U. The General Assembly should require local governments whose jurisdictions encompass Virginia's shoreline to develop integrated shoreline management plans in coordination with VMRC. Such planning efforts would integrate adaptation and response strategies for coastal erosion, sea level rise adaptation, and coastal storm surge into existing state and local policies.

14V. The Virginia Department of Health (VDH) should use disease surveillance programs to track vector-, water- and food-borne morbidity and mortality that might be associated with climate change and conduct or modify prevention/intervention efforts based on information gained through surveillance.

14W. VDH should develop one or more syndrome definitions for climate change related disease or illness for inclusion in a syndromic surveillance system, (e.g., ESSENCE, the Electronic Surveillance System for Early Notification of Community-based Epidemics). Syndromic surveillance can be used as a tool to determine the existence or the absence of an outbreak; the size, spread, and location of an outbreak; or to monitor disease trends.

14X. VDH should work with local health departments and planning district commissions to conduct an assessment of vulnerable populations in Virginia based on different climate change impact scenarios, including the following: sea level rise, increased air temperatures, and heat-related illnesses and deaths. The assessment should include an understanding of the vulnerability of populations as well as its capacity to respond to new and changing conditions.

14Y. VDH should promote the Virginia Medical Reserve Corps (VAMRC) to strengthen local public health initiatives and enhance local emergency response efforts during extreme weather events related to climate change. VAMRC is dedicated to establishing teams of local volunteer medical and public health professionals to contribute their skills and expertise throughout the year, as well as during times of community need.

14Z. VDH should ensure that every Health District in Virginia has a heat emergency response plan.

14AA. The General Assembly should direct the appropriate state institutions to conduct an assessment of the impact that climate change will have on persons of low socioeconomic status, members of racial and ethnic minorities, and people living in coastal areas and flood plains.

14BB. The Department of Historic Resources should oversee an assessment of the social and cultural impact that climate change will have on Virginia, including the impact on historic resources. This assessment should provide recommendations on (i) the feasibility and cost of trying to preserve important cultural or historic resources from being destroyed by the effects of climate change, and (ii) measures to ensure that a historical record of those communities and important cultural or historic resources that cannot be protected from destruction is preserved.

15. Virginia will undertake a thorough review of state agency and local government authority to account for climate change in their actions.

15A. The General Assembly should amend the State Water Control Law to include as a policy of the Commonwealth consideration of changing climatic conditions in the protection and restoration of state waters and living resources.

15B. The General Assembly and Governor should direct a comprehensive review of other state agency and board policies, regulations, and enabling authorities to determine the amendments that are needed to account for the impacts of changing climate conditions on state waters and living resources. Such a review should include, but not be limited to, collaboration among VMRC (§28.2 et seq.), the Virginia Soil and Water Conservation Board (§10.1-603.2:1 et seq.), the State Water Control Board (including water supply planning requirements in §62.1-44.38:1), and the Chesapeake Bay Local Assistance Board (§ 10.1-2100 et seq.).

15C. Local governments are on the front lines of many climate change adaptation approaches and may not have the authorities needed to put those in place. The General

Assembly should, with the assistance of the Virginia Municipal League (VML) and the Virginia Association of Counties (VACo), undertake a review of authorities of local governments, and enact any enabling authority that is needed.

15D. DEQ should incorporate assessment of the current and potential impact of climate change on instream flow into the state water resources plan (§ 62.1-44.38:1) and evaluate the impact of climate change induced alterations in stream flow on in-stream beneficial uses when assessing a Virginia Water Protection Permit (§ 62.1-44.15:20) application for water withdrawals.

15E. The State Water Control Board should amend the comprehensive water supply planning regulation (9 VAC 25-780) to require that localities or regional planning units assess the potential impacts of climate change on existing or proposed water supplies.

V. Commission Deliberations

A. Debate on particular recommendations

Several of the issues discussed during the Commission's deliberations warrant special comment because of significant debate or because the Commission's final action took the form of a close vote. The purpose of this section of the report is to acknowledge the differing positions held by Commission members on several important topics.

Adequacy of Virginia's GHG-reduction Goal

The Virginia Energy Plan, which was released in September 2007, several months before the Commission was formed, contains the Commonwealth's greenhouse gas-reduction goal. The plan calls for a 30% reduction in greenhouse gases emissions from their projected level in 2025. The goal was set by taking into account expected growth in population, economic expansion, and vehicle miles traveled, among other consumer demand measures. Its calculation also included anticipated achievements in conservation and energy efficiency given certain policies previously enacted by law or regulation.

Part of the Commission's charge, as established in Executive Order 59 (2007), was to recommend to the Governor and other policymakers strategies to meet the greenhouse gas-reduction goal set forth in the Virginia Energy Plan. However, this charge did not preclude the Commission from debating the adequacy of the goal and considering whether a different greenhouse gas-reduction goal should be recommended.

Such debate and consideration did take place. In fact, it surfaced numerous times over the course of the Commission's meetings as well as meetings of its workgroups. Some Commission members argued that the Commonwealth's greenhouse gas-reduction goal is inadequate when compared to the recommendation of the Intergovernmental Panel on Climate Change for a global reduction in greenhouse gas emissions – a 25% reduction in emissions by 2020, with an 80% reduction of 1990 levels by 2050. Other Commission members argued that

the Commonwealth's greenhouse gas-reduction goal, as outlined in the Virginia Energy Plan, will be difficult enough to meet and a more aggressive goal will likely result in much higher energy costs for consumers and businesses. Also argued by those opposing a more aggressive state goal was that because a national carbon cap-and-trade program is likely to be established in the relatively near future, a more stringent Virginia-specific greenhouse gas-reduction goal is unnecessary.

The Commission's long-held debate over the adequacy of the Virginia Energy Plan's GHG- reduction goal received more focused attention in the Commission's ninth meeting, when the Commission (i) recommended that a more aggressive goal be considered by the Governor and the General Assembly and (ii) acknowledged that Virginia will need to take additional actions beyond those recommended in this report to achieve reductions recommended by the IPCC. It also should be noted that the Commission's recommendation regarding federal legislation was that Congress should adopt a national carbon cap-and-trade program that achieves at least a 25% reduction in greenhouse gases by 2020 and an 80% reduction below 1990 levels by 2050.

Nuclear Energy

Nuclear energy accounts for approximately 35 percent of the electricity produced in the Commonwealth. Virginia currently has four nuclear reactors used for commercial electricity generation. During operation, nuclear plants generate little or no GHG emissions, although GHG emissions may occur during mining, enrichment, and transport of nuclear fuel and the construction and decommissioning of plants. It is estimated that 6 to 10 MMte of CO₂ may be avoided with the installation and operation of a nuclear unit similar to that proposed for North Anna Unit 3.

For much of the Commission's work, it was advocated that the panel adopt a recommendation that strongly advocates for increased nuclear energy production, both in Virginia and nationwide. Those most strongly advocating this position did so for one simply stated reason: nuclear generation is a viable, proven way to meet a growing energy demand without the GHG emissions that accompany fossil fuel generation. Also, it was noted that new nuclear facilities could, in time, help retire existing, older coal-fired power generation plants.

Opponents on the Commission raised concerns over the high cost of nuclear power, especially relative to what can be achieved to meet energy demand by increased energy efficiency and renewable emissions-free generation sources, such as wind and solar. Also of concern was the safe disposal – storage or reuse – of spent nuclear materials.

The Commission decided to make recommendations regarding both nuclear and emissions-free renewable generation. In both cases, the Commission urged the General Assembly to adopt a statement of policy encouraging the development of additional generation capacity in Virginia. With regard to nuclear energy, the Commission further recommended that the federal government should develop a spent nuclear fuel reprocessing program and that the Virginia congressional delegation should support an extension of federal loan guarantees for new nuclear power plants. With regard to renewable generation, the Commission recommended that

capacity should be developed to meet new needs when it is more cost effective than other emission-free sources (such as nuclear) and that the use of renewable sources should be separately evaluated for meeting base load or peaking power needs.

Wise County Power Plant

A number of Commission members suggested from time to time that the Commission should discuss and perhaps make a recommendation on whether Dominion Virginia Power's proposed coal-fired electric generation station in Wise County, Virginia, should be built given its expected emission of carbon pollutants.

Dominion's "Virginia City Hybrid Energy Center" is a 585-megawatt coal-fired generation station that also is slated to use at least 20% biomass. The facility was first proposed by Dominion more than five years ago, and the General Assembly enacted legislation in 2004 (Senate Bill 651; *Code of Virginia* §56-585.G) that found it to be "in the public interest" to construct a coal-fired generation facility in Virginia's coalfields region that would use Virginia coal and other in-state energy resources. In 2007, the General Assembly again enacted legislation (House Bill 3068; *Code of Virginia* § 56-585.1.6) that, among other things, underscored the ability of the State Corporation Commission to grant approval for an electric-generation station in the coalfields using Virginia coal. In anticipation of the facility possibly being approved, its projected greenhouse gas emissions were conservatively factored into calculation of the state's greenhouse gas inventory and thus the effort to be undertaken to meet the Virginia Energy Plan's greenhouse gas-reduction goal.

In March 2007, the SCC issued a certificate of public necessity and convenience to build the Virginia City Hybrid Energy Center, having found the facility was necessary to meet energy demand and that its proposed construction site, capital cost, and cost-recovery plan to be consistent with state law and regulation. The State Air Pollution Control Board granted the facility an air pollution permit in June 2008. Not only were these decisions made before the Commission began its deliberations on recommendations, but also the Commission, as a purely advisory body, was without any authority to affect the governmental approvals required for Virginia City Hybrid Energy Center to be constructed.

Nevertheless, during the Commission's year-long deliberations – especially over about the first six months of its work – the Commission heard a great deal of testimony from the public concerning the proposed Virginia City Hybrid Energy Center. While a number of individuals from Southwest Virginia supported its construction, mostly based on the need for more in-state, reasonably priced electricity generation, the majority of public comments were in opposition to the proposed facility. Many college students and environmental advocates expressed their opposition, often in strong, passionate terms. It was decided by the Commission that this report should reflect the nature of the proposed facility and the level of public comment submitted regarding it.

A Ban on Coal-Fired Plants Until CCS Technology is Proven

Consistent with the Commission's general discussions regarding the proposed 585-megawatt coal-fired power plant in Wise County, the Commission had placed before it the question of whether the panel should recommend that no additional coal-fired generation facilities be built in Virginia until carbon capture and storage technology has been developed and proven effective on a commercial scale.

Commission members advocating a ban on coal-fired power plants until carbon capture and storage technology is a feasible option did so given the threat carbon pollution poses to Virginia's natural resources and public health. They also suggested that despite coal being a relatively less expensive source of power, the net, true cost to consumers may be higher when factoring in the costs of dealing with the effects of carbon pollution.

Commission members opposing a ban on coal-fired power plants until carbon capture and storage technology is proven effective on a commercial scale cite an impractical ability to immediately eliminate the option of new coal-fired generation given the Virginia Energy Plan's demonstrated demand for additional power – especially for base load generation – over the coming decade and the likely inability for alternative energy sources to be deployed on a timetable to meet that demand at a cost that would be reasonably acceptable to Virginia consumers. Even among those who opposed the provisional ban on coal-fired power generation, many agreed that coal should be an increasingly cleaner and smaller part of Virginia's and the nation's energy portfolio.

The generation of electricity from coal-fired power plants is controversial. It will remain so for years to come. That it is controversial was reflected in the Commission's very close vote to reject the proposal to ban coal-fired generation in Virginia until carbon capture and storage technology is proven feasible.

Renewable Portfolio Standard

Virginia law currently provides for a voluntary Renewable Portfolio Standard (RPS). It provides incentives for investor-owned utilities to produce 12% of its power from renewable sources by 2022. The Commission debated whether Virginia should continue having a voluntary RPS or move to a mandatory RPS.

Those opposing a mandatory RPS (and arguing for a continued voluntary RPS) cited evidence that the voluntary standard is achievable. The State Corporation Commission already has approved Appalachian Power's plan to meet the goals, and Dominion Virginia Power is actively working on its plans to meet the RPS goals. Changing to a mandatory RPS standard would not, according to those opposing a mandatory RPS, increase the amount of renewable electricity generated to serve Virginia, but would introduce new complications into the marketplace.

Commission members advocating for a mandatory RPS suggested such a policy would provide a higher level of assurance that the policy would be reached. They suggested that if the

Commission is to rely on the greenhouse gas emissions savings attributable to the RPS, the RPS should be mandated to ensure the savings are achieved. They also point to the value of mandatory PRS requirements in other states as a driver for substantial new renewable project development in the states.

The Commission adopted a recommendation that retained a voluntary RPS. However, the panel recommended that the Governor and General Assembly support legislation that increases the incentive-based goal for utilities to produce 12% of its power from renewable sources by 2022 to 15% by 2025. It is estimated that this additional three percent of generation from renewable sources will avoid approximately 1.5 MMT of greenhouse gas emissions.

Cap-and-Trade: Free Allocations vs. Auctioned Allocations

The vast majority of the Commission has advocated for the establishment of a carbon-trading system. Such is a market-based pollution-control approach that has been proved effective in the United States, most notably by the sulfur dioxide trading program enacted in 1990 to alleviate the nation's acid rain problem. However, as the Commission discussed cap-and-trade, one primary point of debate repeatedly surfaced – whether allocations to emitters should be granted free of charge, as with the federal acid rain program, or auctioned.

Those advocating that emission allocations should be granted free of charge cite the precedent of doing so for sulfur dioxide credits in the acid rain program, which achieved results at one-quarter of the costs estimated in the program's early years. Advocates for free allocations also suggested that should there be a price paid for emissions credits, such costs would be passed on to consumers.

Commission members advocating for an auction system suggested that an auction would immediately set a market value for a ton of carbon and would more accurately reflect the true cost removing CO₂ from the atmosphere. Those supporting an auction also suggested that money raised from auctions could be invested in energy-efficiency programs, adaptation measures, and carbon capture and storage technology, among other things.

The Commission decided to recommend generally that a “hybrid” system that includes both free allocations and auctions be established to ensure the existence of a financial incentive to reduce carbon emissions, with revenues to be used for actions to mitigate and adapt to climate change.

It also should be noted that Virginia's manufacturing community has consistently expressed concerns over a cap-and-trade program, especially one that auctions all or most emission allowances. They have suggested that the costs to manufacturers associated with such a carbon trading program would be excessive, which would substantially drive up the cost of doing business, making their products uncompetitive with offshore producers that do not face the same limitations. The manufacturing community believes that ultimately, production (jobs) and emissions would move to places that do not have limitations on carbon emissions, significantly damaging our economy and doing little to reduce global GHG emissions.

CAFE vs. CALEV

Under Section 209 of the federal Clean Air Act, states generally may not develop their own vehicle emission standards. The exception to that rule, however, is that the State of California may set its own standards provided they are at least as stringent as federal standards; other states may adopt California's standards once a waiver has been granted by the U.S. Environmental Protection Agency (EPA). The California Low-Emission Vehicle (CALEV) regulations apply to passenger cars, light-duty trucks and medium-duty vehicles and include a tailpipe GHG standard that does not exist in federal emission standards and a zero-emission-vehicle (ZEV) requirement (electric vehicles). States that choose to adopt CALEV standards have the option to include the GHG and ZEV requirements or not. The GHG standards have been adopted as part of the CALEV program but California has not yet been granted the necessary waiver by EPA to implement the program. The waiver denial has triggered litigation that has yet to be resolved.

CALEV reductions would apply to motor vehicles manufactured in the 2009 model year and thereafter. The regulations require reductions in fleet averages, rather than compliance by individual vehicles, and provide flexibility by including credit generation from alternative fuel vehicles and averaging, banking, and trading of credits within and among manufacturers. The regulations require the gradual reduction in fleet average GHG emissions until they are approximately 30% below the emissions of the 2002 fleet in 2016. Virginia DEQ has estimated that adoption of CALEV in Virginia would result in a cumulative GHG reduction of 17 MMT beyond the reduction that will be achieved by federal CAFE standards by 2020.

On a close vote, the Commission rejected a recommendation that Virginia adopt its own version of CALEV, as have 18 other states. Those advocating for Virginia-specific low-emission vehicle requirements cited the significant GHG reductions that could be achieved thereby. Those opposing Virginia-specific low-emission vehicle requirements did so on grounds that numerous state standards are difficult for auto manufacturers to comply with and raise prices for consumers. As an alternative to Virginia adopting the CALEV standard, the Commission considered a proposal to include imposing California Low-Emission Vehicle requirements nationwide as an option in a recommendation regarding federal CAFE standards, and this proposal was adopted by a wide margin.

B. Workgroups

1. Electricity Generation/Other Stationary Sources

The Electricity Generation/Other Stationary Sources Workgroup was charged with looking at changes that could be recommended for Virginia's fuel mix, how to advance carbon capture and storage technology, and other actions that can be taken by Virginia utilities to help achieve the Commonwealth's GHG emissions reduction goal. The workgroup's discussions focused on six broad areas to help achieve the GHG emissions reduction goal: Interaction with Federal Action; Nuclear Energy; Renewable Portfolio Standard; Renewable Distributed Generation/Combined Heat and Power; Conservation Pricing; and Research and Development.

Interaction with Federal Action

Given the global nature of climate change and current activities at the federal level, the Workgroup concluded that it was likely that the federal government will take action to mitigate carbon emissions economy-wide. It also appears that such action will be in the form of a cap-and-trade program. Because of the likelihood of federal action, the workgroup did not believe Virginia should develop its own cap-and-trade program or join an existing regional program like the Regional Greenhouse Gas Initiative (RGGI).

The workgroup discussed how cap-and-trade programs work. Under a GHG cap-and-trade program, a regulatory agency sets a maximum limit or cap on the total amount of emissions of GHGs. The cap limits emissions from all covered facilities. The regulatory agency then implements an emissions trading program by creating and distributing a specific number of allowances for use by regulated entities. An allowance represents an authorization to emit a specific amount of a pollutant during a particular period of time. The total amount of allowances cannot exceed the cap, thereby limiting total emissions. At the end of each compliance period, each regulated entity must demonstrate that it possessed sufficient allowances to cover all emissions of the capped pollutant. If an entity releases emissions in excess of the allowances it holds, it can meet the program requirements by buying additional allowances from entities that have excess allowances due to reduced emissions.

Under a cap-and-trade program, each regulated entity can design its own compliance strategy to meet the overall reduction requirement, including sale or purchase of allowances, installation of pollution controls, implementation of efficiency measures, and use of offsets, among other options. Offsets are emission reduction projects undertaken at sources outside a cap-and-trade program. An offset mechanism enables covered entities to offset their own emissions by purchasing emission reduction credits generated through projects at facilities not covered by the cap. Offsets lower the overall cost of the program by bringing in low-cost emission reduction opportunities from outside the cap. Examples of projects that may generate offsets include afforestation, landfill methane capture and other projects. Individual control requirements are not specified under a cap-and-trade program, but each regulated entity must surrender allowances equal to its actual emissions in order to comply. Sources must also completely and accurately measure and report all emissions in a timely manner to guarantee that the overall cap is achieved.

The workgroup discussed the various facets of a cap-and-trade program: whether there should be a benefit to sources that act early to reduce emissions; the method for allocating allowances (auction v. free allocation); whether trading/purchase of allowances and offsets should be national or global; and whether there should be a “safety valve” if allowance prices are higher than expected. There was much debate among workgroup members regarding the appropriate method for allocating allowances to affected sources in a cap-and-trade program with members discussing the advantages of each allocation method.

Nuclear Energy

The workgroup considered the potential for increasing nuclear generation in Virginia and discussed the barriers to the development of nuclear generation including: there is a single supplier

for nuclear turbine blades (Japan Steel Works) and the waiting list is approximately 7 to 8 years; limited sources of uranium; large economies of scale; and long construction/development period.

Currently, the federal government has a loan guarantee program designed to help facilitate new nuclear construction. This Department of Energy loan guarantee program was established by the U.S. Energy Policy Act of 2005 to assist companies pursuing the licensing of new nuclear units to finance the first wave of new commercial reactors in the United States. If a loan applicant's project is selected under this program, the federal government could guarantee all of the project's debt so long as it does not represent more than 80 percent of the project's qualified construction costs. Congress has appropriated \$18.5 billion to support the nuclear loan guarantee program, however, the loan guarantees were conditioned on being awarded no later than 2009.

Renewable Portfolio Standard

Electricity demand is increasing in the Commonwealth, requiring the development of additional resources to meet that need. Renewable energy resources can help meet this demand while producing low or no GHG emissions. A renewable portfolio standard (RPS) is a mitigation option requiring electric utilities to supply a certain percentage of retail electricity from renewable energy sources by a stipulated date. Currently, Virginia has a voluntary RPS goal that, by 2022, 12% of an electric utility's total electric energy sold in the base year* (2007) will come from renewable sources.

There was much discussion among the workgroup about whether to make the current voluntary RPS goal a mandatory requirement for Virginia utilities. Some workgroup members suggested that because both Dominion and AEP have publicly committed to meet the voluntary standard, making the standard mandatory should not be problematic and would encourage the development of renewable energy sources in Virginia. Other workgroup members expressed concern with establishing a mandatory standard that may be unattainable due to the limited sources of renewable energy available within the state. A suggestion was made that pumped storage facilities/generation associated with non-dispatchable renewable sources (e.g. wind) should be counted towards the RPS goal. It also was suggested that if the goal of an RPS or of the Commission is to reduce emissions of greenhouse gases, then the standard should be expanded to accommodate nuclear energy as an option or that both new and existing nuclear energy should be subtracted from a utilities total generation, as is currently done (so that nuclear generation does not count against a utility trying to reach the RPS goal). Another suggestion was increasing the RPS goal after 2022 (e.g. 15% by 2025). The suggestion also was made that perhaps rather than recommending a revision of the RPS goal, the group should establish an "emissions free energy" goal or standard which would count traditional renewable sources as well as nuclear generation, but no consensus was reached on such a standard.

The workgroup also discussed the potential for developing a feed-in tariff similar to the renewable energy incentives established in many European countries. A feed-in tariff is an

* "Total electric energy sold in the base year" means total electric energy sold to Virginia jurisdictional retail customers by a participating utility in calendar year 2007, excluding an amount equivalent to the average of the annual percentages of the electric energy that was supplied to such customers from nuclear generating plants for the calendar years 2004 through 2006.

incentive structure to encourage the development of renewable energy sources by obligating utilities to buy renewable energy at above market rates. A feed-in tariff essentially offers a long-term guaranteed price contract (usually about 15 to 20 years) to any entity that contributes electricity to the grid via renewable sources. Feed-in tariffs, modeled after the German approach, have been proposed in Michigan, Illinois and Minnesota. Several workgroup members expressed concern that they lacked sufficient information to discuss at greater length a feed-in tariff for Virginia at this time.

Renewable Distributed Generation/Combined Heat and Power

Renewable distributed generation (DG) is energy generated at or near the sites of consumption by naturally replenishing resources, avoiding GHG emissions and the costs associated with conventional electricity supply and electricity losses during transmission and distribution. Combined heat and power (CHP) is the simultaneous production of electricity and heat from a single fuel source, such as: natural gas, biomass, biogas, coal, waste heat, or oil. CHP is more energy efficient than separate generation of electricity at a central electric plant and production of localized thermal energy for the end user. This distributed generation resource allows for recycling the heat, which is normally wasted to meet onsite thermally-driven demand such as process and space heating, cooling, and dehumidification. Because less fuel is burned to produce each unit of energy output, CHP reduces air pollution and GHG emissions.

Workgroup members noted that Virginia has policies in place to facilitate net metering and to facilitate interconnection and solar installations for residences. There are, however, no subsidies to facilitate or support renewable DG (except for certain subsidies for wind power). The workgroup generally supported the idea of facilitating the development of renewable DG and CHP. Some workgroup members raised concerns, however, about the high costs associated with renewable DG and suggested that efforts to subsidize renewable DG may raise the costs of electricity when it may be more cost-effective to work towards lowering GHG emissions from the larger, centralized power plants. Additionally, workgroup members noted that many of the barriers associated with renewable DG may be at the local level through building or local zoning codes and homeowner association regulations.

With respect to CHP, workgroup members suggested that many manufacturers are already using CHP where appropriate to save fuel costs and that CHP may be a good idea in specific industrial applications but may not be broadly applicable. Some workgroup members believed that the specific CHP goals in the climate change action plans for other states may be more aspirational than actually achievable.

The workgroup generally expressed concern about the cost-effectiveness of DG and CHP and believes more expertise and/or site-specific information/research may be necessary to identify the hurdles to investment in DG and CHP and to determine how the Commonwealth may best use available resources to facilitate these activities.

Conservation Pricing

The workgroup noted that utilities in Virginia are in a good position to develop and implement energy efficiency and conservation programs, but that utilities need some incentive to develop and implement programs which would reduce sales of electricity. Utilities generate a predictable long-term earnings stream from investments in new energy supply resources that are needed to meet customer demand. Conservation and energy efficiency projects reduce sales and the predictability of future earnings of the utility. Under traditional ratemaking, costs incurred by utilities, including a return on investment, are recovered through the sales of electricity. Because conservation and energy efficiency can decrease the volume of electricity sales, traditional cost-recovery mechanisms have created a financial disincentive to utility support for these demand-side programs.

The workgroup discussed the policies/programs that may encourage utilities to develop energy efficiency and conservation programs, including: utility cost recovery on investment (or even enhanced return on investment), demand response programs, and the need to have programs which motivate customers. Workgroup members noted the importance of educating the public about conservation and available conservation programs. Some workgroup members pointed out that utilities have had time-of-use programs in place for a long time, but few customers participate because of the behavioral change required. It is possible that a real-time time of use rate would help solve this problem as customers would not have to defer actions until late at night to reduce costs. Real-time time of use rates also allow for use of automated systems to control consumption, lessening the behavioral change required to benefit from such rates.

Research and Development

Research and development in carbon-free energy resources and advancement of energy technologies is critical if the United States is to reduce its dependence on fossil fuels and mitigate GHG emissions. Workgroup members noted that a number of energy technology research and development programs are already underway at organizations and academic facilities throughout Virginia. For example, in July 2008, the Virginia Tobacco Commission approved more than \$36 million to fund a variety of energy research centers in Southwest and Southside Virginia, including \$8 million for a center in Abingdon which will focus research on carbon sequestration, \$8.07 million to establish a sustainable energy research center in Danville, \$7.69 million for a nuclear energy research center in Bedford County; \$873,845 in additional funding for a Gretna, Virginia facility that converts crops into bio-diesel fuel; nearly \$8 million for a nuclear research center in Halifax; and \$4 million for an energy research center in Wise.

The Virginia Research & Technology Advisory Commission (VRTAC) in its report entitled “Collaborative Research and Development Strategies and Directors for the Commonwealth of Virginia” recommended energy, conservation, and the environment research and development as one of three priority areas for investment by the Commonwealth, contingent upon cost sharing by universities and industry. VRTAC found that research institutions in the Commonwealth are involved in a substantial, but largely uncoordinated, base of research and development activities across the following areas: alternative energy, including biorenewables (UVA, VT, JMU, VCU, ODU, VSU), fuel cells (VT, UVA, VCU, JMU), hydrogen (UVA, VT,

JMU, VCU, WM), photovoltaics (UVA, VT, JMU, VCU, ODU, NSU, NASA, Jlab), wind and coastal (ODU, JMU, VT, WM, NSU); conservation and sustainability (UVA, VT, JMU, GMU, HU, NASA); environment, environmental health and safety (UVA, JMU, VT, GMU, WM, ODU, VCU, EVMS, NSWC, Jlab, NASA); societal implications of policy (VT, UVA, WM, JMU, GMU). VRTAC recommended funding of large scale collaborative research programs through a consortium of stakeholders to achieve a focused, state-wide effort to coordinate resources and activities.

Similarly, the Virginia Energy Plan (VEP) noted the importance of advancing energy technology and the significant opportunity for leadership Virginia has in this area. The VEP recommended strengthening energy R&D in Virginia by providing a consistent funding source and using a governance system involving university, business, and government stakeholders to set energy research and development priorities by setting out a roadmap identifying the growth areas for energy research and development, the areas where Virginia researchers can bring added value to these growth areas, and recommend projects for state support.

With respect to funding research and development, workgroup members expressed belief that there would be substantial resistance to a public benefits fund which may increase the cost of electricity. A public benefits fund is used to fund energy efficiency, renewable energy and/or research projects and is collected either through a small charge on the bill of every electric customer or through specified contributions from utilities.

2. Built Environment

The Built Environment Workgroup was charged with identifying opportunities to reduce greenhouse gas emissions and minimize negative effects of climate change on investments in Virginia's built environment. These primarily are available through improvements that will reduce the energy needed to heat, cool, light, and operate equipment and systems in residential, commercial and industrial facilities and operations.

When this workgroup was formed, the Governor's Energy Policy Advisory Council (GEPAC) had already begun to develop recommendations about needed policy changes to advance energy efficiency and conservation. Therefore, the Built Environment Workgroup joined with the GEPAC to complete these deliberations.

Energy efficiency and conservation are the first steps available to Virginians to reduce greenhouse gas emissions. They can be implemented more quickly and in smaller increments than many other greenhouse gas reduction strategies. However, researchers have identified a number of barriers that limit investment in conservation and efficiency in the built environment below optimally economic efficient levels. These cause a failure of traditional markets to optimize investments. The workgroup considered the following barriers when evaluating its recommendations.

- Upfront costs: Consumers face a barrier due to first-cost sensitivity and short time horizons for many energy-savings investments. Many consumers find it difficult to fund the one-time, upfront investment needed for efficiency projects or equipment and expect a one-to-four payback on investments.
- Confusion: Consumers may not be aware of, or have inadequate information about, the energy wasted by individual parts of their buildings or pieces of equipment or about what are the best energy-savings investments. This keeps consumers from being able to make informed choices. Additionally, there often are real or perceived quality differences in energy efficiency options, raising the risk in consumers' minds about investments in energy efficient technologies. Confusion often results in no action being taken. Consumers also may not find energy efficient choices readily available to them in the marketplace.
- Multiple attributes: Consumers typically do not give as high priority to multi-attribute products, particularly when some attributes may be to society as a whole, not to the individual consumer.
- Principal agent: There are barriers where the person responsible for an investment, such as a building owner, is not the same as who is responsible for paying energy bills, such as a tenant.
- Regulatory: Energy providers may not be able to recover costs they might incur helping customers reduce energy use and may be penalized from decreased sales. Additionally, energy providers may receive enhanced returns from investments in supply infrastructure so are more likely to invest in supply than conservation.
- Dispersed actions: For ease of management and control of variables, private sector firms are more inclined to take on one large project rather than take on many small projects. Supply tends to be provided through large, central projects, whereas energy efficiency projects tend to be small and dispersed.

These barriers lead consumers and energy providers to apply a higher discount rate to investments in energy conservation and efficiency than for many other opportunities. State actions to increase investments in energy conservation and efficiency must overcome these market failures.

Workgroup members considered recommendations in multiple areas. They considered options to address the barriers to optimal investment in energy conservation and efficiency. This section outlines the topics considered by the workgroup and its recommendations to advance energy efficiency and conservation and reduce Virginia's greenhouse gas emissions.

Investments in Energy Efficiency

Utility investments in energy efficiency, both for internal operations and for their customers, are more strongly motivated if the utility can receive a rate of return equal to supply side options.

Under legislation enacted in 2008, natural gas utilities may receive an enhanced rate of return under a rate-decoupling program. There is no such provision for electric utilities.

There are other investments in energy efficiency that would not be part of any utility-sponsored program. These include those that address non-utility fuels, have multi-fuel benefits, or provide a broader benefit beyond a single utility's ratepayers.

Overcoming the barriers for energy efficiency for non-utility fuels will require public support. This may be provided through a number of mechanisms. To overcome the first cost barrier, the workgroup recommended that local or state government entities provide capital for loans to consumers, returned on a pay-as-you-save basis. These groups should work with other local community groups and energy efficiency businesses to establish local efficiency businesses to deliver the energy efficiency services to their residents and businesses.

These programs also could be supported through use of general tax revenues or a system benefits or similar surcharge on electric bills. While there may not be a direct nexus between an electric system benefit charge and general savings, electric bills are paid by all consumers. It would not be appropriate to use natural gas or water or sewer utilities as they do not serve the full universe of customers.

Smart Metering

Smart metering and smart grids (often referred to as advanced metering infrastructure or AMI) provide new tools to manage energy use and implement energy efficiency and demand controls. Smart meters allow strategies such as remote control of equipment; use of energy use/cost monitors; smart appliance controls that modify appliance operation based on utility demands and costs; and real-time rates (time of use) that better connect real-time revenue to real-time costs. Smart meters and grids allow electric utilities to better manage service quality. This allows utilities to operate transmission and distribution systems more efficiently, and more efficiently manage service outages.

Educating Virginia's Energy Consumers

Consumers need clear, trusted, timely information to make effective decisions about investing in energy efficiency. While this may not directly reduce energy use or greenhouse gas emissions, consumer education is a critical component to effectively implementing other strategies. Energy conservation and efficiency consumer education also may serve multiple goals, such as leading to practices that reduce water pollution.

Virginia recognized this need and in 2008 charged the State Corporation Commission with the responsibility to develop an electric efficiency consumer education plan. The Commission issued its draft plan on October 6, 2008, outlining a five-year, \$10 million program. Recommendations include branding the energy education program, delivery of messages via purchased advertising on broadcast and in print media, through Web-based tools, through a toll-free phone service, and working in partnership with outside partners to deliver messages to

defined or niche markets. The plan includes pre and ongoing testing of consumer knowledge about energy conservation as a way to measure success of the effort.

The SCC plan recognizes the opportunities to partner with groups to enhance consumer education. For example, the Virginia Cooperative Extension has a network of experts around the state, but in recent years has done limited energy efficiency consumer education. With sufficient funding, energy education could be a natural add-on to their services. State agencies such as the Departments of Housing and Community Development, Social Services, and Mines, Minerals and Energy may be used to enhance service to specific audiences. Non-governmental organizations also may reach specialized groups.

Funding for the consumer education actions is to come from the surcharge electric utilities pay to fund the SCC operations. This fund was previously used for the electricity choice consumer education plan. Any new program must have sufficient funding to make a meaningful change in consumer knowledge and behavior.

There may be other opportunities to target energy conservation and efficiency training and education at specific targets. For example, there is potential for energy savings and greenhouse gas sequestration on farms. A farm audit program could be enacted to expand efficiency practices in the agricultural sector.

These efforts could be funded from sources with a nexus to the target audience. For example, an effort targeted to fuel oil users or transportation efficiency could be funded through a small increase in the fee that now supports the state's underground storage tank program.

Renewable Energy

Renewable power can be generated from sources that do not add net greenhouse gas emissions to the atmosphere. These sources should receive credit for the value of their emission reductions compared to Virginia's current greenhouse gas emission profile. This can be provided for through use of carbon credits.

Individuals implementing small renewable energy systems in Virginia are eligible for net metering where electricity produced in excess of what is used on site is sent back onto the distribution network. The customer is credited for this power at the retail value of the power up to the amount of use by the customer.

In accordance with 2007 legislation, Virginia's electric utilities are beginning to offer special tariffs for customers purchasing 100% green power. Under these green power tariffs, customers will typically pay a higher rate for green power. To provide parity between green generation and charges, net metering customers should be paid for production back into the grid at the same rate the utility charges customers under the 100% green power tariff, not under the standard tariff rate.

Many consumers have been reluctant to invest in renewable energy systems due to the first cost of the systems. To help overcome this barrier, the workgroup recommended the consideration of incentives for consumer investment.

Weatherization

The Weatherization Assistance Program (WAP) is operated by weatherization service providers in accordance with a program operated by the Department of Housing and Community Development. The program is funded through the federal Weatherization Assistance Program grant and a set aside of 15% of the Low Income Housing Energy Assistance Program (LIHEAP) funds received by the Commonwealth. The Commonwealth has periodically supplemented the federal funds with a General Fund appropriation or through use of Temporary Assistance for Needy Families (TANF) funds during times of rapidly rising energy costs. Weatherization services are available for low-income households, particularly for the elderly, individuals with disabilities, and families with children.

The Weatherization Assistance Program provides direct installation of energy-saving measures such as installing insulation; sealing air-leaks with caulking and weather-stripping; repairing leaky duct systems; repairing or replacing inefficient or unsafe heating systems; and installing carbon monoxide and smoke detectors. These improvements result in a permanent decrease in energy use and bills for families receiving weatherization services. Reduced energy use results in reduced greenhouse gas emissions from the fuel used to heat or cool the homes.

Under recent funding levels, (approximately \$4.2 million Weatherization Assistance Program funds, and \$6.8 million in LIHEAP funds in Fiscal Year 2007) the WAP has been able to improve around 2,000 families' homes each year. Each \$1 million increase in funding would allow an additional 200 homes to be weatherized. The WAP works most efficiently with relatively consistent funding from year to year. Sharp increases in funding followed by sharp decreases cause inefficiencies from having to staff and train crews and then eliminate crews as funding decreases.

Utility rate schedules

Electric utilities traditionally offer residential and small commercial rates that include a fixed monthly charge and a block rate that may vary as use increases. The fixed charge is to cover basic costs of service that remain the same regardless of use. The variable usage rates are cost-based and are designed to recover the remaining fixed costs as well as variable costs that change with use.

For Dominion Virginia Power, rates increase with greater consumption in the summer to account for higher costs of power during summer months. The company uses an inclining block structure during the summer where customers pay more for the higher usage blocks of power. This is reversed during the winter when the higher usage block is priced below the base block. Appalachian Power charges the same for both base and higher usage blocks.

Virginia's electric utilities also offer residential and small commercial consumers time-of-use-rates. The charges are higher during on-peak periods and lower off peak. Dominion Virginia Power's summer peak runs from 11 a.m. to 10 p.m.; in winter from 7 to 11 a.m. and 5 to 9 p.m. Appalachian Power has the same 7 a.m. to 8 p.m. peak period year round.

Large commercial and industrial users pay a basic monthly charge, a charge for electric demand (rate of use at any one time – comparable to maximum flow in a hose), and a charge for electric use (total amount used over the billing period – comparable to volume out of a hose). The demand is typically measured over a 15 or 30 minute period. Customers may be required to pay a minimum demand charge equal to 60 to 85% of their highest peak use even if they don't reach that demand in any billing month.

Utilities often offer special rates for churches, customers with ice storage systems, customers who agree that water heaters or air conditioners may be cycled off during peak periods, and customers with other special circumstances.

Virginia electric utilities do not offer residential and small commercial customers a true time of use rate. These rates vary over the day, such as hour-by-hour, and from day-to-day as cost of power varies. The customer pays more as the utility must pay more for electricity during peak demand periods and less during low demand times. Customers using a true time-of-use rate have the ability and motivation to reduce electric use during periods of high demand and price. They may use less or shift use to lower demand periods. If enough customers reduce demand during peak periods, less power will be used during these peaks and less power must be either generated from peak power plants or purchased from outside suppliers. This reduces the greenhouse gas emissions associated with peak generation. However, this also may shift emission patterns if electric use is shifted to off-peak times.

To the extent that coal-based imports are replaced with off-peak, base load nuclear and coal generation, there will be a net reduction in greenhouse gas emissions. To the extent that natural gas peak power use is offset by increased firing of coal-fired base load generation, there will be a net increase. These impacts should be assessed based on Virginia's unique fuel mix and load profile. This analysis was beyond the scope of the workgroup's assessment.

Public funds for energy efficiency

As noted above, two primary barriers to implementing energy efficiency improvements are lack of upfront funding and customer confusion. To overcome these barriers, the Commonwealth could work with localities and community groups to provide a central, publicly-administered capital fund for energy efficiency investments, with the energy efficiency projects implemented through local organizations.

For example, a local government could work with community groups to form a low profit, limited-liability company (L3C) to deliver services to local homes and businesses. Other potential local service providers could include current Weatherization Assistance Program service providers, or other local non-governmental organizations. Capital funds could be made

available through the Virginia Resources Authority. Consumers would have a greater level of trust when the service is affiliated with their local and state governments.

The service should include an energy audit identifying savings potential, financing tied to energy savings, use of certified contractors to ensure quality control, and follow-up monitoring to ensure savings.

A central administrative body (state government or a non-governmental organization) could provide central energy efficiency consumer education material, central administrative services such as account management, and technical assistance to local service providers.

Building standards

Minimum building performance standards may be set through two paths. Building codes provide for minimum safety and comfort standards. They have been expanded to include other minimum standards such as energy efficiency and handicapped access. In Virginia, building codes are based on standard codes developed through a consensus-building process by the International Code Council. Specifically, these include the International Energy Conservation Code (IECC) for single-family homes and low-rise residential structures and the ASHRAE 90.1 standard for large structures. The International Code Council updates the code on a three-year cycle. Other codes, such as the national electric code and national fire protection code, also may affect energy using systems.

At the time this report is being issued, Virginia uses the 2006 IECC and ASHRAE 90.1-2007 codes in its building code. The codes are adopted as part of the Uniform Statewide Building Code by the Board of Housing and Community Development following promulgation by the International Code Council. The codes are administered and enforced by local building officials in each city and county, subject to review by the state.

A relatively new type of building standard has been developed to address energy and environmental impact of buildings and communities. These are generally referred to as green building or high-performance building standards. They include standards such as Energy Star, Earth Craft Homes, Leadership for Energy and Environmental Design (LEED), and Green Globe. These have been introduced as voluntary standards.

Compliance with these standards result in buildings that use less energy and therefore cause fewer greenhouse gas emissions. Additionally, these buildings use less water and have less overall environmental impact. Well-designed green buildings offer improved occupant comfort. Studies have shown generally increased retail sales in high-performance stores and increased student performance in high-performance schools.

Over the last few years, some local jurisdictions have required commercial buildings meet these green building standards. For example, starting in 2009, commercial buildings over 200,000 square feet in size in the District of Columbia will be required to meet LEED standards. Building size limits will be reduced until 2013, when all commercial buildings over 50,000 square feet in size must meet LEED standards.

Appliances

The federal government has established minimum efficiency requirements for different types of energy using equipment such as heating and cooling systems and hot water heaters. Some states have established minimum appliance standards for energy-using equipment lacking federal minimum efficiency standards such as DVD players, compact audio equipment, hot food holding cabinets, portable electric spas, water dispensers, and furnace fans. States can use standards developed by the Appliance Standards Awareness Project to ensure that the state standards are consistent with other states and minimize market disruptions for manufacturers. Of Virginia's neighboring states, Maryland is setting up state-specific appliance standards.

3. Transportation and Land Use

The Transportation and Land Use Workgroup looked carefully at many possibilities for contributing to reductions in GHG emissions, and strove to make sure each of its recommendations is consistent with the short- and long-term prosperity and welfare of the citizens of Virginia. Wherever possible, the workgroup tried to offer recommendations that provide additional benefits, including environmental, economic, health, and cultural benefits.

In making recommendations, the workgroup focused on three primary categories: (i) initiatives that reduce GHG emissions through improved vehicle fuel economy, (ii) initiatives that reduce GHG emissions through low-carbon (alternative) fuels, and (iii) initiatives that reduce GHG emissions through transportation, land use, and operational improvements. There was a strong consensus among workgroup members that actions to support or accelerate measures in each of these categories should be actively encouraged by state policy, state incentives, or state standards with the Commonwealth itself setting an example for individuals, local governments, and the private sector, as well as providing funding and policy support.

While the workgroup's recommendations focused mostly on automobile and truck transportation, public transportation and rail, it also was noted that additional efforts are necessary to assess and adopt steps to reduce the annual 17 million metric tons of GHG emissions from off-road vehicles, trains, airplanes, and ports. In addition, the workgroup recognized that decreases in vehicle GHG may lead to some incremental increases in off-road emissions.

Reducing GHG Emissions Through Improved Fuel Economy

Initiatives that reduce GHG emissions through improved fuel economy include the imposition of standards regarding fuel economy, providing incentives for citizens and businesses to purchase fuel efficient vehicles, encouraging driving behavior that increases fuel efficiency, leading by example in state procurement of vehicles, and encouraging research and development of new technologies to improve fuel economy. All of these approaches reduce GHG emissions by reducing the amount of fuel that must be burned to move goods and people.

According to DEQ, transportation sources emitted 53.5 million metric tons of GHG emissions in 2005, approximately one-third of the overall GHG emissions in the Commonwealth. The Business As Usual scenario recently prepared by DEQ predicts that transportation-generated GHG emissions in 2025 will be 78.1 million metric tons. Until recently, the transportation sector represented the fastest growing source of GHG emissions in the state, and it still is projected to be the fastest growing source through at least 2025. Over the past year, however, primarily as a result of higher gasoline prices, emissions from the transportation sector most likely did not increase or may have decreased as driving decreased. Recent experience suggests that the growth rate in vehicle miles traveled (VMT) will not continue at the historic level of 1.9% on an annual basis. Through the first seven months of 2008 (which is the latest data available), VMT throughout the United States is down by almost 3% versus 2007. If the slower growth rate persists over the middle- and long-run, there may be a corresponding slower growth rate in transportation-related GHG emissions than previously forecast. Declines in VMT projected with confidence should be part of the continuing discussion on how best to respond to the challenge of climate change.

The 2007 CAFE standards adopted by Congress are forecast to have a major impact on transportation-related GHG emissions in Virginia, without further action on the part of Virginia's leaders. A vehicle fleet averaging 35 mpg will emit fewer GHG emissions than one averaging 22 mpg. DEQ has completed a preliminary analysis of the effect of the 2007 CAFE standards and projects that Virginia will see a 20 million metric ton reduction from the Business-As-Usual forecast in 2025. This would represent a 30% reduction in the transportation emissions in 2025. The estimated GHG reduction is heavily dependent on a continuation of the historical rate of fleet turnover, which currently is not being achieved. A number of the workgroup recommendations are aimed at helping accelerate fleet turnover, which, if implemented, could complement the current slowdown and ultimately help achieve the CAFE benefits earlier than 2025.

Executive Order 48 (2007) directs the Department of General Services to include policies and procedures for the purchase of fuel-efficient, low-emission state-owned vehicles in its fleet management program. E.O. 48 further directs DGS to include policies and procedures for leasing vehicles that give a preference to compact, fuel-efficient, and low-emission vehicles. State vehicles used for law enforcement and emergency response are exempt; however, public safety agencies are expected to make all reasonable efforts to reduce transportation energy use when possible in ways that do not adversely impact their missions and ultimately the safety of Virginia's citizens.

As of July 2008, there were 4,187 passenger vehicles in the DGS fleet, and they averaged 27.63 miles per gallon. There were an additional 12,636 state owned vehicles not managed by DGS OFMS. These vehicles averaged 15.41 miles per gallon. The difference in MPG can be attributed to the various models of agency owned vehicles (i.e., State Police Crown Victorias) that do not get the higher MPG of DGS managed vehicles which are primarily compact model vehicles.

Reducing GHG Emissions Through Low-Carbon (Alternative) Fuels

The Commonwealth can increase the use of alternative fuels by improving the market through its purchasing power, providing funding for research and development, and providing services to encourage the use of alternative fuels, such as installing electrification services at state-owned or private truck stops.

The full Commission raised one issue relevant to this topic that should be noted. The Virginia General Assembly established a goal to reduce by 2022, electricity consumption by retail consumers, in an amount equal to 10% of electricity consumed by retail customers in 2006. Measures of whether Virginia is meeting this goal should take into consideration the impact of increases in electric consumption by the transportation industry due to increased electrically-driven mass transit, plug-in vehicles, and other uses. Electricity consumption for transportation should not be included in the total consumption of electricity for the purposes of calculating progress towards the 10% reduction by 2022. Virginia should consider the net change in emissions when considering policies to promote movement from petroleum-based transportation to electric-based sources.

Reducing GHG Emissions Through Transportation, Land Use, And Operational Improvements

Initiatives that reduce GHG emissions through transportation, land use, and operational improvements include actions to reduce congestion, increase accessibility, and provide a wide range of transportation choices that result in fewer or shorter automobile trips while still accomplishing the desired trip outcomes (e.g., commuting to work, personal trips for shopping, medical appointments, education, leisure travel, etc.). Such actions include providing greater access to transit, including rail transit; shifting freight transport from truck to rail; city and town revitalization; infill development; transit-oriented and transit-ready development; community designs that promote walking or bicycling; community designs that facilitate combining of trips or shorter trips; and telecommuting, telebusiness or telecommunication.

The workgroup noted that the report, “Commission on Transportation in Urbanized Areas,” commissioned by Governor Mark R. Warner and finalized in 2005, contains a myriad of transportation and land use recommendations, many of which complement the recommendations of the workgroup. The report can be found at www.vtrc.net/urbanized/pdf/FinalCommissionReport.pdf.

The workgroup had a spirited discussion regarding whether the ultimate objective was to reduce vehicle miles of travel or to reduce emissions. A strong consensus emerged that reducing emissions was the workgroup’s primary objective and the transportation, land use, and operational improvements for achieving this objective should focus on expanding consumer choice, improving the efficiency of the existing transportation system, and promoting community designs that result in lower emissions. Reduction in VMT and associated GHG emission reductions may very well be the consequence of these strategies. The workgroup also notes that reduction in VMT obtained through its recommendations also will have positive co-benefits such as reduced congestion, improved air quality, lower transportation costs for households and businesses, and lower impacts on Virginia’s transportation infrastructure.

The workgroup noted with approval that the Commonwealth has steadily increased its investment in rail and transit funding over past six years. For fiscal years 2007-2010, \$822 million in transit funding is available, a 51% increase over fiscal years 2003-2006. During the same time frame, \$210.1 million in rail funding is available, a 500% increase over fiscal years 2003-2006. While rail and transit funding has increased, so too has the demand for transportation options with the growth in freight imports and exports, the increasing congestion on highways, the rise in fuel prices, and the need to reduce transportation GHG emissions. There was considerable consensus that the Commonwealth should continue to increase its investments in passenger and freight rail, transit, and other modes to ensure that Virginians can maintain their quality of life. Funding also is needed for walking and biking networks, improved customer access around transit stops, reengineering existing streets for operational improvements and access management, improved street crossings, and travel demand management.

Code of Virginia § 2.2-2817.1 requires each agency head to establish a telecommuting and alternative work policy for eligible employees. Each agency was required by July 1, 2009, to have a goal of not less than 25 percent of its eligible workforce participating in alternative work schedules. By January 1, 2010, each agency except State Police is required to have a goal of not less than 20 percent of its eligible workforce telecommuting. As this document is being finalized, no status reports are available on telecommuting or alternative schedules.

4. Adaptation and Sequestration

The Adaptation and Sequestration Workgroup focused its deliberations on protecting Virginia's citizens, natural resources, and economy given the expected impacts of climate change. These impacts include sea level rise, increasing temperature, and changing weather and precipitation patterns. While the workgroup recognized that it is impossible to predict the exact nature and extent of all future impacts, there is enough evidence of changes already occurring and commonly accepted predictions of likely future impacts, that the time to start planning for impacts is now. For the purposes of its discussions, the workgroup defined adaptation as the following: "Actions taken or decisions made in response to actual or expected climate change impacts to society, ecology, or economy. Adaptation decreases vulnerability, or conversely, increases resilience to these impacts."

The goal of a comprehensive policy response to the challenges posed by climate change is to reduce emissions to mitigate the extent and severity of climate change impacts. However, there is a broad scientific agreement that even if efforts to dramatically reduce emissions are immediately successful, human-induced climate change will continue to intensify through 2030 (IPCC, 2007). Several recent national and international climate change reports, including the Intergovernmental Panel on Climate Change's Fourth Assessment Report, recognize the urgency to address the causes and potential consequences of climate change. Workgroup members noted the urgency for adaptation planning as cited in the Stern Review Report on the Economics of Climate Change (2006), "adaptation is the only response available for the impacts that will occur over the next few decades before mitigation measures can have an effect." Therefore, a plan for how to adapt to these impacts represents an essential component of any climate change response.

To assist Virginia in developing adaptation plans, workgroup members identified planning targets to establish an adaptation framework. These targets for changes in sea level rise, temperature, and weather patterns drove the development of the workgroup's recommendations. After reviewing several sources of information and predictions, the workgroup members decided to use estimates provided in the recent Chesapeake Bay Program Scientific and Technical Advisory Committee (STAC) report, "Climate Change and the Chesapeake Bay: State-of-the-Science Review and Recommendations" (Pyke, *et al*, 2008) because of its regionally-specific nature. The authors of the STAC report reviewed literature and several model runs to identify current projections specifically for the Chesapeake Bay region.

The workgroup recommended that, at a minimum, Virginia should plan for a 3.6°F increase in air and water temperatures, and at least a 2.3 foot rise in sea level. The full range of sea level rise expected throughout the Chesapeake Bay region is estimated to be between 2.3-5.2 feet, with great local variability as a result of subsidence (or land sinking). Air and water temperatures are projected to increase 3.6-10.8° F. Changes in precipitation and weather patterns are more difficult to estimate, although there has been scientific consensus that most of Virginia will experience a slight (0 to 10%) increase in precipitation and an increase in coastal storm intensity (IPCC, 2008; Pyke et al, 2008). While it is unlikely Virginia will see drastic changes in the next few years, advance planning is recommended, given the scale of many adaptation efforts and the risks associated with being unprepared for key impacts (e.g., large scale coastal flooding from sea level rise).

In addition to establishing a basic framework to guide adaptation planning efforts, the workgroup members also used the following strategic principles to guide the development of its recommendations:

- Uncertainties require a risk management approach.
 - Consider both probability and magnitude of the consequences.
 - Lack of complete certainty is not a reason to delay action.
- Maximize proactive (anticipatory) adaptation, minimize reactive adaptation.
- Avoid and minimize maladaptive responses, or a response to one issue that creates a larger problem on another front (e.g. shoreline hardening that destroys wetlands important to buffering storm surge).
 - Seek cost-effective responses such as the conservation of natural systems instead of built solutions where appropriate.
 - Prioritize maintaining resiliency and diversity and connectivity in natural systems.
- Seek economic opportunities in impacts that cannot be prevented or minimized.
- Successful response requires coordination and collaboration among federal, state, local authorities, and the private sector.

Based on these principles, the workgroup recommended that Virginia should establish a program to closely monitor and assess trends in these climate change effects, adjust projections

based on additional data and new scientific findings on climate change, and revise state adaptation policies accordingly. Such monitoring and assessment is critical to avoid either underestimating the impact of climate change and taking insufficient action to adapt to it, or overestimating the impact of climate change and implementing unnecessary or excessive adaptation measures.

The workgroup had several discussions on the need for high resolution elevation data, in order to establish a baseline for planning decisions. Light Detection and Ranging (LiDAR) data is generally recognized as being the standard elevation data for state planning efforts. This data, along with additional processing and application development, provides essential capabilities for states and localities in planning for specific sea level rise scenarios, street level storm surge predictions, identifying critical ‘at risk’ infrastructure, and other planning needs. Workgroup members strongly supported the acquisition of LiDAR data, particularly for within Virginia’s coastal zone.

The workgroup recognized the key role that local governments play in adapting to climate change. Local governments and regional commissions and authorities appear not to have sufficient statutory authorities to implement effective climate change adaptation policies and programs. As an example, local governments currently may not be able to base permitting or zoning decisions on future climate change projections, such as sea level rise. In order for localities to effectively protect human health, the economy and infrastructure, and the ecosystem, localities will have to plan for changing climate conditions and must have requisite authorities, and sufficient funding, to implement those plans.

While the scope and complexity of the climate change challenge will require new ideas, new investments and new approaches, workgroup members noted that Virginia already has a number of strong and effective environmental statutes and programs. Additionally, implementation of many of the adaptation recommendations would complement many of the Commonwealth’s existing goals and commitments, such as those for land conservation and water quality. The workgroup suggested taking full advantage of existing state programs in lieu of creating new state programs. This will require ensuring that existing state programs are appropriately staffed and funded and that their authorities include consideration of climate change impacts.

Impacts to Natural Resources

The Commission heard from several experts regarding projected climate impacts to ecosystems and species. Virginia is likely to see species range shifts (both inside and outside of the state), local extinctions, and habitat loss. Many new exotic or invasive species may move into Virginia. Exotic species are typically opportunists that can readily adapt to a wide range of conditions, and out-compete native species. Another concern is that pest species (e.g., emerald ash borer, gypsy moth, and pine beetles) may flourish under changing conditions and cause much more widespread damage than they are now.

One principle emerging in the workgroup’s study of adaptation responses was that the species and ecosystems most likely to be able to adjust to disturbances or changes in their

environment are those that are healthy and intact to begin with. For this reason, a cornerstone of the workgroup's recommendations to develop adaptation strategies for wildlife and natural habitats was to conserve and enhance Virginia's most viable, important, and resilient lands and waters.

Workgroup members recognized that many important habitats in Virginia would be directly impacted by climate change. These include coastal wetlands that are expected to become "squeezed" between rising sea levels and the built environment. Virginia's freshwater streams and high elevation areas currently offer essential habitat to many species that require cooler conditions. As temperatures increase and precipitation patterns change, these habitats will no longer support the same suite of species they do today. Adaptation planning must address how to maintain important species and habitats in light of changing climate conditions.

Impacts to the Economy

Workgroup members recognized that the economic impacts of climate change will be felt across all sectors of the economy, including military, agriculture, forestry, commercial and recreational fishing, energy, transportation, and tourism. Many of Virginia's largest industries are climate dependent, including agriculture, forestry, and fishing and therefore may be particularly threatened by climate change. Workgroup members recommended a variety of responses to minimize negative impacts, including early efforts to address unavoidable impacts to significantly reduce the overall costs of continued climate change.

Climate change also poses serious and growing threats to Virginia's roads, railways, ports, utility systems and other critical infrastructure. In the coastal zone, existing hazards such as storm surge, coastal flooding and erosion will become more severe because of sea level rise. Across the Commonwealth, an increased frequency of severe storms may produce more frequent and intense flooding and other hazards. Ironically, unstable weather patterns also could produce periods of drought that threaten municipal water supplies. Temperature rise and the threat of more frequent and intense heat waves can seriously impair the functioning of critical infrastructure.

While the challenges posed to Virginia's infrastructure are complex and multifaceted, two complementary approaches provide the best strategy for adapting to these threats. First, the state needs to begin to quantify the extent of the threats to existing infrastructure and develop cost-effective measures to address those threats. Second, the Commonwealth needs to factor likely climate change impacts into its various infrastructure planning processes to ensure that new infrastructure is both located and designed to minimize its vulnerability future threats.

Impacts to Virginia's Citizens

Climate change is likely to have wide-ranging and mostly adverse impacts on human health. Climate change can affect the health of Virginians directly and indirectly. Extreme weather events (e.g., floods, droughts, hurricanes or windstorms, wildfires and heat waves) can directly affect health through injuries, drowning, or mental health problems. These extreme weather events could lead to compromised water and food supplies, resulting in increases in

waterborne and food-borne illnesses. Indirect impacts include disruptions of natural systems that also may make it possible for vector-borne diseases (i.e., arthropod-borne diseases such as West Nile virus, malaria, dengue and Lyme disease) to spread to or emerge in areas where they had been previously limited or non-existent. Climate change also is expected to increase the incidence of diseases associated with air pollutants and aeroallergens and exacerbate other respiratory and cardiovascular conditions. The workgroup also recognized that certain groups of people are more vulnerable to the health impacts of climate change because of their age, socio-economic status, existing health issues, or geographic location.

Sequestration

The workgroup also was charged with examining the role that natural sequestration could play in reducing atmospheric concentrations of carbon dioxide and how protecting or enhancing those sequestration opportunities might complement the Commonwealth's overall climate change strategy. For the purposes of its discussions and subsequent recommendations, the workgroup concentrated only on sequestration through biological processes or by natural systems, such as forests and wetlands.

Virginia's forests, wetlands, farmland, and other undeveloped open space lands play an important role in removing carbon dioxide from the atmosphere. Vegetation on these lands absorbs carbon dioxide during photosynthesis and stores it as carbon within biomass, both above and below ground. Some of this carbon is recycled fairly quickly but millions of tons of carbon are stored for far longer periods in woody biomass and within soils rich with organic material. Recent studies indicate that even very old forests provide a net sink for carbon, meaning that while rates of sequestration differ, all of Virginia's forests likely represent a net sink for carbon emissions.

To date, most research on natural sequestration has focused primarily on forest systems. The Department of Forestry's Forest Inventory Assessment estimates that Virginia's forests sequester approximately 23.5 MMTe (million metric tons equivalent) of carbon dioxide each year. Far less is known about the sequestration capacities of lands such as wetlands and farmlands. In the case of wetlands, the workgroup recommended that Virginia develop a statewide monitoring program to assess the status of this vital resource. Virginia is, on average, currently losing more than 50,000 acres of land to development every year, including roughly 27,000 acres of forestland and 25,000 acres of farmland. When that land is converted to developed uses, its ability to sequester carbon is greatly diminished, if not lost altogether. Thus, unless the current trends in forest, farmland, wetlands, and open space loss in Virginia can be reversed, atmospheric carbon dioxide removed through sequestration will decrease over time, and it will be more difficult for the Commonwealth to meet its emission reductions overall. Many of the workgroup's recommendations addressed the need for increased understanding of the role that natural systems play in sequestering carbon, as well as enhanced protection efforts for these lands to effectively decrease Virginia's greenhouse gas emissions.

Overall Conclusions

The workgroup members recognized there is much work to be done now and in the years ahead. In order to effectively carry out the Climate Action Plan, members observed there should

be a single agency or entity within state government that is positioned to carry the Commission's work forward and unify and coordinate the Commonwealth's response to climate change. Because of this, the workgroup recommended that Virginia establish an Office of Climate Change Response to implement Virginia's Climate Change Action Plan, as well as to help monitor progress toward the recommendations and goals listed within the Plan.

The workgroup did not attempt to catalogue all the adaptation measures that may be required in the years ahead. These recommendations should not be viewed as a comprehensive list; rather, they should be viewed as a starting point for state and local government agencies, boards and commissions, and regional commissions and authorities, to develop detailed adaptation plans.

C. Stakeholder Testimony

During its meeting on August 27, 2008 meeting, the Commission set aside time for representatives of stakeholder organizations to provide recommendations regarding the Commission's charge and deliberations. This was in addition to the public comment periods that were held at each meeting to allow individuals to provide input to the Commission. (The public comment is summarized in the next section.) The Commission heard from energy industry (natural gas and coal), alternative energy representatives, and environmental and wildlife advocates. A brief summary of the stakeholders' testimony is provided in this section.

Energy Industry

Natural gas representatives suggested to the Commission that coal-producing states can reduce carbon dioxide emissions and achieve energy policy goals by helping the coal industry evolve from focusing on production of a single product (coal), to becoming a dual production industry (producing coal and methane). The natural gas industry believes that such an evolution has the benefit of reducing the coal industry's carbon footprint while improving safety, and that the states can help the coal industry become such dual producers by providing economic incentives and/or removing impediments to capturing methane generated from coal mining.

The natural gas industry has consistently promoted the efficiency and low emissions benefits of natural gas, and it has suggested that natural gas should play a significant role in meeting energy demands and supporting a cleaner environment.

Representatives from the coal industry suggested that Virginia enjoys relatively modest electricity costs, which creates an attractive economic environment for Virginia, and suggested that the state's reliance upon coal-based electricity generation is a primary reason that Virginia electricity rates are so modest. It was recommended that the Commission commit to tackling climate challenge with the continued use of coal as a means to provide affordable and reliable electricity by becoming a full partner with industry in funding the cost of carbon capture and storage research.

Alternative Energy

Alternative energy advocates have consistently suggested to the Commission that Virginia should be more aggressive with regard to implementation of renewable energy sources and that the cost competitiveness of renewable energy sources becomes clearer with consideration of the external benefits of clean fuels. Solar advocates also have suggested that there should be funding in the state budget and that there should be implementation of the tax credits for renewable energy already authorized in state law.

Environmental Advocates

Environmental advocates who have appeared before the Commission have consistently urged the panel to adopt a more aggressive GHG-reduction goal and avoid perpetuating the use of fossil fuels and disrupting the transition to alternative energy sources. Most have argued that the Commission should adopt a GHG-reduction goal that is more in keeping with the Intergovernmental Panel on Climate Change recommendations. Emissions-reduction goals, some have suggested, should be expressed in science-based targets and recommendations that would support the development of wind power and put a moratorium on the construction of new coal-fired plants.

Additionally, environmental advocates – organizations and individuals alike – have argued that the Commission heavily emphasize efficiency and renewable energy in its recommendations. Virginia’s potential for biomass has been frequently promoted by environmental advocates, with some suggesting that 20 percent of Virginia’s energy could be provided by biomass feedstock. This figure includes the use of biofuels to meet transportation needs as well as the co-firing of biomass to replace as much as 15 percent of the coal combusted to generate electricity.

Wildlife Advocates

Wildlife advocates have noted that in 2005 the Department of Game and Inland Fisheries (DGIF) completed the Wildlife Action Plan, which identified 925 species moving closer to extirpation from Virginia land and waters. It has been argued that the present and future increase in temperatures, sea level rise, and shifting seasons are likely to increase that number unless management options are identified and actions are taken. Similarly, others have advised the Commission that natural systems are experiencing major changes as a result of climate change and suggested that the Commission recommend that a dedicated source of funding be identified for updating and implementing DGIF’s Wildlife Action Plan.

Agribusiness

Agribusiness and farming representatives have urged the Commission to explore possible partnerships with agribusinesses to be part of the solution to climate change, through carbon sequestration in forestry and cropping systems and capture and remediation of gases from some agricultural systems. The agribusiness industry believes that the need to protect the environment and to limit impacts on the climate must be balanced and solutions avoided that drastically

increase the cost of production and that technology and innovation must play a key role in addressing these issues in order to limit the impacts on Virginia's businesses. It also has been argued by farming advocates that agriculture and forestry may offer solutions to climate issues, such as natural sequestration.

D. Public Comment

Public comments were invited at each of the Commission's meetings. Meetings were held throughout Virginia to allow access to all citizens. More than 125 public statements were given during the hearings, and the Commission is grateful to members of the public who took the time to participate and provide remarks. Public comments addressed many different topics, including electricity generation, energy efficiency, environmental conservation, legislation, and coastal management.

Many speakers commended Commission members for tackling the issue of climate change. Speakers also emphasized the responsibility the Commission has in taking bold action for the sake of future generations. Many speakers, particularly those representing local governments, pointed out that the state has a role for establishing policy but the burden of implementation would fall mostly to localities. Commissioners were asked to be thoughtful of the resources available to those responsible for implementation. Several participants stressed the need for increased education on climate change and expected impacts to ensure that the public would be prepared when asked to make lifestyle changes. Others encouraged the Commission to support federal legislation establishing a cap-and-trade system for emissions and recommended against having Virginia create its own cap-and-trade system.

Several young students appeared before the Commission and made suggestions for actions to increase conservation that would have an immediate positive impact on greenhouse gas emissions. These include eliminating the use of plastic bottles for water, eliminating the use of plastic and paper shopping bags and requiring use of reusable bags, and encouraging drivers to properly inflate tires to reduce fuel consumption.

Citizens, particularly students and representatives from environmental groups requested that Commissioners strive to exceed the stated goal of a 30% reduction in greenhouse gas emissions by 2025. They urged the Commission to be aggressive in its reach to reduce emissions and thereby help mitigate climate change. Several speakers felt that the United States and Virginia should take a leadership role in mitigating greenhouse gas emissions and addressing the impacts of climate change, such as sea level rise.

Some students and representatives from the environmental community discouraged the development of new nuclear energy facilities within the state. Their remarks included concern over the risks of nuclear energy, the relative inexperience of the United States in developing nuclear facilities, and that because nuclear reactors depend on limited uranium supplies, it does not constitute a renewable energy source.

Many people suggested caution when developing recommendations that might increase energy costs and emphasized that electricity should remain affordable and accessible to all who

need it. Several private citizens and representatives from academic institutions and the energy industry recommended pursuing a diverse energy portfolio, including nuclear energy and other forms of alternative energy, to maintain a low cost of electricity for Virginians and reduce emissions. Some recommended a public benefit fund to offset service upgrades for low-income homeowners or to fund new energy programs. Representatives from environmental groups, academic agencies, and private citizens spoke in support of mandating energy efficiency measures to achieve large reductions in greenhouse gas emissions. Changes in land use practices also were addressed by speakers. Several landowners pointed out a need for incentives for landowners to keep their land undeveloped. Incentives would encourage landowners to maintain areas that sequester carbon dioxide or buffer sea level rise in their natural states. Others noted the need for reliable public transportation throughout Virginia that could help decrease automobile emissions.

The Virginia City Hybrid Energy Center brought comments from a number of different groups, including representatives from the energy industry, environmental conservation groups, and local residents. Many local residents praised the plant's potential to add new jobs and tax revenues as well as its reliance on clean coal technologies. Many others expressed concern over increasing air pollution, particularly carbon dioxide emissions, and mountaintop coal extraction methods.

Several citizens expressed skepticism over a link between increasing global temperatures and human activities emitting greenhouse gases. They urged the Commission to consider reports that recent warming trends might be due to normal planetary cycles, not human activities. Other climate change skeptics suggested that the Earth may actually be entering into a cooling period. Many of these speakers still agreed that recommendations to increase energy efficiency and broaden Virginia's energy portfolio made good economic sense, even if they did not agree with the goal to reduce emissions.

Because several of the Commission meetings were hosted by Virginia universities, many students were able to participate. They spoke passionately on the urgent need to address climate change. Students expressed a desire to be actively engaged in developing and implementing recommendations as their generation would almost certainly inherit the consequences. Many students, as well as other speakers, were strong advocates for exploring alternative energy sources, such as solar, wind, bio-diesel, and hydropower, to reduce Virginia's dependence on fossil fuels and provide economic opportunities to Virginians.

APPENDIX A

MEMBERS OF THE GOVERNOR'S COMMISSION ON CLIMATE CHANGE

The Honorable L. Preston Bryant, Jr., Chair
The Honorable Patrick O. Gottschalk, *ex officio*
The Honorable Pierce R. Homer, *ex officio*
Mr. Stephen A. Walz, *ex officio*
Ms. LuAnn Bennett
The Honorable Donald S. Beyer, Jr.
The Honorable Joseph F. Bouchard
The Honorable David Bulova
Mr. Dan Carson Jr.
Christine Chmura, Ph.D.
The Reverend Richard Cizik
The Honorable John Daniel, II
The Honorable R. Creigh Deeds
The Honorable Paul Ferguson
Mr. Robert J. Fledderman
Mr. Stuart Freudberg
Mr. Felix Garcia
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The Honorable Joe T. May
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The Honorable Ron Rordam
Mr. Harrison B. Rue
Jagadish Shukla, Ph.D.
Mr. Bruce Smart
Mr. William A. "Skip" Stiles
Dr. Lydia W. Thomas
Mr. Michael Townes
The Honorable Frank W. Wagner

**GOVERNOR'S COMMISSION ON
CLIMATE CHANGE**

Interim Report

September 10, 2008

**The Honorable L. Preston Bryant, Jr.
Secretary of Natural Resources
Chair, Governor's Commission on Climate Change**

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Governor's Commission on Climate Change
Interim Report
September 10, 2008

I. About This Interim Report

Over the course of five meetings between February and June of 2008, the Governor's Commission on Climate Change received presentations from nearly 40 state and national experts about the impacts of climate change on Virginia's economy and natural resources. The purpose of this interim report is to present what the Commission has heard in the information-gathering phase of its work. The facts and figures and charts and graphs herein are among other information that have been submitted to the Commission in testimony by invited subject-matter experts, as reflected in the Work Plan adopted by the Commission in February 2007.

The Commission's work is ongoing. At the time of this Interim Report's publication, the Commission's four workgroups – Adaptation/Sequestration; Electricity Generation and Other Stationary Sources; Transportation and Land Use; and Built Environment – remain at work. Commission-endorsed findings of fact and recommendations will be made in its Final Report, which is due to be published in December 2008. Therefore, the facts and figures and charts and graphs herein should not be read, at this time, as necessarily having received endorsement by the Commission as a whole.

This interim report may best be thought of as a "status report," seeking only to reflect the Commission's proceedings to date. It does not attempt to draw any conclusions at this time from the information presented, nor does it seek to interpret or validate or dispute any information herein. Last, this Interim Report does not seek to make any recommendations at this time.

Note: This report contains reproductions of PowerPoint slides used in presentations to the Commission. All presentations are available on the Commission's website: www.deq.virginia.gov/info/climatechange.html.

II. Background

The Commission was established as the result of a recommendation contained in the Virginia Energy Plan (VEP). Below is a chronology for the VEP and the Commission:

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| July 1, 2006 | Senate Bill 262, which established an energy policy for the Commonwealth and directed the Department of Mines, Minerals and Energy to prepare a ten-year comprehensive Virginia Energy Plan, became effective. |
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- April 5, 2007 Governor Kaine issued Executive Order 48 (EO 48), which set standards for energy efficiency in state government, and established the position of Senior Advisor to the Governor for Energy Policy as well as the Governor's Energy Policy Advisory Council (GEPAC). The responsibilities of the GEPAC include monitoring the implementation of the VEP.
- September 12, 2007 The Virginia Energy Plan was released. The VEP contained four broad goals, one of which was to reduce greenhouse gas emissions by 30 percent by 2025. The VEP also recommended the creation of a Commission on Climate Change to develop a plan for how to reach the greenhouse gas reduction goal.
- December 21, 2007 Governor Kaine issued Executive Order 59 (EO 59), which established the Governor's Commission on Climate Change, and announced appointments to the Commission.
- February through June, 2008 The Governor's Commission on Climate Change held five day-long meetings around the Commonwealth.
- December 15, 2008 The Commission's final report is due.

EO 59 states the importance of the issue of climate change to Virginia this way:

The Intergovernmental Panel on Climate Change's Fourth Assessment Report stated, with an increased confidence level over previous reports, that most of the observed increase in globally averaged temperatures since the mid-20th century is "very likely due" to the increased anthropogenic greenhouse gas concentrations. Energy consumption is the largest manmade contributor to greenhouse gas emissions. States across the nation are acting to study the effects of climate change and limit their greenhouse gas emissions.

Carbon dioxide emissions rose in Virginia by approximately 34 percent from 1990 to 2004, a rate nearly twice the national average. This increase results, in part, from growth in Virginia's economy and development patterns that have produced sprawl and long commutes. Virginia ranked in the top ten states with a 30 percent increase in gasoline-powered cars during this period.

Over the long term, climate change will affect Virginia's population, wildlife, and economy. The Virginia Institute for Marine Science estimates that the mid-Atlantic sea-level will rise between four and twelve inches by 2030, threatening coastal islands and low-lying areas. Air and sea temperature changes would cause more frequent tropical storms with increased damage to Virginia communities. The Chesapeake Bay is particularly susceptible to damage caused by climate change. Changing rain and temperature patterns would disrupt agriculture and forestry.

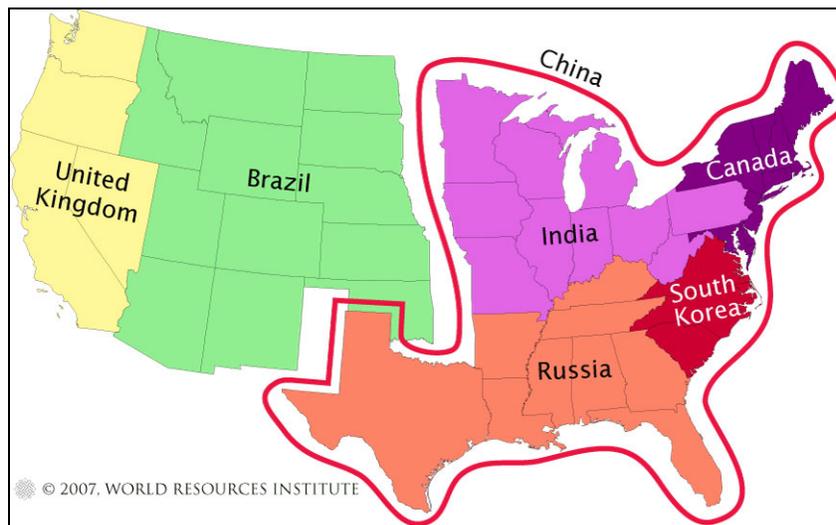
In response to these conditions, EO 59 calls on the Commission to:

- Inventory the amount of and contributors to Virginia’s greenhouse gas emissions, including emissions projections through 2025;
- Evaluate the expected impacts of climate change on Virginia’s citizens, natural resources and economy;
- Identify climate change approaches being pursued by other states, regions and the federal government;
- Identify what Virginia needs to do to prepare for the likely consequences of climate change; and
- Identify any actions (beyond those identified in the VEP) that need to be taken to achieve the 30 percent greenhouse gas reduction goal.

A. Governor Kaine’s Charge to the Commission

At the Commission’s introductory meeting, Governor Kaine pointed out that no environmental issue has captured the attention of the nation and world like global climate change. Americans have moved far in recent years in recognizing the science of climate change. Gone are the days when people are debating whether the phenomenon exists, and there is significant motivation and increasing momentum at the state level to address climate change.

The Governor told the Commission that he favors the development of a federal approach to addressing climate change, but because Congress has been slow to act and because the impact of climate change on Virginia is likely to be significant, the Commonwealth cannot wait for the federal government. It is important to recognize that actions taken at the state level can make a considerable difference. For example, according to the World Resources Institute, the greenhouse gas (GHG) emissions of the three states of Virginia, North Carolina, and South Carolina taken together equal the emissions of the Republic of South Korea.



Adapting to the effects of climate change also will be important, as some of those effects will occur even if efforts to reduce emissions are successful. Virginia has 112 miles of coastline and 3,300 miles of tidal shoreline, all of which could be affected by sea level rise. The Governor asked the Commission to seek information on possible effects of climate change on Virginia's forests, wetlands, wildlife, fisheries, military installations, and ports. He also asked the Commission to learn how climate change will affect agriculture, utility costs, the insurance industry, transportation infrastructure, and the way we think about emergency preparedness.

B. Commission Work Plan

The Commission adopted a work plan at its first meeting that listed the topics to be covered at each of eight meetings, several of which were to be held at universities around the Commonwealth. The Commission agreed that each meeting should include a roundtable discussion among Commission members and an opportunity for public comment. Because climate change is such a complex issue and the Commission's charge is substantial, at least four of the meetings were planned to last for an entire day. The sixth meeting was planned to include a public hearing, to allow citizens who could not attend meetings during work hours to be able to share their thoughts with the Commission. Information regarding the public testimony that has been received by the Commission at its meetings and the public hearing can be found in the meeting minutes posted on the Commission's website: <http://www.deq.virginia.gov/info/climatechange.html>. The Commission also has accepted (via e-mail on its website) public comment without limitation.

The Virginia Energy Plan estimated that if all of the VEP's recommendations regarding energy conservation and efficiency and renewable energy were implemented, that would result in approximately a 15% reduction in GHGs from the business-as-usual case by 2025. Therefore, per EO 59, the Commission planned to focus on how to achieve the remaining 15% reduction.

III. Climate Change Information Presented to the Commission

Commission members all came to the Commission with some knowledge about the phenomenon of global climate change. In order to ensure that everyone on the Commission had the same basic understanding, however, it was important for the Commission to receive information from nearly 40 subject-matter experts on widely-accepted science and policy regarding climate change, its causes, and its impacts. To begin the process, the Commission received a presentation on the proceedings of Intergovernmental Panel on Climate Change. The Commission also received a presentation on nature's role in capturing and storing carbon emissions. The third and final foundational presentation received by the Commission was on sources of greenhouse gas emissions in Virginia.

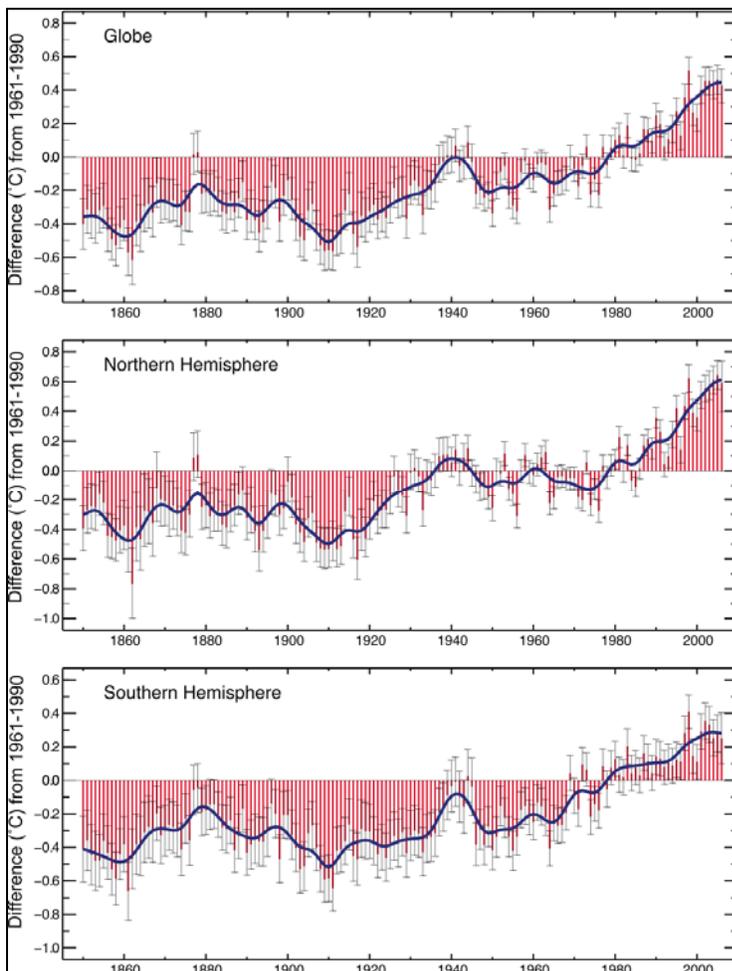
A. Intergovernmental Panel on Climate Change

The work of the Intergovernmental Panel on Climate Change (IPCC) was presented by Mr. Benjamin DeAngelo of the U.S. Environmental Protection Agency (EPA). The IPCC was established by the United Nations (UN) and World Meteorological Organization (WMO) in

1988. It is an international scientific body that is open to all member countries of WMO and the UN Environment Programme. The IPCC produces policy-relevant assessments and reports on climate change, and hundreds of scientists all over the world contribute to its work as authors, contributors, and reviewers.

The IPCC's 4th Assessment Report, issued early in 2008, consists of three working group reports (Working Group I – Physical Science; Working Group II – Impacts, Adaptations, and Vulnerability; Working Group III – Mitigation) and a fourth Synthesis Report. All reports issued by the IPCC undergo a rigorous four-tiered approval process, with the first three tiers each involving an expert review and revision under supervision of review editors, and the fourth and final review consisting of a line-by-line approval by government delegations in a joint plenary session.

The 4th Assessment Report concludes that evidence of global warming is “unequivocal.”



Observed Global Warming

Warming of the climate system is *unequivocal*, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level

Global average warming in the past century is 0.74°C (1.3°F)

U.S. temperatures warmed during the 20th and into the 21st century; temperatures are now approximately 0.56°C (1.0°F) warmer than at the start of the 20th century, with an increased rate of warming over the past 30 years

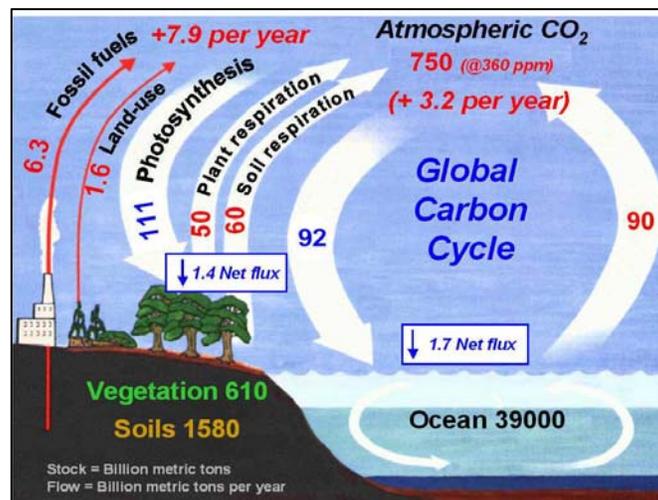
The findings of the 4th Assessment Report, as presented to the Commission, include:

- Global GHG emissions have grown 70% between 1970 and 2004.
- Carbon dioxide (CO₂) accounted for 77% of total worldwide emissions in 2004.

- Atmospheric concentrations of CO₂ and methane (CH₄), both long-lived greenhouse gases, in 2005 far exceeded the natural range over the last 650,000 years.
- The net effect of human activities since 1750 has been of global warming.
- Most of the observed increase in globally averaged temperature since the mid-20th century is very likely due to increase in anthropogenic GHG concentrations.
- Continued GHG emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century that would very likely be larger than those observed during the 20th century.
- All of the U.S. is very likely to warm during this century, and most areas of the U.S. are expected to warm by more than the global average, exceeding 3.6° F by the end of the century.
- An increase in the amount of precipitation is very likely in high latitudes, while decreases are likely in most subtropical regions. Increases are not evenly distributed throughout the year; rather, major rain events followed by extended droughts are expected.

B. The Role of Nature in Storing Carbon

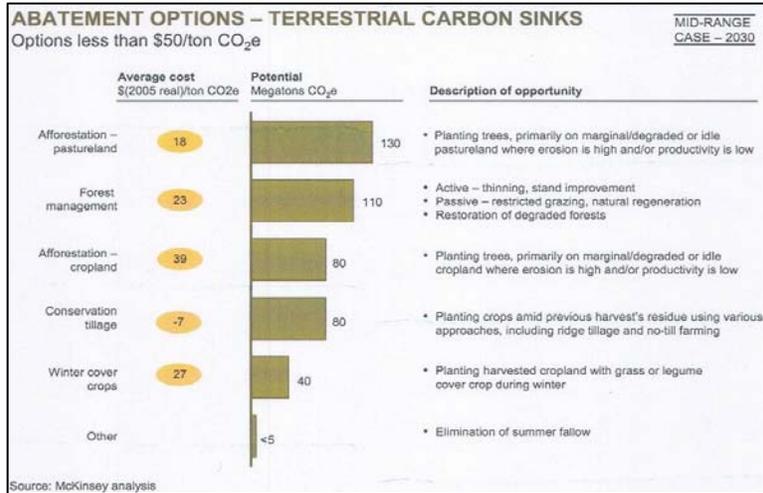
Nature's role in capturing and storing carbon emissions was explained by Mr. Bill Stanley of The Nature Conservancy. Global carbon currently held in vegetation is 610 billion metric tons (BMT); soils hold 1,580 BMT; and the ocean holds 39,000 BMT.



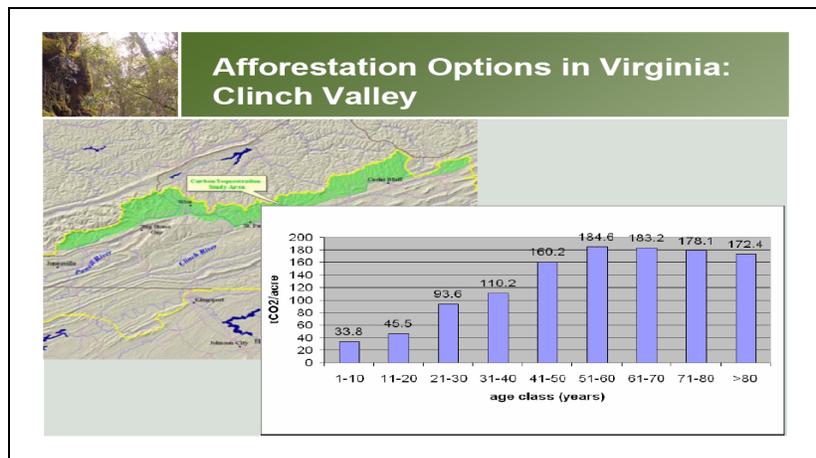
A significant correlation exists between the amount of carbon stored in Earth's different regions and deforestation rates in those regions, which demonstrates that deforestation is negatively impacting carbon retention.

As a way of demonstrating the importance of natural carbon storage, Mr. Stanley presented a list of 12 key climate change mitigation options. These are: stop global deforestation and double reforestations, double vehicle fuel economy, double coal power efficiency, increase wind power by 50 times, increase global ethanol production by 50 times, increase solar power by 700 times, cut vehicle use in half, capture carbon from 3/4 of current coal plant capacity, cut

emissions from buildings and appliances by a quarter, double current nuclear capacity, replace current coal power with natural gas, and adopt conservation tillage for all agriculture. Accomplishing any seven of these twelve options by 2050 would stabilize global GHG concentrations. (GHG emissions are often measured in the aggregate as CO₂ equivalent, or CO₂e). Those options that are focused on increasing the capacity of terrestrial carbon sinks are among the most cost effective ways to abate climate change.



The Nature Conservancy has identified options for afforestation – planting trees on lands that have not been forested for many decades, such as marginal crop or pastureland or abandoned minelands – in Virginia. Two potential sites for such work are the Clinch River Valley in southwest Virginia and the Middle Peninsula and the Northern Neck in the coastal plain. In the Clinch River Valley, The Nature Conservancy is working in partnership with the Virginia Department of Mines, Minerals, and Energy and Virginia Tech, with funding from Dominion, on a pilot project at the Flint Gap Carbon Sequestration Site in Russell County, Virginia. In the coastal plain, The Nature Conservancy worked with U.S. Department of Energy, Mirant Corporation, and the Virginia Department of Forestry to identify over 380,000 acres of lands for possible afforestation efforts. Total carbon sequestration potential of afforestation in the study area, realized over a 100 year timeframe, ranges from 58 to 66 million tons of carbon dioxide equivalent (between 152 to 171 tons per acre).



C. Greenhouse Gas Inventory for Virginia

In order to assist the Commission in its responsibility of providing an inventory of the amount of and contributors to Virginia's GHG emissions, the Department of Environmental Quality has developed an inventory report for the Commonwealth based on energy consumption and other activities within the state and projected emissions in the future through 2025. This report, presented over the course of several meetings by Mr. Tom Ballou, will allow the public to assess the Commonwealth's impact on climate change and the effectiveness for potential mitigation measures. The emissions inventory covers the standard GHG pollutants:

- Carbon Dioxide (CO₂): Carbon dioxide enters the atmosphere through the burning of fossil fuels (oil, natural gas, and coal), solid waste, trees and wood products, and also as a result of other chemical reactions (e.g., manufacture of cement). Carbon dioxide also is removed from the atmosphere (or "sequestered") when it is absorbed by plants, as part of the biological carbon cycle, or the ocean.
- Methane (CH₄): Methane is emitted during the production and transport of coal, natural gas, and oil and combustion of fossil fuels. Methane emissions also result from livestock and other agricultural practices and by the decay of organic waste in municipal solid waste landfills. Methane is a 20 times more potent heat-trapping gas than CO₂.
- Nitrous Oxide (N₂O): Nitrous oxide is emitted during agricultural and industrial activities, as well as during combustion of fossil fuels and solid waste.
- Fluorinated Gases: Hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride are synthetic, powerful greenhouse gases that are emitted from a variety of industrial processes. Fluorinated gases are sometimes used as substitutes for ozone-depleting substances (i.e., CFCs, HCFCs, and halons). These gases are typically emitted in smaller quantities, but because they are potent greenhouse gases, they are sometimes referred to as High Global Warming Potential gases ("High GWP gases").

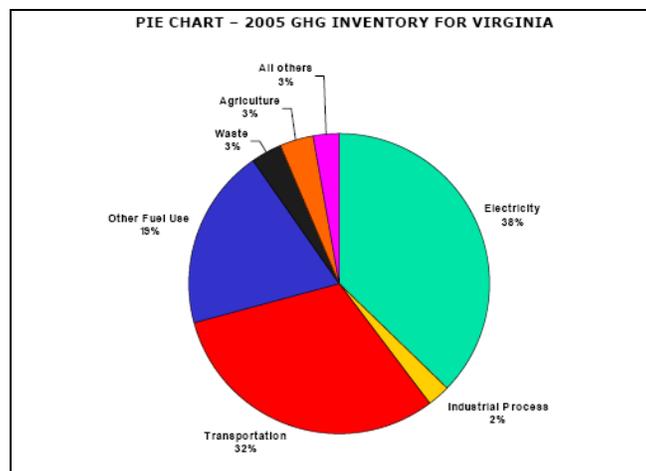
The GHG inventory has been developed using methodologies and models provided by the EPA and includes estimates for each year during the period from 2000 to 2025. For 2005 and earlier, emissions are estimated based on available published data. For subsequent years, emissions are projected using historical trends and other available growth information such as expected electricity demand and population growth and known in-state energy development projects.

Emissions from highway vehicles were developed using the EPA Mobile Source Emission Factor Model (MOBILE 6.2.03) based on likely vehicle traffic activity provided by the Virginia Department of Transportation (VDOT). Emissions from non-highway transportation uses were estimated based on fuels consumption. The report includes emissions generated within the state as well as those generated outside the state due to imported electricity consumed within the state.

The inventory identifies several source sectors that contribute to statewide GHG emissions. For example, the 2005 GHG inventory estimates a total of 175 million metric tons of carbon dioxide equivalent (MMte) emissions from the following sources:

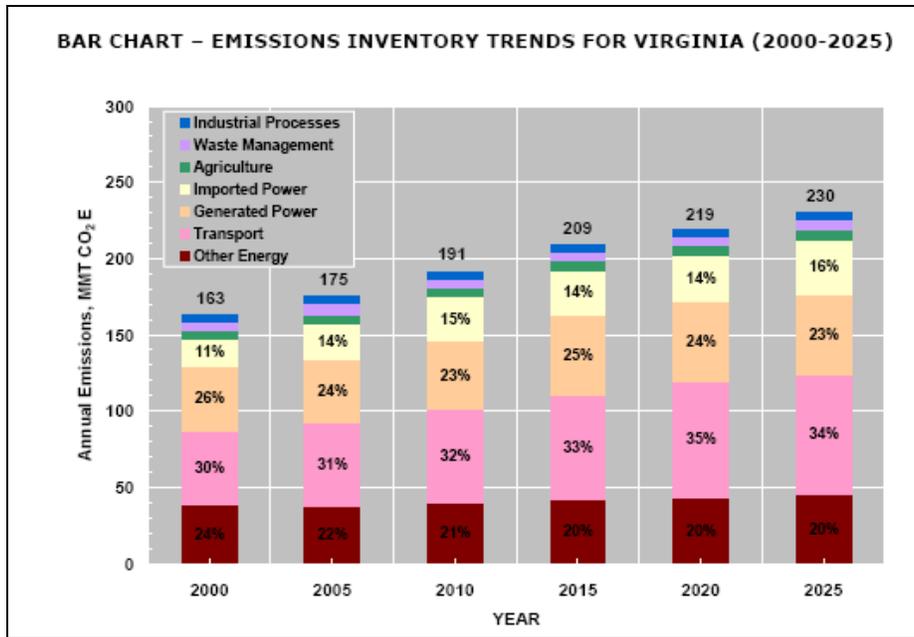
- Electricity: Mainly CO₂ emissions from the combustion of fossil fuels to generate electricity. This sector also includes electricity consumed in Virginia that is generated from outside sources.
- Transportation: Mainly CO₂ emissions from the combustion of fossil fuels such as gasoline and diesel by motor vehicles. This sector also includes emissions from other mobile sources such as aircraft, construction equipment, and ships.
- Other Fuel Use: Mainly CO₂ emissions from the combustion of fossil fuel at non-utility stationary sources (industrial, commercial, and residential).
- Waste Management: Mainly methane emissions from landfills and water treatment facilities.
- Agriculture: Methane and nitrous oxide emissions from various farming activities.
- Industrial processes: Process (non-fuel combustion) emissions of CO₂, nitrous oxide, and fluorinated gases at industrial facilities.

These six sectors were responsible for 97% of all GHG emissions attributable to Virginia in 2005.



A preliminary estimate of carbon removal resulting from natural sequestration also has been developed but has not yet been factored into the overall inventory estimate due to the current uncertainty and confidence in the estimate. This estimate will be evaluated further so that it can be included in the final inventory through a net emissions inventory calculation.

Looking to the future, projection inventories that reflect a “business as usual” (BAU) scenario have been developed for each year out to 2025. Based on the growth projections for key indicators such as population, electricity demand, and vehicle travel, it is expected that Virginia’s GHG emissions will grow by 31% to 230 MMte in 2025. This growth assumption includes an estimate of 3,641 megawatts of new in-state generation capacity from new generation projects. It also includes a significant increase in the need for imported electricity.



As a result of these future BAU estimates, the goal of a 30% reduction by 2025 equates to a mass emission reduction target of 69 MMtE. A 69 MMtE reduction would bring GHG emissions levels back to 161 MMtE, which is close to 2000 levels.

IV. Impacts of Climate Change on Virginia

A. Impacts on Natural Systems and Public Health

The Commission received several presentations on the impact of climate change on Virginia’s natural systems. These presentations enabled the Commission learn about effects on terrestrial ecosystems, fisheries, and wildlife; the Chesapeake Bay; and other coastal and marine resources. The impact of climate change on public health also was of keen interest to the Commission.

Information regarding the effects a warming climate will have on Virginia’s terrestrial ecosystems and the role of Virginia’s terrestrial ecosystems in context of the global carbon cycle was presented by H. H. Shugart, Ph.D., of the University of Virginia’s Department of Environmental Sciences. According to Dr. Shugart, the Commonwealth is facing a climate change that is equivalent in magnitude to the end of the last ice age. Some ecosystems are more vulnerable than others, but no ecosystems are immune.

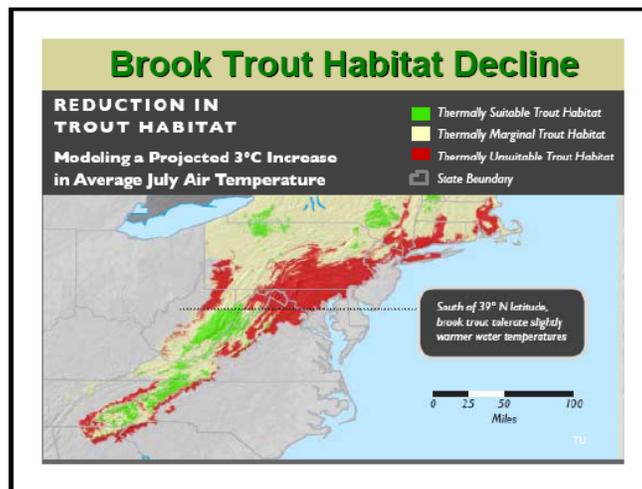
According to Dr. Shugart, current climate models predict that Virginia’s average temperatures are expected to rise by 3° C and precipitation is likely to increase between 0% and 10%. This will impact both agricultural lands and native ecosystems. It is most likely that agricultural production (such as corn) will decline as the climate warms, but specific predictions are unreliable due to the confounding effects of economic systems that can influence the success or failure of crop production and distribution. Several vegetation models, which evaluate forest

responses to climate change, predict that plant species are likely to move from current locations to higher altitudes and higher latitudes. As such, according to Dr. Shugart, Virginians should expect “significant changes to Virginia’s forests and other ecosystems,” and these changes will result in equally significant changes in the forestry sector of Virginia’s economy. Some ecosystems that already occur at high elevations or which occupy narrow geographic ranges may be extirpated completely. When driven by a continuously warming climate, forests are expected to have “a delayed then abrupt” response where many trees die quickly. Once forests have died, it will be difficult, if not impossible, to replace them.

Doug Inkley, Ph.D., Senior Scientist with the National Wildlife Federation, spoke about the impacts the warming climate is having on fisheries and wildlife resources in the United States and Virginia.

The U.S. Fish and Wildlife Service maintains 127 National Wildlife Refuges in the Southeastern United States which provide habitat to hundreds of game and nongame species. Climate models indicate that, as the climate warms, as many as 78% of these areas will cease to provide the types and amounts of habitats they were created to provide.

Dr. Inkley also drew attention to Virginia’s viable and valuable brook trout fisheries. However, these fish are vulnerable to rising water temperatures. The brook trout’s body functions are impaired when water temperature exceeds 70° F, and water temperatures above 75° F are lethal. Climate models indicate that 40% to 100% of Virginia’s brook trout habitat could be lost by 2090. As the climate warms, any remaining populations will be restricted to isolated high elevation streams. These isolated populations will need to be intensively managed if this popular game fish is to persist in Virginia.

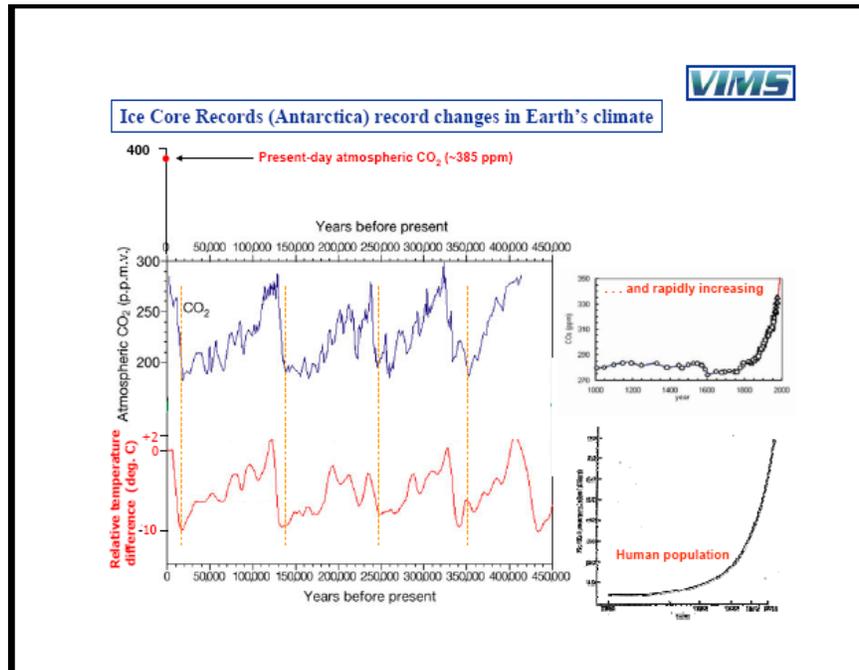


Climate change also has reduced the number and variety of waterfowl that spend winters on the Chesapeake Bay. Rising sea levels, according to Dr. Inkley, will reduce the size and quality of winter habitats currently provided by the Chesapeake Bay. Reductions in hunting opportunity could have significant social and economic ramifications for local communities.

Dr. Inkley believes that for Virginia’s wildlife resources to be conserved for future generations, Virginians must reduce the pollutants that cause global warming; manage resources to maintain healthy, connected, and genetically diverse wildlife populations; reduce non-climate stressors such as pollution and invasive species, which either kill wildlife or degrade wildlife habitats; and protect and restore native habitats. The National Wildlife Federation is concerned that none of these conservation efforts may be achievable unless new sources of conservation funding are created.

Impacts to the Chesapeake Bay region were addressed by James E. Bauer, Ph.D., Professor of Marine Science at the Virginia Institute of Marine Science. Coastal Virginia is one of the most susceptible regions to climate change partly because it experiences some of the highest rates of relative sea level rise of any other region in the country. Virginia also could suffer more impacts of climate change than other states because of its latitude. Virginia currently represents the northern extent for many southern species and the southern extent of many northern species. As the climate changes, Virginia’s coastal ecosystem may be much different than what we see today.

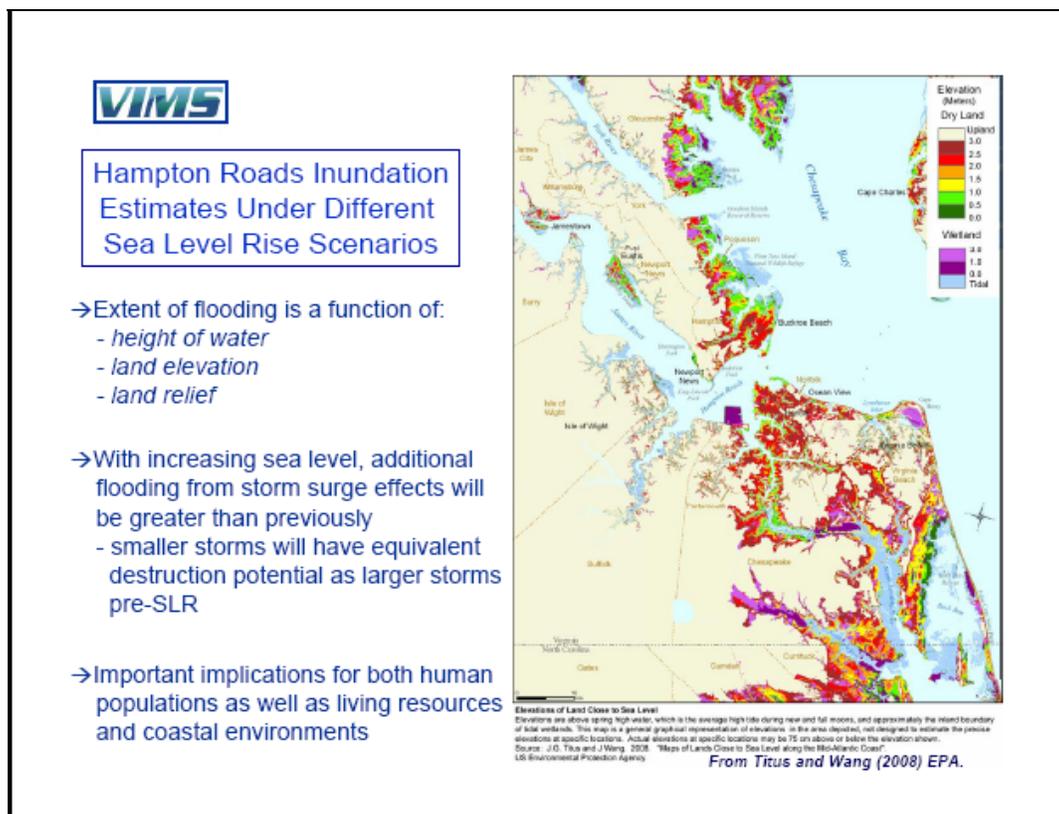
The Earth has seen several climate shifts, along with concomitant shifts in sea level and coastlines throughout time. What is drastically different now is the rate of change. According to ice core records taken in Antarctica, CO₂ levels, temperature, and worldwide populations are strongly correlated.



These records indicate that the highest historical levels of CO₂ on Earth were no greater than 300 parts per million (ppm). Today, atmospheric levels of CO₂ are ~385 ppm and steadily rising due to human activities. Air and water temperatures are showing increases above long-term averages as well. On average, water temperatures have been increasing ~0.3° C (or 0.6° F) per decade.

Dr. Bauer stated that in Virginia's coastal zone, climate change is likely to have significant impacts on people, infrastructure, and ecosystems. These changes include higher sea levels, increased salinities, increased shoreline erosion and inundation (flooding), and increased nutrient inputs from land into the Chesapeake Bay. Currently, sea level is rising at approximately 3.5 mm/year Bay-wide, with local variation from 2.7 to 4.5 mm/year. Precipitation monitoring programs show a slight increase in the amounts of rainfall in Virginia over the last decade. It is difficult to predict future precipitation patterns for the state, but most models show between a 1% to 10% increase in rainfall. Increasing precipitation can carry more terrestrial material (sediment, nutrients, toxics, etc.) into the Chesapeake Bay and coastal areas, causing increasing issues for the Chesapeake Bay restoration process.

Coastal flooding is a function of water height, adjacent land elevation, and land relief. With rising sea levels, additional flooding from storm surge effects will be greater than have been previously seen, such that smaller storms may have equivalent damage potential as did larger storms prior to increases in sea level. This will affect human populations and living resources along the coastline.

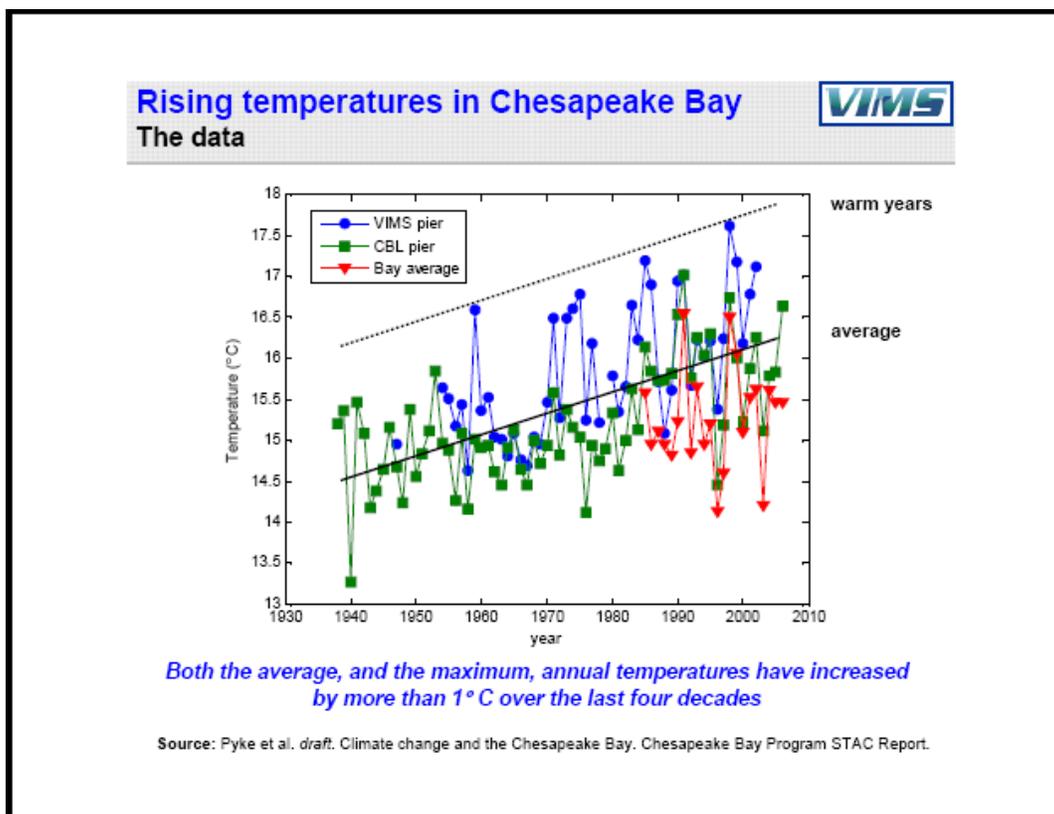


Further, according to Dr. Bauer, oxygen levels in the Chesapeake Bay are expected to decrease due to increasing temperatures (warmer water holds less dissolved oxygen), and increasing stratification due to increased nutrient inputs and temperature increases. This will have negative impacts on Bay species like striped bass, blue crabs, and oysters that require certain levels of dissolved oxygen for survival. Another impact of concern for the Chesapeake

Bay is ocean (and Bay) acidification. As atmospheric CO₂ levels increase, the oceans absorb more CO₂, increasing ocean acidity. In the pre-Industrial era, the oceans had an average pH level around 8.2. Currently ocean pH levels are less than 8.1. Acidification causes problems with shell formation and physiology of many oceanic organisms, like some phytoplankton, shellfish, and corals. Because phytoplankton is a keystone of the Chesapeake Bay food-web, acidification of Chesapeake Bay waters could have severe ramifications for other Bay species.

Further information on impacts to the Chesapeake Bay and its living resources was provided by J. Emmett Duffy, Ph.D., of the Virginia Institute of Marine Science. The Bay's ecosystem and its living resources are already being impacted by increasing water temperatures, sea level rise, and salinity changes. Many "foundation species," such as underwater grass beds, zooplankton, and oyster reefs, could decline or disappear altogether as salinity and temperatures continue to increase. Foundation species support many other species, so these impacts would be felt throughout the ecosystem.

The average and the maximum annual temperatures of the Chesapeake Bay, according to Dr. Duffy, have increased by more than 1° C over the last four decades.



The life cycles of animals and plants are closely tied to temperature cues. For example, many Chesapeake Bay fish are triggered to spawn when water temperatures reach about 15° C in the spring. Since 1960, springtime has advanced by three weeks, causing fish to spawn much earlier in the year. Similar shifts also have been documented in many other types of plants and animals, causing changes to typical predator/prey relationships. One such shift has been

observed in jellyfish within the Bay. Jellyfish have been blooming earlier in the year, consuming zooplankton and potentially depriving later arrivals of juvenile fish of this food source.

According to a National Wildlife Federation report, 50 percent of the nation's annual blue crab harvest comes from the Chesapeake Bay. Warmer winters may extend their growing season and lead to population increases; however, eelgrass, an underwater grass that provides essential refuge habitat for young blue crabs, already has seen marked decreases following slight temperature increases. In 2005, Virginia waters lost about 15,000 acres of eelgrass following a heat wave that increased average water temperatures 2.5-3.0° F, and much of this acreage has yet to return. Because eelgrass, which also is suffering the effects of nutrient pollution, is at its southern extent in the Bay, warming waters may mean that this species could no longer thrive here. Underwater grassbeds are essential habitat and food sources for many fish, shellfish, and waterfowl populations. They also are important because they can offer erosion protection to adjacent shorelines.

Coastal wetlands, a critical habitat for many of the Chesapeake Bay's plants and animals, also are being lost as sea levels rise. Wetlands can migrate upland, assuming there are no impediments and the rate of sea level rise is slow enough. When the rate of sea level rise outpaces the rate of upland migration, wetlands can drown in place. Sea level rise, subsidence, erosion, saltwater intrusion, and grazing by nutria have all led to the loss of approximately 8,000 acres of tidal marsh within Blackwater Wildlife Refuge on Maryland's Eastern Shore since the late 1930s.

The native oyster, another foundation species, could be threatened by climate change. The oyster diseases, MSX and Dermo, thrive in high water temperatures and high salinities. As water temperatures and salinities continue to increase, oysters likely will experience more frequent and intense disease outbreaks. Given the combined pressures of harvest, disease, and already low abundances, the native oyster may cross a "tipping point" from which populations could not recover.

Human health impacts of climate change were addressed by Kristie L. Ebi, Ph.D., M.P.H. The impacts of climate change on human health may be direct or indirect and include increases in heat-related illnesses; injuries, or deaths from extreme weather events; cases and outbreaks of infectious diseases, specifically vector-borne diseases spread by mosquitoes or ticks and rodent-borne diseases; cases of skin cancer; cardio-respiratory diseases and deaths from changes in air quality; cases and outbreaks of waterborne and food-borne diseases; health effects from food and water shortages; and mental, nutritional, and other health effects.

Health impacts, according to Dr. Ebi, depend on and may be mitigated by a number of factors including geography, such as baseline climate; an abundance of natural resources, such as soil and fresh water supplies; biology, such as age, genetics, immunity, or pre-existing medical conditions; and socioeconomic factors that affect an individual's ability to respond or adapt.

The Intergovernmental Panel on Climate Change has noted that health impacts are occurring now and will continue to occur for decades, even after control and reduction of

greenhouse gases. The extent of health impacts over the next few decades will depend on the design and effectiveness of adaptation measures implemented now.

Dr. Ebi believes there is a need to identify and assess health risks associated with climate change, especially vulnerable populations and regions. Assessment should include an understanding of the vulnerability of a population as well as its capacity to respond to new and changing conditions. Those at greatest risk include the urban poor, the elderly, children, traditional societies, and coastal populations. Raising awareness and strengthening health systems to adapt and respond to impacts of climate change will reduce the health risks faced by the Commonwealth and the world.

Effective public health adaptation to climate change includes disease surveillance and monitoring, vector control programs, and public education and outreach to reduce and prevent adverse health outcomes; and early warning systems, coupled with effective response capabilities (e.g., medical training and awareness), to reduce current and future vulnerability.

B. Impacts on the Built Environment and Insurance

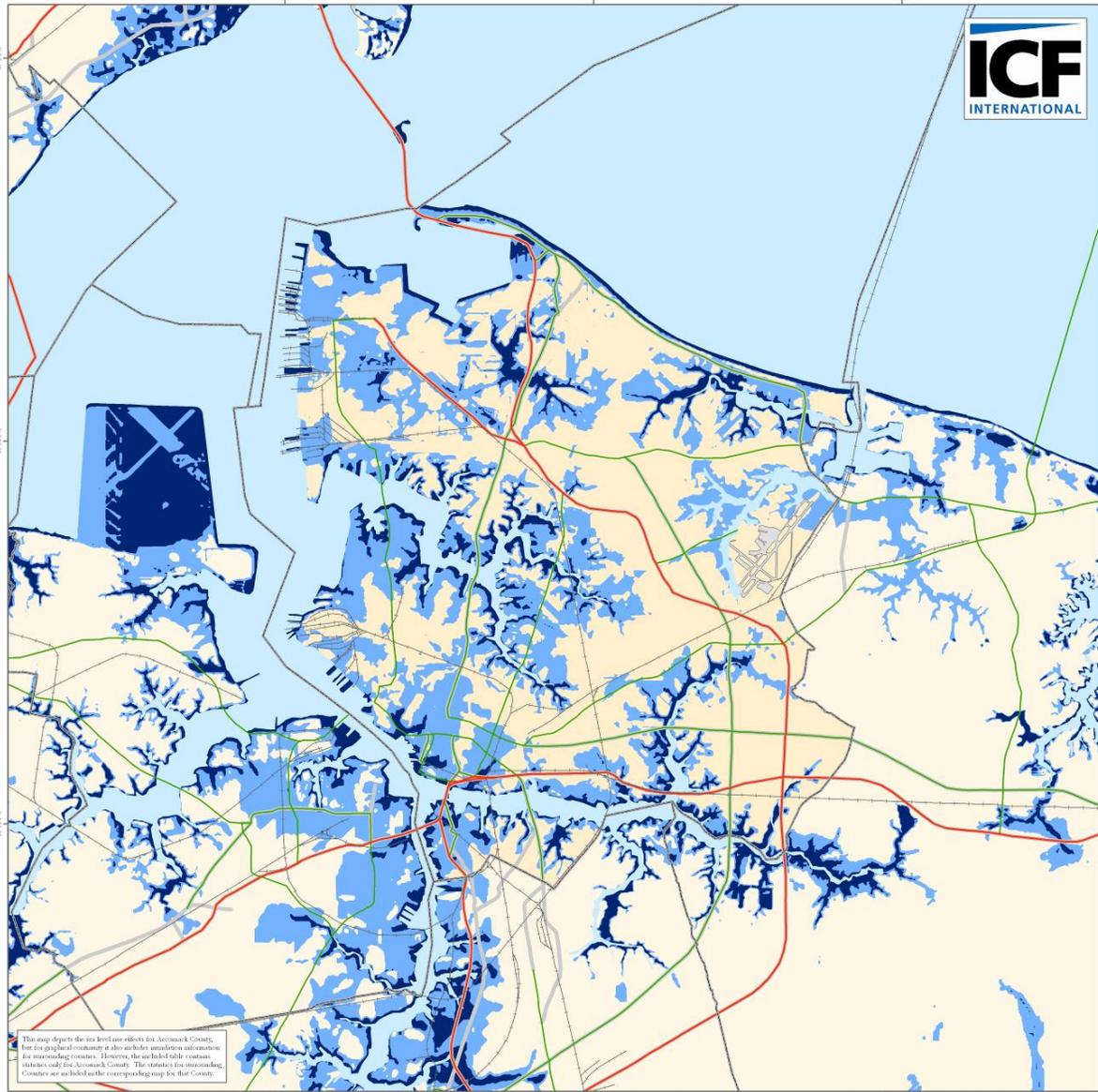
Not only will climate change have effects on Virginia's natural assets, but also buildings and infrastructure will be affected by rising sea levels, severe storms, and other consequences of climate change. The Commission received presentations that addressed projected impacts to transportation infrastructure, military installations, and coastal communities. All of these changes will affect the ability of the insurance industry to help its customers manage risk in an affordable way, so the Commission also heard a presentation on the impact of climate change on insurance.

Recently, ICF International prepared a study for the U.S. Department of Transportation on the potential impacts of global sea level rise on transportation infrastructure. The study, which was presented to the Commission by Mr. Chris Munson, provides estimates of how future climate change, specifically sea level rise and storm surge, could affect transportation infrastructure on the East Coast of the United States. This study explored how the predictions of future global sea level elevations from the United Nations Intergovernmental Panel on Climate Change (IPCC) may affect the coastal transportation infrastructure.

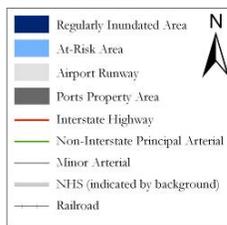
According to Mr. Munson, it is important, for the stability of commerce and the safety of the population, to have a broad picture of the land and infrastructure that may be affected by the change in coastline and resulting periodic flooding. An estimate of the impact must be quantified in order to create a plan to address the potential impacts of sea level rise. The study's major purpose is to aid policy makers by providing estimates of these effects as they relate to roads, rails, airports, and ports. The resulting maps and statistics demonstrate the location and quantity of infrastructure that could be affected under the sea level rise scenarios.

Eustatic Sea
Level Rise: 1 Meter

City of Norfolk, VA
Regularly Inundated Areas, At-Risk Areas and Affected Transportation Infrastructure



This map depicts the sea level rise effects for Accomack County, but its geographic context is also included in addition to the surrounding counties. However, the statistical table contains statistics only for Accomack County. The statistics for surrounding Counties are included in the corresponding map for that County.



| Potentially Impacted Transportation Network Type | Roads (mi) | |
|--|------------|---------|
| | Inundated | At-Risk |
| Interstate Highways | 3.3 | 7.9 |
| Non-Interstate Principal Arterials | 3.0 | 30.4 |
| Minor Arterials | 0.0 | 0.0 |
| National Highway System Features | 5.1 | 25.7 |
| Other Transportation Types (mi) | | |
| Railroads | 5.7 | 30.1 |
| Potentially Impacted Land Area (acres) | | |
| Total Impacted Area | 3,196 | 11,226 |
| Airport Property Area | 0 | 0 |
| Airport Runway Area | 0 | 0 |
| Ports Property Area | 64 | 307 |

Notes:
The methodologies and source data used to generate these maps are discussed in *The Potential Impacts of Global Sea Level Rise on Transportation Infrastructure: Study Goals, Methodologies, and Recommendations*. This report also lists summary statistics for the transportation infrastructure affected according to this analysis. These maps are presented as an overview of areas that, without protection, may be exposed to sea level rise or at risk of periodic inundation due to storm surge, under the methodologies used in this study. These maps are not intended for navigational or engineering purposes, and are meant to provide a rough idea of the areas and transportation facilities that might be affected under the scenarios and methodologies used in this study.
*Eustatic sea level rise refers to the change in sea level caused by any volumetric increase in the oceans worldwide, primarily due to thermal expansion and ice melt.

Sources:
Interstate, Non-Interstate Principal Arterials, Minor Arterials, and NHS - National Highway Planning Network, FHWA - Federal Highway Administration.
Rails - Federal Railroad Administration.
Ports - Digitized from Digital Orthophotos - Quadangles clipped to the mean high water line.
Airport Property and Runways - VDOT Atlas.

Coordinate System: UTM 18 N - North American Datum 1983
1:65,000



ICF20070821KMM002 - 48.5 cm

Another recent study has been completed by the Transportation Research Board (TRB) of the National Academy of Sciences. Released in March of this year, the report was entitled *Potential Impacts of Climate Change on U.S. Transportation* and was described to the Commission by Ms. Nan Humphrey, Senior Staff Officer of the TRB. The primary focus of the

report was on the consequences of climate change for transportation infrastructure and operations. The report identified potential impacts on U.S. transportation and adaptation options and offered recommendations for both research and actions that could be taken to prepare for climate change.

The study's main findings included:

- Climate change will affect transportation primarily through increases in weather and climate extremes. The impacts will vary by mode of transportation and region of the country, but they will be widespread and costly in both human and economic terms and will require significant changes in the planning, design, construction, operation, and maintenance of transportation systems.
- We currently are feeling the results of greenhouse gases that were emitted into the atmosphere over the last 100 years.
- Potentially, the greatest impact will be flooding of coastal roads, railways, transit systems, and runways because of global rising sea levels coupled with storm surges and exacerbated in some locations by land subsidence.
- The Atlantic and Gulf Coasts are particularly vulnerable and seven of the 10 largest ports as well as significant oil and gas production facilities are exposed to disruption and damage.
- The significant costs of redesigning and retrofitting infrastructure to adapt to impacts suggest the need for more strategic risk-based approaches to investment.
- Increases in extreme weather underscore the importance of emergency response plans and the need for better communication.
- In the short term, infrastructure rehabilitation projects in highly vulnerable locations should be rebuilt to higher standards, and greater attention should be paid to the provision of redundant power and communications systems to ensure rapid restoration of transportation services in the event of failure.
- Governments, owners, and operators of transportation infrastructure should incorporate climate change into their long-term capital improvement plans, design, maintenance practice, operations, and emergency response plans.

At its April meeting, the Commission was shown simulations of extensive flooding in the coastal areas, particularly in Norfolk and Hampton, due to sea level rise and storm surges. Such simulation tools provide a dramatic visual picture of the effects of sea level rise and storm-based water flows on land, buildings, and infrastructure.

Expanding the capacity and availability of modeling and simulation tools would provide Virginians with multiple benefits as the Commonwealth looks to manage the impacts of climate change. Sea level increase models are being developed by teams, such as an effort in Virginia by the Virginia Institute of Marine Science, Old Dominion University, and the National Oceanographic and Atmospheric Administration. Additional modeling for emergency management is being completed by Noblis, a non-profit science, technology, and strategy

organization whose clients include both government agencies and private-sector companies. These tools include two-dimensional views. Lockheed Martin is developing three-dimensional modeling using LIDAR (Light Detection and Ranging) data of coastal areas.

The accuracy of these tools can be improved with better land elevation data available from LIDAR and additional research on water flows in Virginia coastal areas during storm events. LIDAR data is available today for only a small part of Virginia.

These tools can help emergency managers predict flooding and plan for actions needed during storms. The tools also can assist with long-term planning of infrastructure improvements. Long-term investments will need to be designed to manage the impacts of long-term sea level rise so that the investments will not be lost. This ranges from coastal infrastructure such as highways, transit, buildings and utilities, to natural areas such as constructed wetlands.

Sea level rise attributable to climate change is caused by two effects, expanding water volume as water temperatures increase and ice melt. Historic records of sea level change show a steady increase of global average sea level of approximately 75 millimeters from the late 19th century through today.

Virginia is at particular risk from sea level rise. The Commonwealth has a much longer coastline than most states with Atlantic, Chesapeake Bay, and tidal river coastal areas. The Hampton Roads region is considered to be the second most populated region at risk from sea level and related storm damage after the New Orleans region. Other populated areas such as Alexandria have seen flooding damage from water inundation and are at greater risk due to sea level rise. Rising sea levels also will affect the availability of fresh water resources in the coastal areas. As the sea level rises, salt water will intrude further into both surface and groundwater sources.

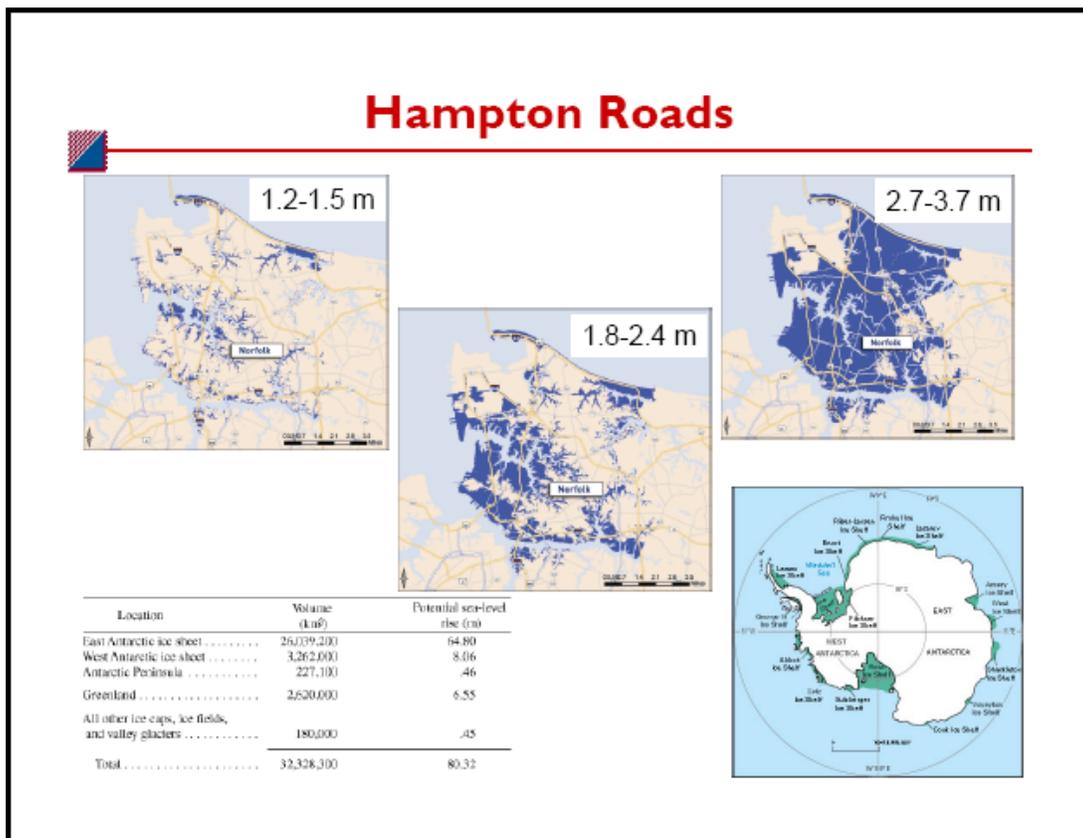
In 2007, CNA Corporation convened a panel of senior military leaders to examine the national security consequences of climate change. The results of that study are reported in *National Security and the Threat of Climate Change*, which was presented to the Commission by Mr. Edward T. (Tom) Morehouse, Jr.

The CNA study concluded that climate change poses a serious threat to national security. The predicted impacts of climate change in coming years include extreme weather events, drought, flooding, sea level rise, retreating glaciers, shifting habitats, and the increased spread of disease. The impacts of climate change provide additional and exacerbating mechanisms for instability and conflict around the world. Projected climate change may threaten already marginal living conditions in some areas causing widespread political instability. Cross-border conflicts may arise as resources, such as clean water, become scarce. The world may experience mass population migrations due to resource shortfalls and land loss (from sea level rise). Additionally, the impacts of climate change have the potential to create sustained natural and humanitarian disasters on a scale far beyond those experienced today. All of these impacts may lead to a number of U.S. agencies, including military forces, having to take on a greater number of more diverse missions around the world.

The impacts of climate change will act as a threat multiplier for instability in some of the most volatile regions of the world. In Africa, climate change will facilitate weakened governance, economic collapse, human migrations, and potential conflicts, which may lead to increased stability operations and human missions for the United States. In the Middle East, water security will be threatened. Two-thirds of the Arab world already depends on water sources external to their borders. Loss of food and water security will increase pressure to emigrate across borders.

Projected climate change will add to tensions even in stable regions of the world. In Europe, tensions may rise as climate change increases immigration from Africa and the Middle East. In Asia, almost 40 percent of Asia’s four billion people live within 45 miles of the coast. Reduced agricultural productivity, threats to water supply, and increased spread of infectious disease will stress the region. In the Western Hemisphere, coastal areas already vulnerable to sea level rise also will face more intense hurricanes. The loss of glaciers will strain water supplies in the Andean regions of South America, and migration to the United States may increase.

Virginia is home to the world’s largest naval station in Norfolk. Thus, the impacts of climate change and its threat to national security will be realized in the Commonwealth as sea level rise affects military installations in and around Hampton Roads and increasing security issues stretch our military resources.



Climate change impacts on insurance were discussed by Ms. Elizabeth Costle, former Vermont Commissioner of Banking, Insurance, Securities and Health Care Administration.

Ms. Costle explained that insurance is a key part of the nation's economy because it keeps risk within reasonable limits so businesses can invest and grow and individuals can recover their losses. Insurers are investors in government, private bonds, business financing, and home mortgages. A survey by Ernst & Young of global leaders on strategic business risk identified climate change as the top insurance risk in 2008. Climate change is a concern to insurers (and the insured) because the predicted increase in the number of severe weather events is likely to result in more claims and because these events are likely to increase catastrophic losses. Because insurers fear that the past may no longer predict the future, the cost of insurance is likely to include a premium for uncertainty.

The potential impacts of climate change on the insurance industry have been illustrated by recent severe weather events. The hurricanes experienced in the United States in 2005 likely cost private insurers \$60-70 billion. Multiple storms in 2004 cost \$22.5 billion. In addition to increasing the number and intensity of hurricanes and severe storms, climate change is expected to increase the number of floods and droughts. Insurers and reinsurers fear occurrence of these multiple events in a single year. The expected impacts of climate change to the insurance industry are far-reaching and go well beyond impacts to property-related insurance and premiums. The increasing potential for climate-related litigation will increase claims against, and affect premiums for, liability and Director & Officer insurance. Health and life insurance claims and premiums also will be affected by expected increasing heat waves, pollution, and vector borne diseases.

In Virginia, homeowner premiums have increased 67.2 percent between 2001 and 2006, compared to a nationwide increase of 46.3%. Based on an analysis by RMS (a catastrophe modeling company), Virginia Beach is the 10th largest coastal city in the world in terms of assets exposed to increased flooding from sea level rise. Future hurricanes could cause more serious damage and future problems with insurance affordability and availability for Virginians.

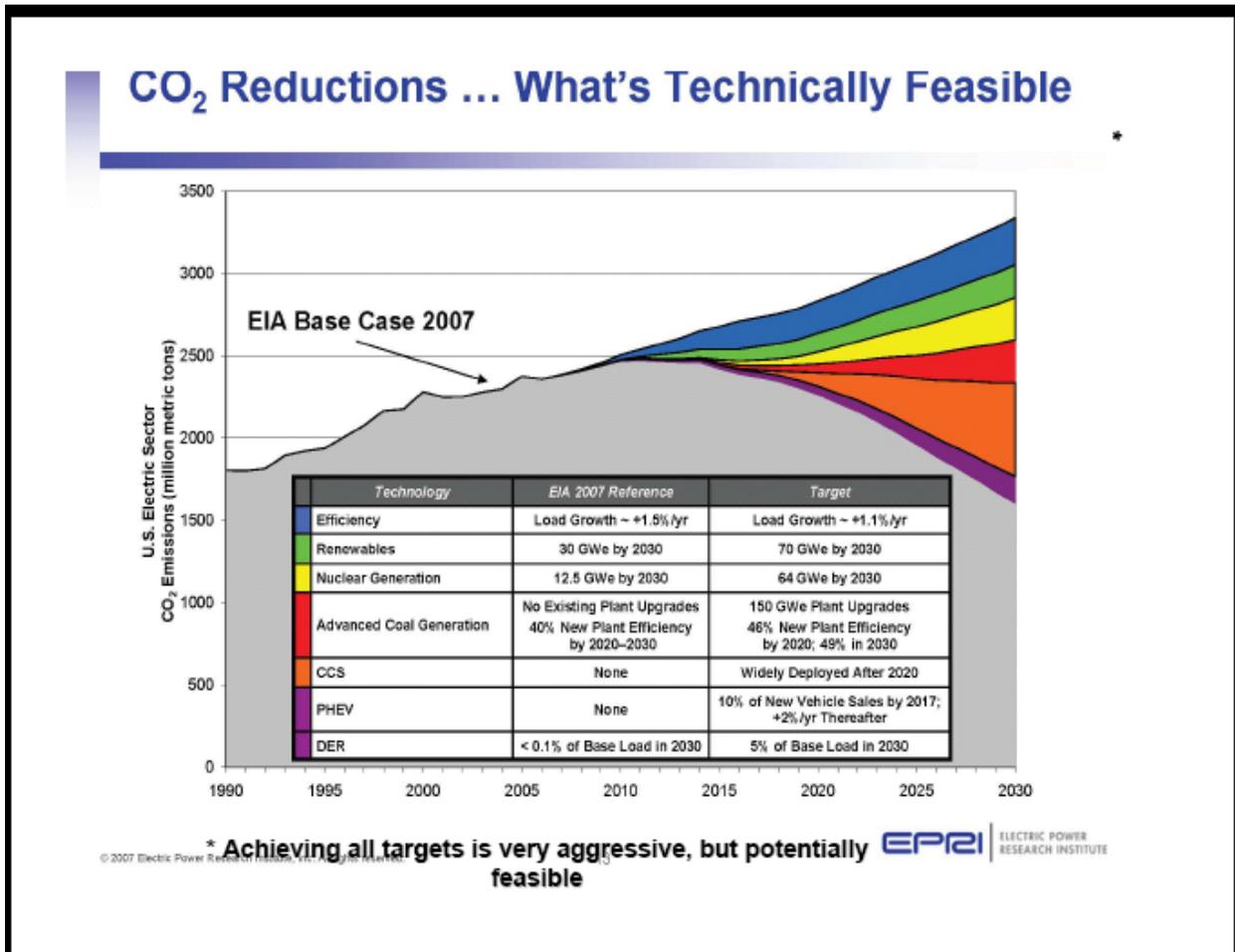
The insurance industry also may provide tools to help mitigate climate change as it looks for opportunities to impact public policy to protect the industry, including pricing to encourage the reduction of GHG emissions. For example, insurers are developing pay-as-you-drive insurance, discounts on green buildings, and discounts and financing for policyholder investments to prevent damage (e.g., hurricane shutters).

C. New Technologies and Economic Opportunities

While most of the impacts of climate change of which the Commission has learned are negative, some opportunities are being brought about as a result of efforts to limit GHG emissions. As the world moves toward a carbon-constrained economy, the need to accelerate the advancement of emerging technologies provides opportunities for researchers, inventors, and investors. The Commission heard presentations on opportunities associated with energy efficiency, green investing, solar energy, algal biofuel, biodiesel, geoengineering, and carbon capture and storage.

Ms. Diane Munns, Executive Director, Retail Energy Services for the Edison Electric Institute, provided information about the potential for energy efficiency to reduce electric use

and indirectly reduce GHG emissions. A study by Edison Electric Institute and the Electric Power Research Institute analyzed potential United States electric efficiency savings between 2008 and 2030. It found that market driven savings should reduce electric consumption by approximately 5% and implementation of advanced energy codes and standards should reduce electric consumption by as much as 15% below the base case consumption estimates without these efforts. The study also found that the “achievable potential electrical savings” of energy efficiency programs, including efforts such as rebates, tax incentives, and innovative rates, is estimated to be 7% of consumption by 2030. An aggressive program could possibly reduce consumption by 11%. These savings strategies would be part of a larger set of wedges used to reduce greenhouse gas emissions.



There may be additional savings from use of smart electronic devices and hyper-efficient technologies. However, these may be offset if consumers use more or greater energy-consuming appliances. Smart electronic devices include smart thermostats, direct energy-cost feedback devices, and next generation lighting such as LED's. Hyper-efficient technologies might include variable refrigerant flow air conditioning, low-energy use data centers, and hyper-efficient appliances. A good example of how these savings may be offset is to look at changes in the television market. A conventional 27-inch television is typically rated at 100 watts. A 42-inch plasma television is rated at 250 watts, 2 ½ times more. Just two 30 watt set-top digital-to-

analog converter boxes at 30 watts each could consume as much energy as an efficient refrigerator.

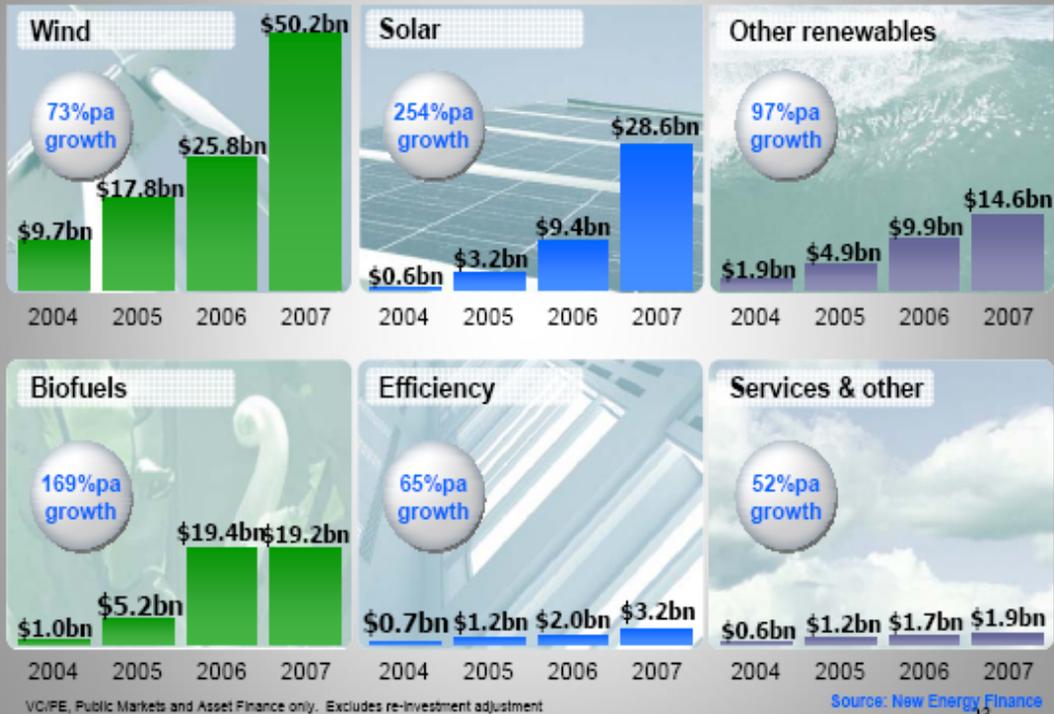
According to Ms. Munns, electric energy efficiency targets will not be reached unless barriers to investment in energy efficiency are addressed. These barriers can be placed in the following categories: market, consumer, public policy, utility, state and regional planning, and program, product and service. Actions to aid in overcoming these barriers include having states and utilities formally recognize energy efficiency as an energy resource; increasing consumer education; adopting and enforcing aggressive building codes and appliance standards; and promoting utility rates that more accurately reflect costs to provide electricity.

Mr. Roger Ballentine, President, Green Strategies, Inc., discussed a number of investment opportunities that are related to the need to abate climate change. According to Mr. Ballentine, the energy marketplace of the future will be defined by two “mega” trends: (i) unprecedented global demand for oil, particularly from China and India, while the supply remains relatively fixed, and (ii) a sustained political response to climate change and security concerns. Investors view the challenges of responding to these trends as investment opportunities. Investors are more likely to be concerned with growth potential in emerging markets than the science or debates surrounding climate change.

Mr. Ballentine cited a recent McKinsey & Company report in stating that approximately half of the available tools to stabilize GHG emissions are already available and can be profitable. These include methods of improving energy efficiency in buildings, appliances, and vehicles and the use of combined heat and power. Many capital investments are now being directed toward developing renewable energy technologies, such as wind power, solar power, geothermal energy, hydropower, biomass energy, and ethanol. Worldwide, clean energy investments have increased rapidly since around 2000. Europe has been a major leader in these expansions, although the United States is making gains. Within the United States, according to Mr. Ballentine, the key issues for expansion of renewable energy sources include government incentives, transmission access, and further research and development to increase performance and reliability. Biofuels, ethanol in particular, have seen particularly rapid increases in the United States since 2000. Ethanol (E85), offers an opportunity for major increases in fuel efficiency. Hybrid engines typically get approximately 50-100 miles per gallon (mpg), whereas hybrid engines using E85 can get between 300-600 mpg.

Total global investments in clean energy between 2004 and 2007 have increased 58-76% annually. The outlook for investment opportunities in renewable energy sectors is good, based on the increasing amount of new investments since 2004.

New Investment by Sector, 2004 - 2007



Venture capital and private equity are moving into the clean energy sector, and public equity funds are growing. Carbon finance also is growing as a result of carbon becoming a commodity of its own. Mr. Ballentine suggested that once there was a price on carbon emissions, market economics would take it from there.

Mr. Travis Bradford of the Prometheus Institute for Sustainable Development and author of *Solar Revolution* provided information on the world photovoltaic (PV) market. Mr. Bradford believes that solar is a powerful driver of world electricity and represents a tremendous business opportunity. PV production reflects a strong annual global growth rate, 50% from 2006 to 2007. Currently, a great deal of PV production is going to Asia (China and Taiwan) and to the U.S. The U.S. growth in PV production is expected to rapidly increase.

US Producers - 2007

| Company | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 06 to 07 Growth | Capacity Y07 | Capacity Y08 |
|-----------------------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|-----------------|--------------|--------------|
| First Solar | - | - | 3.0 | 6.0 | 20.0 | 60.0 | 120.0 | 100% | 135.0 | 150.0 |
| United Solar OXONICS | 3.8 | 4.0 | 7.0 | 14.0 | 22.0 | 28.0 | 48.0 | 71% | 60.0 | 120.0 |
| Solarworld CA (Shell Solar) | 39.0 | 46.5 | 52.0 | 62.0 | 42.0 | 35.0 | 35.0 | 0% | 45.0 | 100.0 |
| BP Solar | 25.2 | 31.0 | 13.4 | 14.2 | 22.6 | 25.6 | 27.7 | 8% | 40.0 | 40.0 |
| Evergreen Solar | - | 1.9 | 2.8 | 6.0 | 14.0 | 13.0 | 16.4 | 26% | 16.0 | 86.0 |
| Schott Solar | 5.0 | 5.0 | 4.0 | 10.0 | 13.0 | 13.0 | 10.0 | -23% | 15.0 | 15.0 |
| Global Solar | - | - | 2.0 | 1.0 | 1.0 | 2.5 | 4.0 | 60% | 5.0 | 40.0 |
| Other | 27.3 | 32.2 | 18.8 | 25.5 | 18.5 | 2.5 | 5.0 | 100% | 2.0 | 65.0 |
| Total | 100.3 | 120.6 | 103.0 | 138.7 | 153.1 | 179.6 | 266.1 | 48% | 318.0 | 616.0 |
| w/o First Solar | | | | | 133.1 | 119.6 | 146.1 | 22% | 183.0 | 466.0 |

All figures in MW-dc of Cells

US production growth almost completely driven by First Solar
- \$2.45 per Watt selling price

Polysilicon shortage pinched majors

Day of Data, Bradford, Page 6



As large manufacturing plants go online in the next few years and PV production increases, costs for average modules are expected to go down from the 2006 average of \$3.75 to an average \$2.20 in 2010.

With respect to policy and state legislation, according to Mr. Bradford, a number of states are enacting policies to increase their solar generation, particularly California at 3,000 megawatts (MWs). Renewable portfolio standards (RPSs) in many states are adding to demand. Federal legislation for solar energy tax credits from the Energy Policy Act of 2005 was the first tax credit in 20 years, although it was only available for two years. Proposed federal legislation (HR 550, S 590) revises and extends these credits for 10 years retroactive to January 1, 2008.

Patrick G. Hatcher, Ph.D., of Old Dominion University (ODU) and Executive Director of the Virginia Coastal Energy Research Consortium (VCERC), discussed work being carried out by ODU and VCERC on biodiesel production from algae. The specific focus on algae-to-diesel is attractive because the quality of oil production from algae is high, reproduction occurs rapidly, the ensuing biodiesel can be coupled with numerous industrial processes, and it is clean-burning. Algae production also does not require agricultural land. Biodiesel produced from algae can be grown on municipal wastewater. The process is carbon-neutral and avoids reliance upon fossil fuels.

Algal biofuel production is attractive for Virginia, according to Dr. Hatcher, because Virginia has plenty of sunshine and has many coastal areas, often choked with algae, that are amenable to locating algal production. Virginia also hosts many federal and state government vehicles, military needs, and high energy demand coastal cities.

VCERC's strategy for production of biodiesel from algal wastewater has led to the development of a "one step process" chemo-reactor to convert algal biomass to liquid biodiesel. A functional small-scale test facility and biofuel chemo-reactor is installed in the Virginia Initiative Plant of the Hampton Roads Sanitation District. At this time, processing costs place this biodiesel at around \$4.00 a gallon, although carbon and nitrogen credits or further reduction in waste disposal costs could offset these costs in the future.

David W. Schnare, Ph.D., of the Center for Environmental Stewardship, Thomas Jefferson Institute for Public Policy, made a presentation to the Commission on geoengineering. Geoengineering is defined as the deliberate, large-scale modification of the Earth's environment. It was the view of Dr. Schnare that geoengineering is at present the only economically competitive technology to offset global warming.

There are five large-scale geoengineering approaches that have been considered to cool the planet to combat global warming effects: whitening 30% of the Earth's surface, shading the Earth with 70 square km (27 square miles) of mirrors; using iron fertilization to sequester carbon in the ocean; shading the Earth with volcano-mimicking aerosols to provide more time to implement reductions; and shading the Earth with whiter clouds by spraying seawater into the atmosphere. Of the five approaches, according to Dr. Schnare, launching stratospheric aerosols (mimicking volcanic eruptions) and whitening clouds (utilizing natural cloud reflectivity) offer the ability to be easily turned off and on.

Mr. Dean Price of Red Birch Energy told the Commission about the Red Birch Country Market biodiesel project, which offers a small closed-loop biodiesel feedstock growth, refinery, and distribution system. The process includes growing canola in Southside Virginia near an interstate truck stop, producing biodiesel from the canola at the nearby small-scale Bassett biodiesel facility, and selling the biodiesel at the Bassett truck stop.

This project encourages farmers to grow canola, a winter crop, and deliver the canola to the Bassett facility. Farmers, in turn, could purchase the biodiesel produced from their canola at the local truck stop. The project goal is to have farmers involved in all the value-added steps of biodiesel production. To make similar projects successful, it is important to identify a strategic location where traffic and population are near compatible farm sites.

Emissions from biodiesel are much cleaner than from #2 petroleum-based diesel. Biodiesel is less toxic and biodegrades quickly. Mr. Price argued that from an economics perspective, local enterprises can significantly stimulate local economies. Canola cultivation has nutrient demands that are similar to that of wheat with the exception that more nitrogen and sulfur are needed. No pesticides, fungicides, or herbicides are used.

Michael E. Karmis, Ph.D., Director of the Virginia Center for Coal and Energy Research at Virginia Tech, made a presentation on carbon capture and storage (CCS), which is a potential mitigation tool for CO₂ capture from large point sources, such as coal-fired power plants, and sequestered underground. Carbon can be stored in unmineable coal seams, depleted oil/natural gas reservoirs, or saline aquifers.

Dr. Karmis' presentation focused on addressing whether CCS technology offers a realistic mitigation approach that Virginia could consider. If this technology can be proven reliable, it could play a substantial role in future carbon reduction policies by reducing carbon emissions from power plants by as much as 90% compared to facilities without CCS. However, the state of the science on exploring CCS options is still in its relative infancy. There are three main steps in the process: capture, transport, and ultimate geologic storage. More research is needed on all steps of the process to better understand the potential for broad application of CCS as a mitigation strategy.

The U.S. Department of Energy and energy industry representatives have developed seven regional carbon sequestration partnerships, including one in the Southeast U.S. that run from Virginia to Texas. These partnerships are beginning pilot CCS projects to research the various phases involved with this technology. Some of this work is slated to occur in the Central Appalachian Basin in Virginia. These pilots are scheduled to run through 2017 or beyond.

Dr. Karmis believes that CCS is essential if the world is to stabilize atmospheric concentrations of GHGs. Commercial deployment of CCS requires large-scale tests to develop, demonstrate and confirm geologic storage. Demonstration of CCS requires significant funding, and Dr. Karmis argued that Central Appalachian states should contribute financial resources to support CCS research and development.

V. Climate Change Approaches Being Pursued by Other Governments

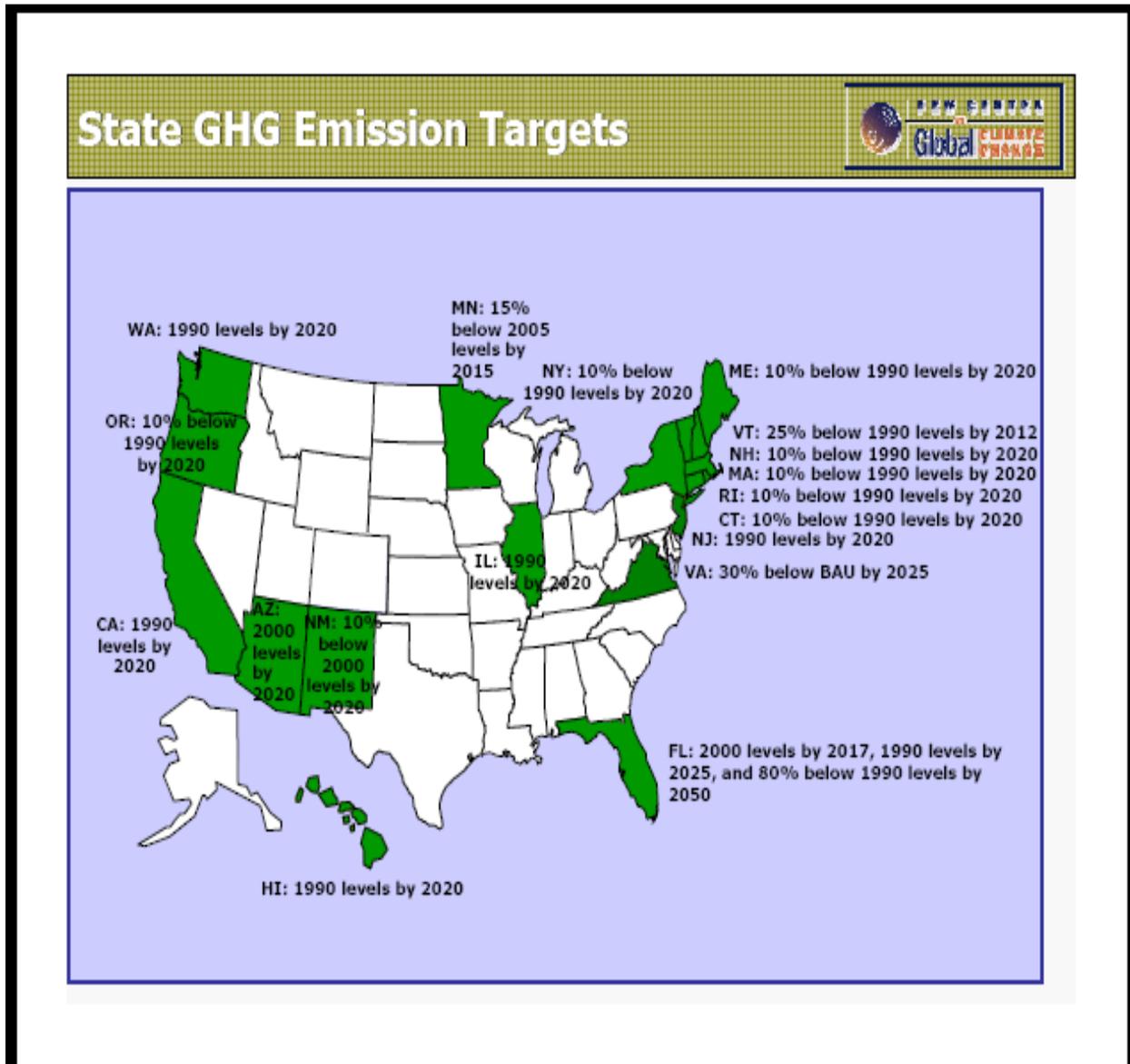
Virginia is not acting alone in seeking ways to reduce greenhouse gas emissions and adapt to climate change. States throughout the nation are preparing climate actions plans, enacting greenhouse gas reduction policies and cooperating in regional efforts. The U.S. Senate has debated one climate change bill, and many other pieces of legislation are currently under consideration in Congress. Many local governments in Virginia and elsewhere are taking actions to conserve energy, increase use of renewable energy and reduce greenhouse gas emissions. The Commission received presentations that provided examples of actions at all levels of government. For comparison purposes, the Commission also heard one presentation on actions being taken in a different part of the world, the European Union.

A. Other States and Regions

Mr. Patrick Hogan with the Pew Center on Global Climate Change provided a summary of state and regional actions that are underway to address climate change. Founded in May 1998, the Pew Center is an independent, non-profit, non-partisan organization that conducts research, engages in education and outreach, and facilitates the Business Environmental

Leadership Council (BELC). The BELC is a business association focused on climate change issues that consists of 42 large corporations (mostly Fortune 500 multinationals that together employ over 3.8 million people). The Pew Center works with these companies to reduce their GHG emissions; develop technologies, products, and services that reduce GHG emissions; and help policymakers design effective policies that also work for business.

Just within the past year (since October 2006), seven states – Washington, Illinois, New Jersey, Minnesota, Hawaii, Florida, and Oregon – have adopted GHG reduction targets. A total of 18 states now have established such targets. This map shows only mid-term targets; most states also have long-term targets:



To date, 37 states have addressed climate change through the development of a climate action plan. Specific information about climate change planning activities underway in mid-Atlantic states was provided by Ms. Paula Jasinski of the National Oceanic and Atmospheric Administration's Chesapeake Bay Office. The mid-Atlantic states of Pennsylvania, Maryland, North Carolina, South Carolina, and Virginia are all taking similar steps in their initial efforts to combat climate change: developing climate action plans; joining The Climate Registry for voluntary greenhouse gas emissions reporting; offering renewable energy portfolio incentives; and establishing building codes that improve energy efficiency.

Pennsylvania is currently focused on developing an energy independence strategy to increase its reliance on domestic energy sources, including renewable energy sources. Mitigation, or strategies to reduce the emission of greenhouse gas emissions, is a significant component of this energy strategy. Although the state has not developed or adopted a climate action plan, the "Climate Change Roadmap" was developed by a non-profit, the Pennsylvania Environmental Council in 2007.

Maryland has recently finalized a Climate Action Plan that includes both mitigation and adaptation strategies. Within the mitigation arena, the Maryland plan proposes that the state adopt legislation to reduce GHG emissions, from 2006 baseline levels, by 25% to 50% by 2020 and 90% by 2050. Other Maryland recommendations include the development of legislation to increase energy efficiency in new development and legislation that would provide enhanced incentives for renewable energy sources. Maryland's draft adaptation strategies largely focus on the projected impacts of sea level rise to its coastline, including mandating regular shoreline condition reports for localities, adopting a unified shoreline management approach across all coastal counties, and increasing public awareness on the impacts expected from climate change and sea level rise.

North Carolina has two complimentary groups addressing climate change planning. One is the North Carolina Legislative Commission on Global Climate Change that was established in 2005. The second is the Climate Action Plan Advisory Group (CAPAG) established in 2006. CAPAG is developing a Climate Action Plan for the state that is due in late summer 2008. Draft recommendations from this report include establishing a Blue Ribbon Commission to address adaptation responses, calling for land development plans that take climate change and natural resource protection into account, and providing financial disincentives for lower efficiency vehicles.

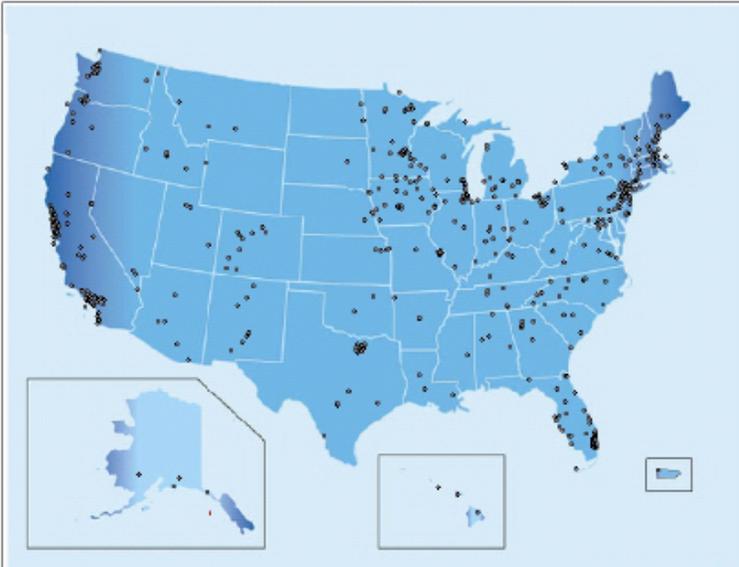
South Carolina released its Climate Action Plan in early June 2008. Recommendations in the plan include encouraging local governments to develop their own climate action plans, establishing a Commission for a Sustainable South Carolina, improving vehicle emissions standards, and increasing in-state production of bio-fuels.

B. Local Governments

Across the United States, many local governments are acting to combat climate change. One coordinated effort is the U.S. Mayors Climate Protection Agreement, under which localities strive to achieve reductions in GHG emissions of seven percent below 1990 levels by 2012.

More than 850 mayors to date across the United States, including nine in Virginia, have signed onto this agreement.

Local Action: Mayors Climate Protection Agreement



- 811 cities have signed on as of March 17, 2008 (representing more than 25% of U.S. population)
- Strive to meet or beat the Kyoto Protocol targets in their own communities (7% below 1990 levels by 2012)
- Urge higher levels of government to enact policies to meet or beat the Kyoto target
- Urge the U.S. Congress to pass bipartisan greenhouse gas reduction legislation establishing a national emission trading system

Source: <http://www.seattle.gov/mayor/climate/>

In Virginia, the Virginia Municipal League (VML), has taken the lead in encouraging local governments to consider actions that can reduce greenhouse gas emissions and save energy. Mr. Jay Fisette, President of VML, made a presentation to the Commission in which he detailed the efforts of the VML's Go Green Initiative, a program largely created to increase awareness among localities regarding climate change. The program launched a website, www.GoGreenVA.org, in February 2008 to provide information resources for local governments, as well as details on the Green Government Challenge. Thus far, 47 localities have registered for the challenge with the incentive of possible VML certification and cash awards for top jurisdictions.

The Green Government Challenge is intended to be a friendly competition between localities that encourages the implementation of 30 policies and practical actions under 11 categories, including government policy adoption, energy efficiency, green buildings, waste management, vehicles, land use and transportation, water and air quality, employee incentives, education and community participation, schools, and innovation. For example, a specific policy under the energy efficiency category is conducting an energy audit of two or more government facilities and implementing at least one recommendation of the audit. For waste management, a specific goal would be establishing a procurement policy for a minimum of 30 percent post-consumer recycled content for everyday paper use. Providing employee benefits for ride sharing, walking, biking, or taking transit to work is an approved practice under employee incentives. For land use and transportation, a locality could adopt a land use or development tool

that preserves open space, farmland, and forests, such as Purchase of Development Rights or Transfer of Development Rights.

Efforts in the City of Roanoke were highlighted in a presentation by Mr. Kenneth Cronin, Director of General Services. Roanoke has joined ICLEI-Local Governments for Sustainability, which is a membership association of local governments committed to advancing climate protection and sustainable development. Roanoke has followed the ICLEI model that identifies five milestones for establishing a green government program, which include: conducting a baseline emissions inventory and forecast (commonly called a “carbon footprint”), adopting an emissions-reduction target for the forecast year, developing a Local Action Plan, implementing policies and procedures and monitoring and verifying results. Roanoke utilizes a software program to determine its carbon footprint. The cost to the city for the software was approximately \$1,600.

Roanoke’s other efforts have included building its first LEED building (a fire station) and implementing a number of practices in its other buildings, including replacing incandescent lights with compact fluorescent lights (CFLs), replacing T12 lamps with T8 lamps in municipal buildings, replacing incandescent traffic lights with compact fluorescent lights (CFLs) and using products that have the EPA/U.S. Department of Energy (DOE) Energy Star rating. The locality is the first in Southwest Virginia to use biodiesel and ethanol.

Roanoke Municipal Measures - Implemented

| Measure | CO ₂ (eq. tons) |
|--|----------------------------|
| 1. Municipal South Building Upgrade | |
| • HVAC upgrade (~50% energy reduction) | -217 |
| • 694 40W T-12 lights changed to 32W T-8 lights (~20% energy reduction) | -135 |
| 2. Eureka Park Recreational Center Boiler Upgrade | |
| • 40-yr old boiler replaced with new, efficient boiler (~10% energy reduction) | -5 |
| 3. Light Bulbs | |
| • 460 - 60 W incandescent light bulbs replaced with 14 W CFL bulbs | -86 |
| • 300 - 90 W exterior halogen lights replaced with 23 W CFL bulbs | -82 |
| 4. Vehicles | |
| • Low-sulfur diesel (LSD) fuel replaced by ultra-low sulfur diesel (ULSD) | |
| • Biodiesel blend increased first to 2% (B-2) and then to 5% (B-5) | -303 |
| • Ford Escape hybrid SUV's purchased to replace standard gasoline sedans | -5 |
| TOTALS | -833 |
| Emission Reduction Relative to 2005 Baseline | -1.5% |





The city also participates in the Safe Route to Schools Program, which is an initiative to educate children about bike safety and increase the use of alternate transportation to school.

As a result of all these efforts, the City of Roanoke has reduced its GHG emissions, its carbon footprint, and its overall energy consumption. The city continues to explore opportunities to do more.

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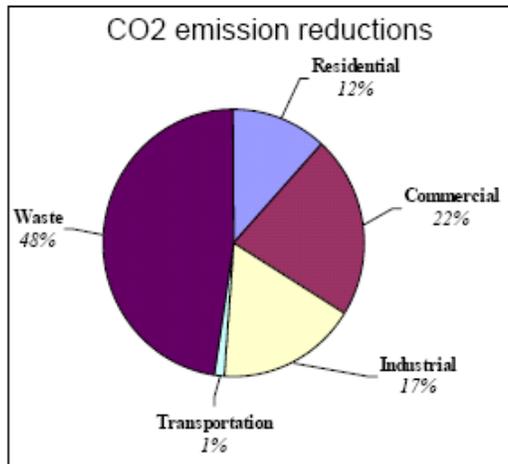




Given that municipal emissions are only a small contributor to a community's overall emissions (1.9% in Roanoke), the city also is working with citizens and businesses to identify initiatives in which everyone can take part. For example, Roanoke has analyzed the following options in the waste, residential, commercial, industrial, and transportation sectors and has found that significant emissions reductions are possible:

- Increase total recycling of municipal solid waste (paper, glass, metal, plastic) by 1% (weight) each year (2008 – 2012).
- Replace one 75 W incandescent bulb with an equivalent 20 W CFL in each Roanoke household each year (2008 – 2012).
- Reduce total commercial and industrial electricity usage by 1% each year (2008 – 2012).
- Replace one automobile trip with one public transportation trip per week for 1% of Roanoke's population each year (2008 – 2012).

Roanoke Potential Measures Results



| Sector | Equiv. CO2 (tons) |
|---------------------|-------------------|
| Residential | -15,656 |
| Commercial | -28,595 |
| Industrial | -22,653 |
| Transportation | - 1,347 |
| Waste | -62,475 |
| TOTALS | - 130,726 |
| Community Total | 2,876,827 |
| 5 yr. Reduction (%) | -4.5% |

- These are simple examples of potential measures that the community could undertake to reduce emissions and energy use - and save money at the same time.
- Further analysis and discussion with city staff is required to determine best use of money and resources (ICLEI steps 3 and 4).

Roanoke City Council also has launched a Clean and Green Campaign to encourage the adoption of such practices in the community. This effort inspired the creation of the Roanoke Business Environmental Leadership Coalition. As a part of the Campaign, some of Roanoke’s largest businesses have said they would calculate their carbon footprint.

Several of the Commission’s members shared information about efforts to combat climate change in their communities.

The Honorable Penelope A. Gross of the Fairfax County Board of Supervisors discussed Fairfax County’s actions to combat climate change, which include: purchasing hybrid vehicles; entering into a three-year wind energy contract; establishing a transit program that includes providing subsidies for mass transit systems and supporting metro-check and teleworking; being a leader in tree planting and tree preservation; developing green building policies; retrofitting municipal lighting; and investigating means by which to transition the largest school bus fleet in the country to a greener system. Ms. Gross emphasized that for many actions like these, local government is “where the action is.”

Mr. Stuart Freudberg reviewed highlights of the Metropolitan Washington Council of Governments (COG) Climate Change Initiative. The COG Climate Change Initiative began a year ago and established best practices, a greenhouse gas emissions inventory and forecast, regional reduction goals, advocacy positions, and a number of recommended actions. COG’s business as usual (BAU) projections of regional greenhouse gas emissions are expected to reflect a 43 percent increase by 2050. Using 2005 as the baseline, COG’s goals include a 10 percent reduction below BAU by 2012 (back to 2005 levels), 20 percent below 2005 BAU levels by

2020, and 80% below 2005 BAU by 2050. To achieve particularly the shorter-term goals, actions must be taken by individuals and businesses; utilization of new technology will be essential for meeting the 2050 goal. COG is supporting a 20% renewable portfolio standard and a commitment by local governments to reduce its energy use by 15 percent by 2012. The draft report contains a number of other initiatives in the areas of energy efficiency and conservation, transportation and land use, and outreach and education. COG plans to partner with George Mason University on an outreach program and to establish a permanent climate and energy policy committee. The report is now circulating for COG-member, stakeholder, and public review through September 30, 2008.

Finally, the Honorable Ron Rordam, Mayor of the Town of Blacksburg, discussed what is being done in Blacksburg and referred Commission members to the Public Works webpage found under the Government tab on www.Blacksburg.gov/. Mayor Rordam posed a series of questions: How do we encourage in-fill and transportation efficiencies? How do we encourage reducing vehicle miles traveled? How do we bring developers on board to plan for workforce housing that is close to town? To address these concerns, the Blacksburg Planning Commission is coordinating zoning efforts in localities in the New River Valley to encourage green development. Blacksburg also is endeavoring to get the community involved by devising Sustainable Blacksburg, which is comprised of the Town of Blacksburg, representatives from Virginia Tech, and community leaders. Each year, Sustainable Blacksburg sponsors a week-long program that offers educational opportunities and discussions.

C. Federal Approaches

Information regarding the U.S. government's current approach to climate change was provided by representatives of the U.S. Environmental Protection Agency (EPA). Pending federal legislation was discussed by staff from the office of Senator John Warner and by Representative Rick Boucher. An analysis of the economic impacts of federal legislation that would cap GHG emissions was presented by the Environmental Defense Fund. (The next section of this report also contains views on economic impacts presented by Mr. Paul Loeffelman and Mr. Keith McCoy, which were included in presentations they made as representatives of private industry.)

1. Current Approach

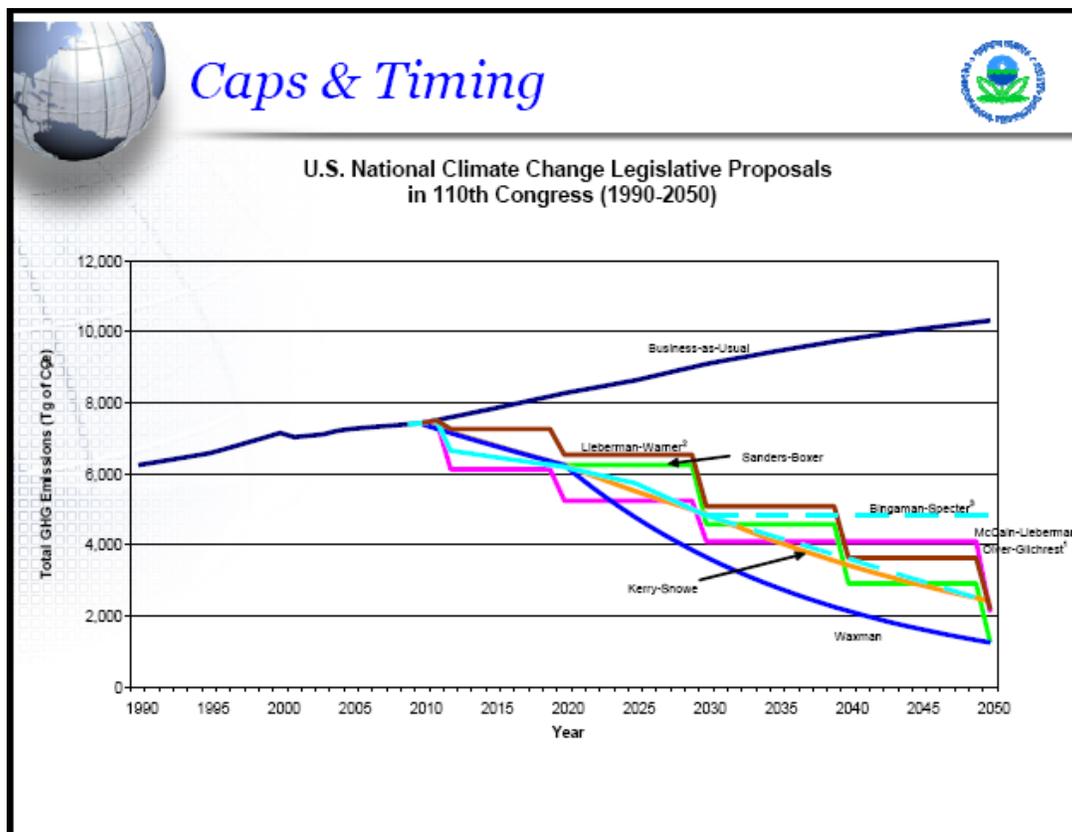
Mr. Bill Irving and Ms. Rebecca White of EPA's Office of Air and Radiation made a presentation to the Commission on U.S. Climate Policy and Programs. According to Mr. Irving and Ms. White, federal policy relating to climate change has focused on slowing the growth of emissions, strengthening science, technology and institutions, and enhancing international cooperation. The United States has a national goal to reduce the GHG intensity of the American economy by 18 percent over the 10-year period from 2002-2012. To achieve this goal, the federal government has tried to promote near-term opportunities, through voluntary programs and partnerships, to conserve fossil fuel, recover methane, and sequester carbon. Programs like EPA's Climate Leaders and Methane Outreach programs, DOE's Climate VISION program and the EPA/DOE Energy Star program, are designed to promote these near-term reductions.

Federal policy also is intended to encourage the adoption of existing technologies, energy efficiency improvements and renewable resources to reduce emissions cost-effectively. In the longer term, development and deployment of breakthrough technologies, through the Climate Change Technology Program and the Climate Change Science Program, are expected to provide safe and reliable energy to fuel the United States economy with reduced or no GHG emissions. Other administration activities include EPA's proposed rulemaking for geologic sequestration of CO₂ and the SmartWay Transport Partnership, a collaboration with the freight industry to increase energy efficiency while reducing GHG emissions and air pollution.

As part of its Omnibus FY 2008 Appropriations Bill, Congress has mandated that EPA implement a mandatory GHG reporting program for all sectors of the economy. Congress also passed the Energy Independence and Security Act of 2007, which establishes new fuel economy standards and requires fuel producers to supply at least 36 billion gallons of renewable fuel by 2022. Congress also has required EPA to conduct a lifecycle GHG analysis, including indirect land-use changes of various fuels, including evaluation of the implications of growing increased amounts of food grains for ethanol production.

2. Proposed Legislation

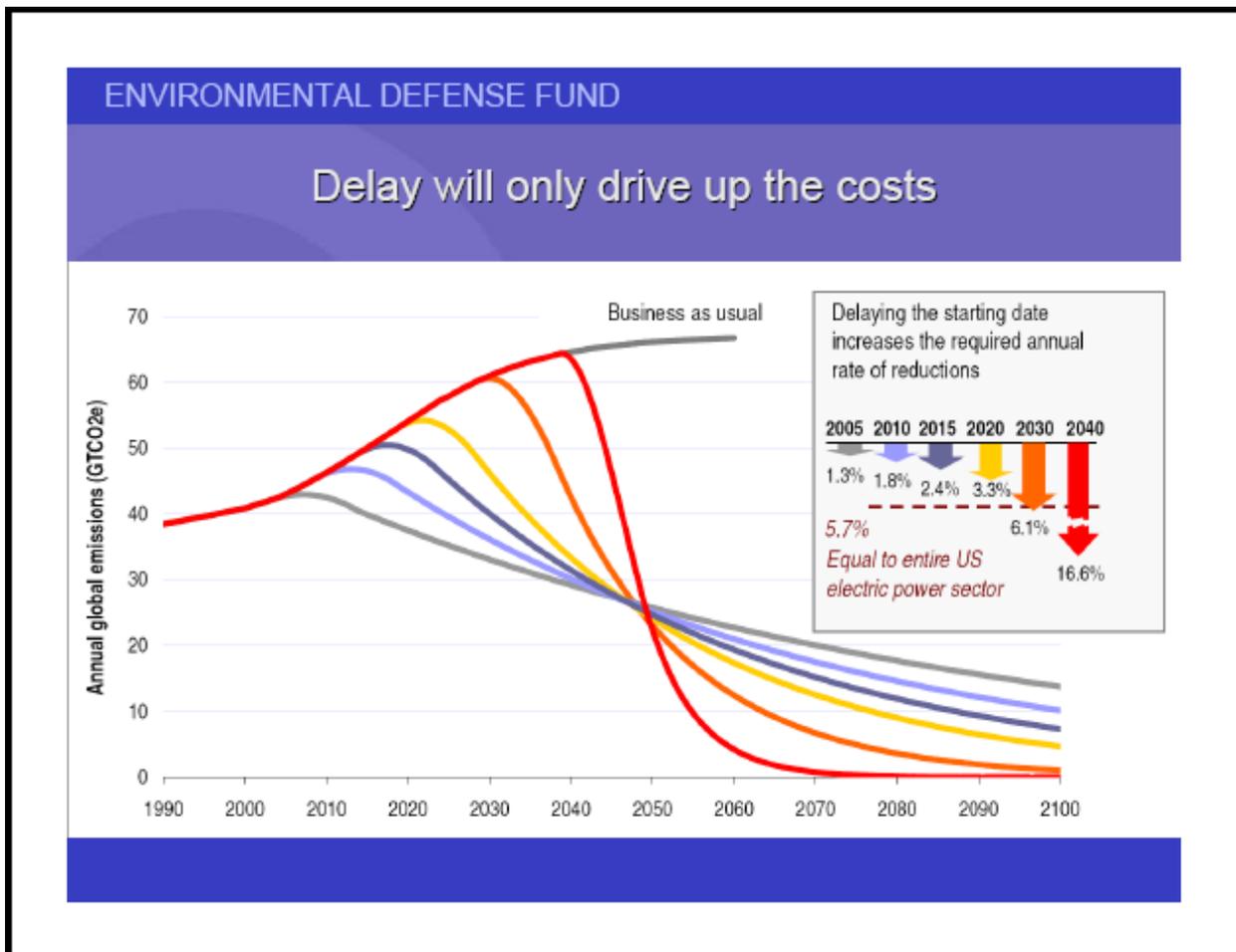
EPA has performed analyses of all of the GHG reduction legislation that has been introduced in the 110th Congress and provides the following depiction of the reductions that would be achieved by each bill:



Carter Cornick, Chief of Staff, and Chelsea Maxwell, Senior Policy Advisor, in the Office of U.S. Senator John Warner provided an update on congressional action at the Commission's May meeting. The Climate Security Act, legislation sponsored by Senators Warner and Lieberman, is the first climate change bill to have emerged from a committee to the Senate floor. Subsequent to the presentation made at the May meeting, the Warner-Lieberman bill was debated in the Senate for several days, but a final vote was not taken.

Congressman Rick Boucher spoke to the Commission at its June meeting. Congressman Boucher cautioned the Commission not to take the defeat of Senator Warner's bill as an indication that Congress will not act on climate change. He predicted that there is an 80% chance that a cap-and-trade bill will pass Congress in the next two years, and a 100% chance that a bill will pass in the next four years.

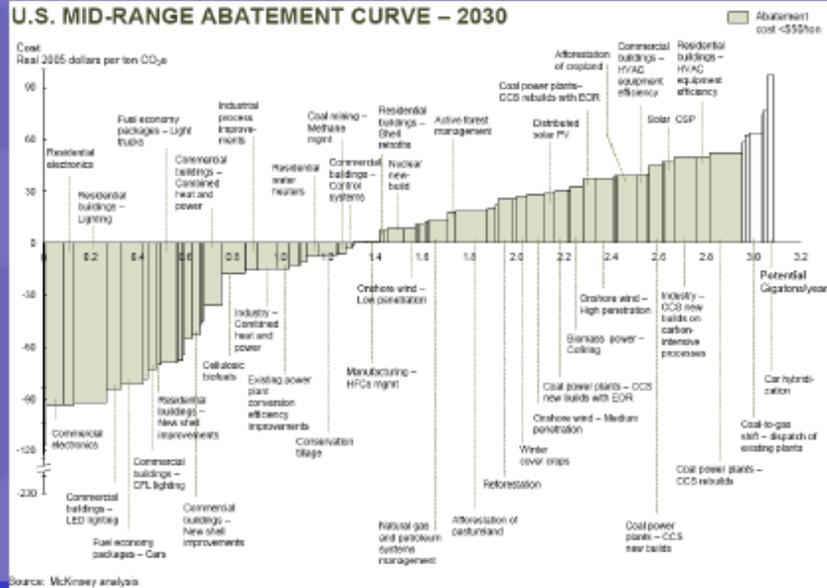
Mark MacLeod, Director for Special Projects, Environmental Defense Fund (EDF), talked to the Commission about the economic ramifications of national cap-and-trade legislation. It is the view of EDF that the most expensive action is to do nothing to address climate change. He also argued that delay drives up the costs of climate change abatement, that technology to begin moving to a low-carbon economy is already available, and that public policy can effectively advance the development of new technology.



ENVIRONMENTAL DEFENSE FUND

We have the technologies to begin reducing emissions right away

Bottom line:
We can cut emissions 33-50% (3-4.5 GT) by 2030 for <\$50/ton, using technologies already in the pipeline



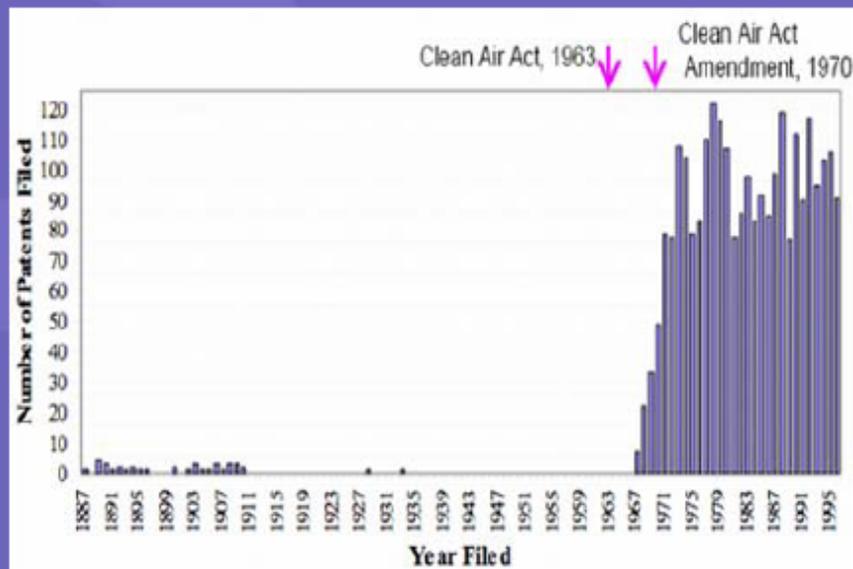
Mr. MacLeod indicated that most economic models that address climate change consider only the costs associated with abatement actions and fail to address the benefits of avoiding catastrophic climate change. They also have difficulty predicting the rate of technological change.

According to EDF's analysis of five economic models, the impact of a national cap-and-trade program on the economy (measured as gross domestic product) will be small. Under a business as usual analysis, the total output of the U.S. economy is projected to reach \$26 trillion in January 2030. With a cap on greenhouse gases, the economy will reach this amount just four months later. (It should be noted that the EDF economic analysis of certain climate change laws proposed at the federal level differs from analyses prepared by some industry analysts. See, for example, Section F below, "Industry View of Federal Legislation.")

Public policy can accelerate technology. An example is the acid rain program. After a cap on sulfur dioxide (SO₂) emissions was imposed, technology to limit emissions developed rapidly. The result has been very successful reductions in acid rain pollution.

ENVIRONMENTAL DEFENSE FUND

Public Policy Can Accelerate Technology



Source: The Effect of Government Actions on Technological Innovation for SO₂ Control
The EPA/DOE/EPRI Mega Symposium, August 20-23, 2001.

D. The European Union

Professor Noah M. Sachs, Assistant Professor of Law, University of Richmond, made a presentation to the Commission on the European Union's (EU) Climate Change Strategy, and the lessons Virginia can learn from the EU experience. The EU is different from the United States in many ways, not the least of which is energy consumption patterns. Europe may serve as a model of what can be accomplished when additional conservation and efficiency measures are implemented in the United States.

How does Virginia compare?

Per Capita Energy Consumption (2005)

Virginia 345 million BTU

UK 165 million BTU

Germany 176

Italy 138

France 182



Source: US Energy Information Agency

The EU is on track to meet the EU-wide commitment of reducing GHG emissions by 8% below 1990 levels by 2012. The EU has developed policies in the following areas to reach this cap: emissions trading, fuel pricing, mass transit, renewable energy sources, biofuels, energy efficiency, and waste management. The centerpiece of these policies is the emissions trading system (ETS), which is a cap-and-trade system for power plants and major emitting industries. The trading system was designed for two phases: Phase I (2005-2007, “warm up”) and Phase II (2008-2012). Under the initial phase of the EU’s trading program, most allowances were distributed for free to emissions sources by EU member states under the supervision of the European Commission. Phase I of the EU ETS has been criticized because caps for individual member states turned out to be too high (due to a lack of monitoring and reporting data) and too many allocations were distributed. Additionally, because of the absence of a transition to the second phase of the program, the allowance market has experienced price volatility making planning difficult for regulated facilities.

Despite these setbacks, however, the concerns during this “warm up” phase are being addressed and provide lessons about the creation of a carbon trading scheme. The system has worked much as it was envisioned by establishing a European-wide carbon price for businesses to incorporate into their decision-making and developing a multi-national trading program.

Additionally, even in the “warm up” phase, emission reductions were realized in some of the covered sectors, which put the EU on track to meet its initial goal.

In 2007, the EU Heads of State developed the 20/20/20 plan by committing to achieve the following by 2020:

- 20% GHG reduction below 1990 levels;
- 20% improvement in energy efficiency; and
- 20% renewables in energy mix (up from 8.5% today).

To help achieve these goals, the ETS after 2012 will include an EU-wide cap with no national allocation plans. The EU will move toward full auctioning of allowances, with 20% of auction revenues to be devoted to combating climate change. The EU plans to increase the scope of the cap to include more sectors of the economy and more GHG gases, and the total cap in 2020 will be 21% lower than CO₂ allowances available in 2005.

According to Professor Sachs, the lessons learned for Virginia include: (i) markets do work, but cap-and-trade is only as good as the tightness of the cap; and (ii) climate change strategies need to be wide (all sectors of the economy), deep (not just industry, but agriculture, suburban areas, and the transportation sector, the building sector, and the land use sector must all bear the burden), and long (long-term, 2020 or beyond).

E. Industry Perspective on Voluntary Actions and Experience with Government Programs

A number of representatives of electric utilities and industries whose products, processes, or use of energy result in GHG emissions were asked to speak to the Commission about ways in which their businesses are voluntarily reducing emissions or helping consumers to do so. Presentations from industry also enabled the Commission to learn how existing climate change policies at different levels of government are affecting businesses.

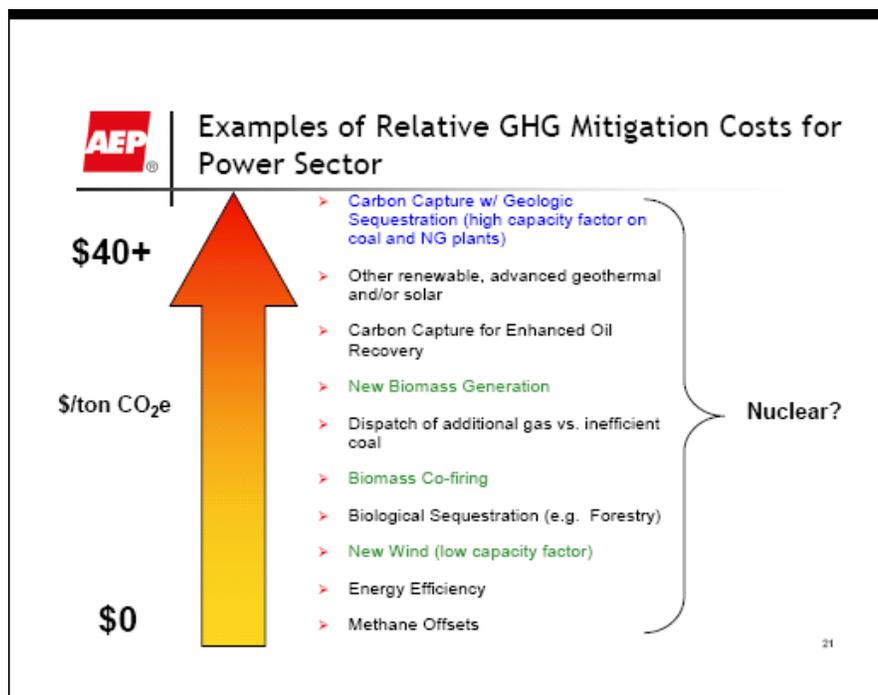
Mr. Paul Loeffelman, Director of Environmental Public Policy for American Electric Power (AEP), explained how his company has voluntarily developed a corporate climate change strategy. AEP is one of the largest United States electricity generators with a capacity of 38,000 megawatts (MW). Currently, AEP uses 76 million tons of coal per year. In 2007, 150 million metric (MM) tons of CO₂ equivalent were emitted. The electricity generated by AEP is used by 5.2 million customers in 11 states.

Measures that are part of AEP’s voluntary strategy include being politically engaged in the development of climate change policy, investing in science and technology research and development, and participation in the EPA Climate Leaders Program and Chicago Climate Exchange. Also, through the Electric Power Research Institute, AEP is investing in long-term technological solutions such as carbon capture and storage.

AEP initiatives to reduce CO₂ emissions include improving plant efficiencies, utilizing renewables such as wind (800 MW) and hydro (300 MW), and using forestry projects to help offset emissions. The current \$500,000 per year investment in forestry projects offsets .35MM tons of CO₂ emissions.

AEP believes that the path forward to reducing emissions is dependent on several factors. There must be technology financing policies that encourage investment and reduce costs. Reduction targets and timelines need to allow for commercial technology to be developed and deployed. AEP feels that a cap-and-trade program with allocated carbon credits will support the development of emissions reduction technologies, while the cost of emission reductions would be much higher if carbon allowances are auctioned rather than allocated to emitters.

The choices available to the power sector to mitigate GHG emissions can range greatly in cost. For example, the cost associated with utilizing methane offsets or increasing energy efficiencies may be relatively low while the costs associated with carbon capture and storage may be quite high (\$40 or more per ton of CO₂ equivalent). AEP estimates the costs associated with different strategies as follows:

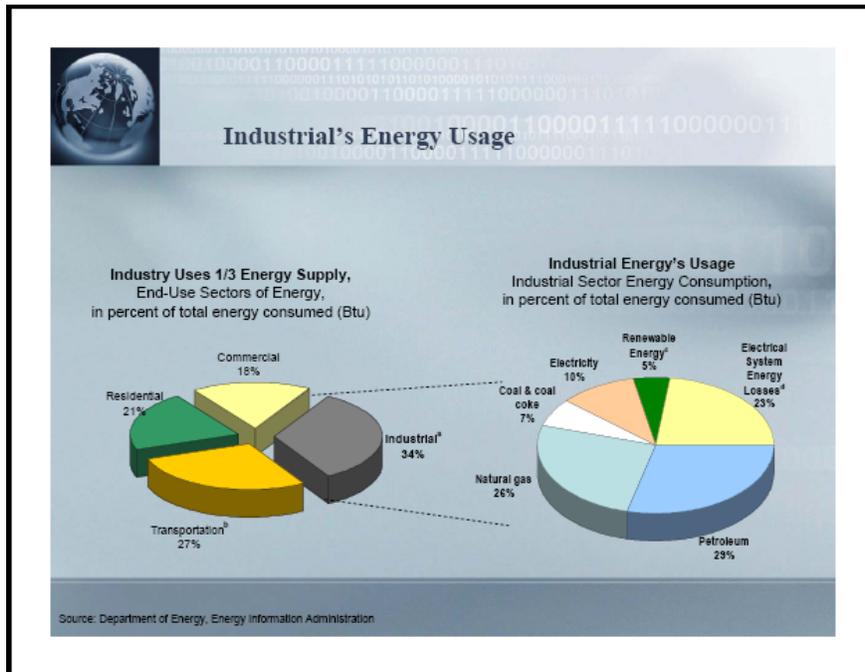


Reducing GHG emissions will be particularly challenging given increasing demands for electricity which result in a need for new generating capacity. According to the Energy Information Administration (EIA) *2004 Annual Energy Outlook* report, it is expected that 335 gigawatts of electricity will need to be added between 2002 and 2025.

The National Association of Manufacturers (NAM) is an advocacy organization that seeks to influence legislation and regulatory policy that is favorable to manufacturers and economic growth. Mr. Keith McCoy, Vice President of Energy and Resources Policy, made a

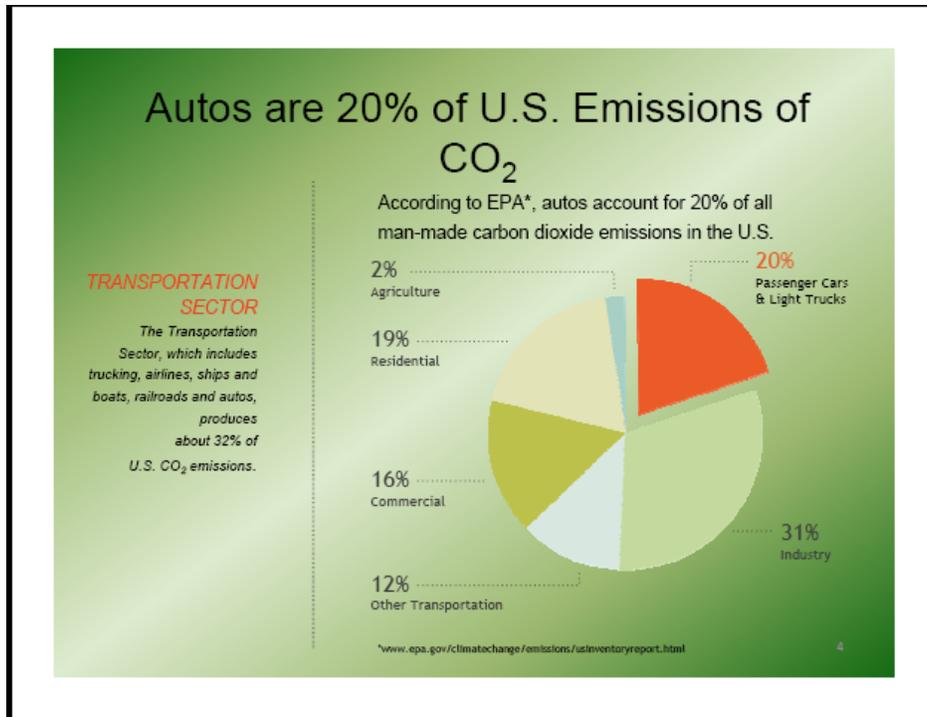
presentation to the Commission on behalf of NAM. Currently, NAM represents approximately 11,000 companies with a workforce of 14.1 million employees.

According to NAM, manufacturing is responsible for the largest portion of U.S. economic growth during the past decade. Manufacturing alone contributed 14% to Gross Domestic Product (GDP) growth between 1996 and 2006. Energy consumption in the nation, according to the U.S. Department of Energy, will increase by 30% between 2005 and 2030, even after factoring in an expected 35% gain in efficiencies, and the industrial sector utilizes 34% of the nation's energy supply. Petroleum and natural gas make up the largest portion (55% combined) of this energy usage.



NAM's recommended strategies for reducing global GHG growth include making improvements to the tax code that reduce the cost of energy investments and provides incentives; removing barriers to the developing world's access to more energy and cleaner technology by promoting economic freedom and market reforms; increasing research and development for new technologies to reduce energy intensity, capture and store carbon, and develop new energy sources; and promoting nuclear power for electricity. NAM also advocates using a cost/benefit analysis when considering adopting new GHG-reduction policies.

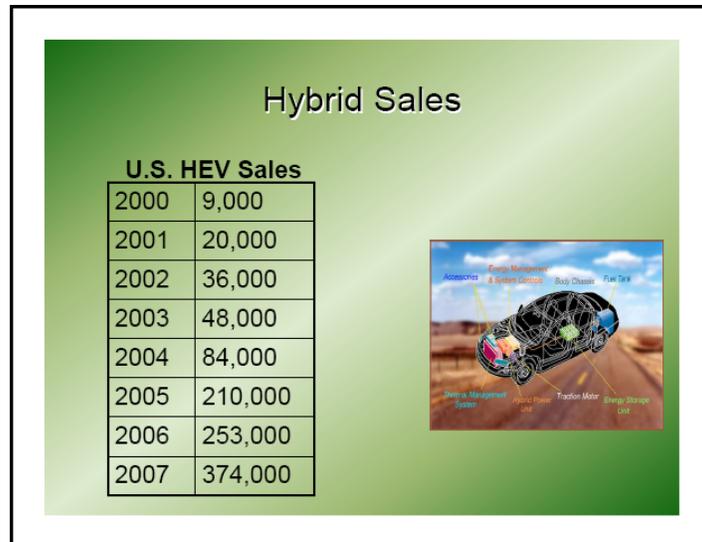
To share the automobile industry's views, Mr. Michael Stanton, President and CEO of the American Automobile Manufacturers Association, delivered a presentation to the Commission. Twenty percent of total CO₂ emissions nationwide come from cars and light trucks.



According to Mr. Stanton, the automobile industry recognizes its role in climate change issues and its obligation to be part of the solution. The primary means for the auto industry to mitigate CO₂ emissions is to make quick and ongoing improvements in vehicle fuel economy. In the short term, the industry is focusing on improving the operation of engines and transmissions, reducing the weight of vehicles, improving aerodynamics and finding alternate fuels. The longer term objective will require a shift to low-carbon or no-carbon fuels by switching entirely to electric vehicles, hybrid-electric vehicles, or hydrogen fuel cell electric vehicles.

In addition to the engineering challenges faced in pursuing greater fuel economy, there are additional factors that will further complicate the industry's progress toward a smaller carbon footprint, including a growing population; an increase in the number of vehicles and miles driven; continued efforts to increase occupant safety; performance that will suit the needs of customers; how to properly recycle batteries to minimize environmental damage; and how to ensure that the infrastructure needed to support the new technologies is available.

Challenges faced by the auto industry include putting new technologies on the road in sufficient numbers and at affordable prices quickly, given the long lead times and heavy spending the industry requires to engineer, design, and build next-generation products. Maintaining customer satisfaction while employing new and different technologies also is a challenge. As the price of fuel has increased, customers have reacted by shifting their buying preferences to smaller, more fuel-efficient vehicles, putting even more pressure on manufacturers to shift as quickly as possible to "next generation" products.



Market Segment

| | SHARES (%) | | | | | |
|------------|------------|-------|--|-------|-------|-------|
| | 2007 | | | 2008 | | |
| | March | YTD | | March | YTD | Δ |
| Small Car | 15.2% | 14.7% | | 17.4% | 16.5% | 1.8% |
| Middle Car | 20.1% | 19.8% | | 22.0% | 21.2% | 1.4% |
| Large Car | 4.5% | 4.6% | | 3.6% | 3.9% | -0.7% |
| Luxury Car | 7.4% | 7.4% | | 7.5% | 7.3% | -0.1% |
| CUVs | 16.7% | 16.5% | | 18.5% | 18.8% | 2.3% |
| SUVs | 12.2% | 12.7% | | 9.4% | 10.2% | -2.5% |
| Vans | 7.1% | 7.5% | | 6.7% | 6.6% | -0.9% |
| Pickups | 16.9% | 16.9% | | 14.9% | 15.4% | -1.5% |

The industry also is revamping its manufacturing operations to reduce GHG emissions from stationary sources (its factories), with improvements reaching as high as 30% in some instances. Additional efforts, such as operating zero landfill plants and high use of recyclable materials, also are well underway.

The industry feels it is important to recognize that, in addition to improving vehicles and the factories where they are made, changes in personal behavior also can help reduce society’s carbon footprint, including more fuel-efficient driving practices, taking fewer trips by car, increasing use of mass transit, joining rideshare programs, and telecommuting.

F. Industry View of Federal Legislation

Mr. Loeffelman and Mr. McCoy presented an analysis of the Lieberman-Warner legislation’s economic impact that differed markedly from that presented by the Environmental Defense Fund. Mr. Loeffelman cited an analysis by the American Council for Capital Formation

(ACCF) and the National Association of Manufacturers (NAM). In this analysis, Gross Domestic Product will experience losses up to \$669 billion in 2030. Other concerns cited were: employment losses approaching 4 million jobs by 2030, electricity prices increasing between 101% and 129% by 2030, and gasoline prices increasing by as much as 145% by 2030. Mr. McCoy presented numbers for GDP, job loss, and loss of household income that were similar to those presented by Paul Loeffelman in the AEP presentation. He correlated carbon allowance prices with increases in gasoline, residential electricity, industrial electricity, and industrial natural gas prices. Based on the particular carbon allowance scenario used, estimates of price increases nationally for gasoline, residential electricity, industrial electricity, and industrial gas could be as high as 145%, 129%, 185%, and 244% respectively by 2030.

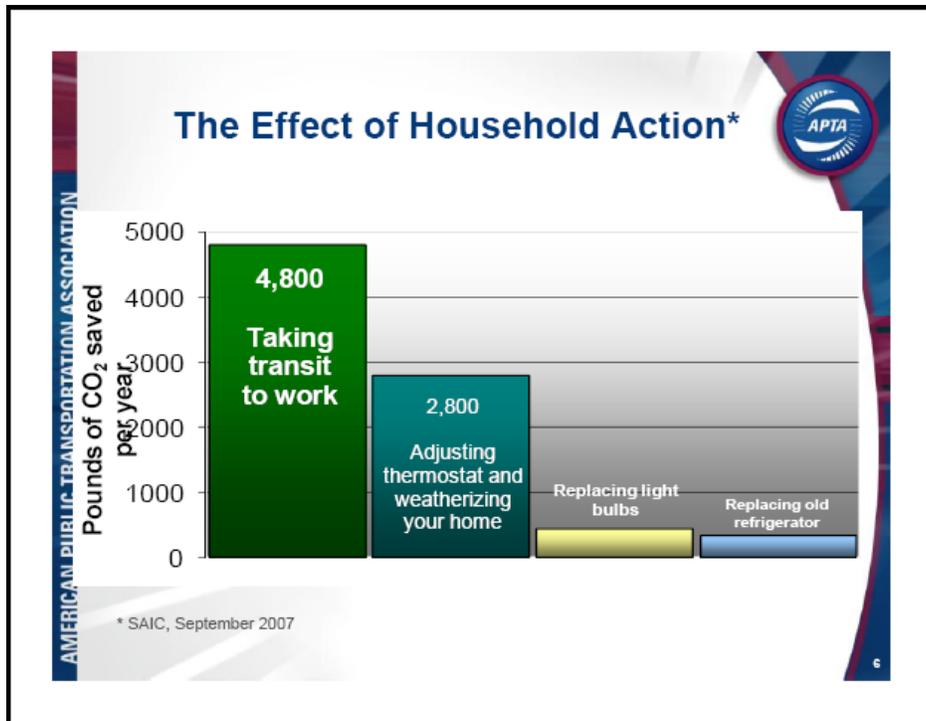
Ms. Pamela Faggert, Chief Environmental Officer for Dominion, told the Commission that Dominion supports federal legislation that: regulates greenhouse gas emissions economy-wide, establishes a cap and trade regulatory approach, sets a realistic baseline year and schedule of compliance, promotes technology development, and includes a safety valve to protect customers. Dominion's strategy for reducing GHG emissions while also meeting increasing demands for electricity is to use three major tools: conservation and efficiency, renewable generation, baseload and intermediate generation and other infrastructure improvements. Climate change is a global issue and requires a consistent national approach as well as international efforts. Dominion believes that regional and state efforts should work in tandem with a consistent national approach.

VI. The Connections Between Climate Change, Transportation and Land Use

In order to better understand the interrelationships between climate change, transportation, and land use, the Commission received presentations from a representative of a group that promotes transit, an expert working to develop certification standards for sustainable neighborhood design, a planning professional from one of Virginia's planning district commissions, and a smart growth specialist from the U.S. Environmental Protection Agency.

Ms. Petra Mollet of the American Public Transportation Association (APTA) gave a presentation entitled *Providing Transportation Choices to Reduce Greenhouse Gas Emissions*. To put transportation's GHG contribution in perspective, the transportation sector contributes 32 % of total CO₂ emissions in the U.S. (with 85% coming from surface transportation). Viewed on a household scale, automobile use contributes 55% of all household carbon emissions.

Ms. Mollet concluded that CO₂ reduction targets cannot be met by relying solely on recently enacted fuel efficiency standards. APTA views public transportation as a "Net Carbon Reducer" in that it generates far less CO₂ than it offsets by reducing vehicle miles traveled and congestion. On a household scale, substituting public transit for driving an automobile to work reduces twice as many pounds of CO₂ than any other household energy conservation measure (e.g., adjusting thermostats, weatherizing, replacing light bulbs, replacing old refrigerators). A 30% savings in household carbon emissions can be achieved by switching one automobile to public transportation or other non auto-related modes.



In addition, increased public transportation infrastructure provides a “leverage effect” by supporting more efficient land use patterns that result in reduced growth in vehicle miles traveled and reduced congestion.

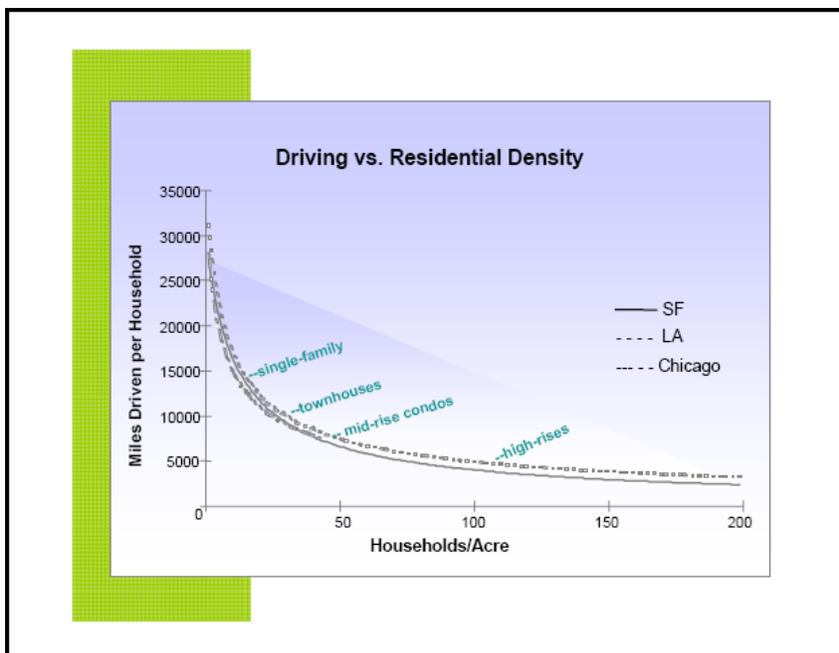
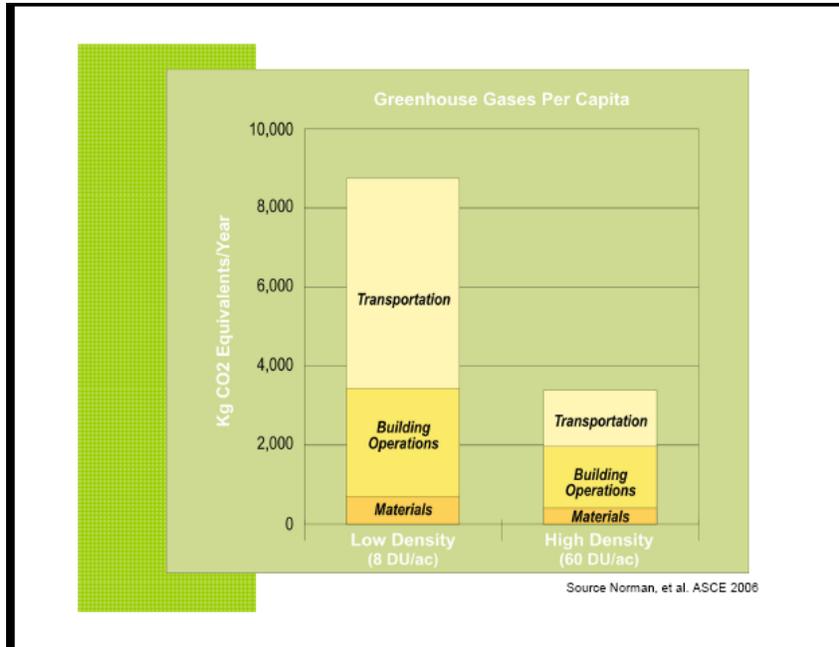
Higher density regions produce less carbon emissions per year from cars. Data was presented that showed that the average Richmond resident (relatively low density region) generates larger annual auto carbon emissions (1.335 tons) compared to the higher density regions of Virginia Beach (1.004 tons) and DC metro (0.984 tons).

APTA’s recommendations for policy makers include: (i) avoiding increases in public transportation fares, (ii) protecting existing public transportation assets and services, (iii) expanding public transportation coverage and frequency, (iv) recognizing transit’s net benefits in carbon programs, and (v) promoting energy efficient transportation technologies. APTA believes that transportation investments could be made more effective by: (i) linking public transit investments to land use policies, (ii) increasing accessibility to public transit through improved park & ride, bike paths, and sidewalks, and (iii) using both carrot and stick-type approaches to increase public transit occupancy and decrease the GHG emissions per passenger.

LEED (Leadership in Energy and Environmental Design) is a third-party certification program and the nationally accepted benchmark for the design, construction, and operation of high performance green buildings. LEED-ND (Neighborhood Development) is an effort, still in pilot phase, to move beyond construction of individual green buildings into the certification of holistic neighborhood development. Ms. Elizabeth Humphrey Schilling explained that, in addition to green construction and technology, LEED-ND certification will encompass additional factors related to smart location, linkages, and neighborhood pattern and design. A rating system will assign points allowing for neighborhoods to achieve silver, gold, or platinum status. The

LEED-ND certification process reduces the carbon footprint of a proposed development by assessing: (i) building energy performance, (ii) location efficiency, (iii) compact development and focus on existing disturbed sites, (iv) preservation of carbon sequestration sites, (v) accessibility of diverse uses (e.g., parks and schools), and (vi) reduced demand for power for storm and wastewater management, light, and other needs.

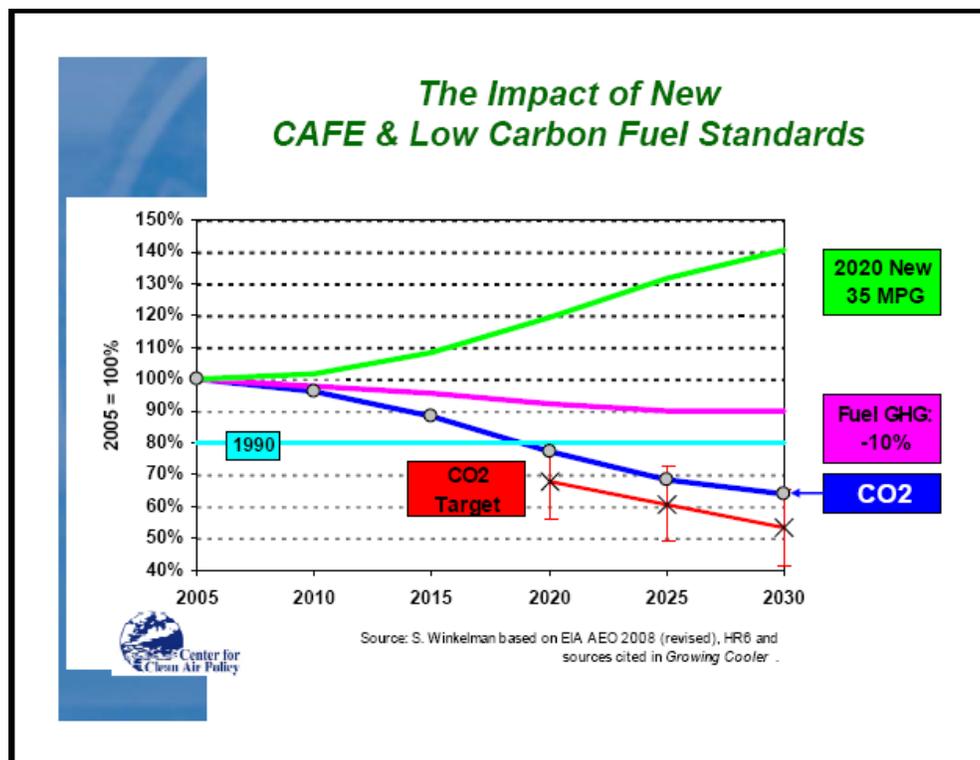
The following two figures illustrate the significant difference in greenhouse gas emissions per capita and miles driven per household for low density vs. high density neighborhood development.

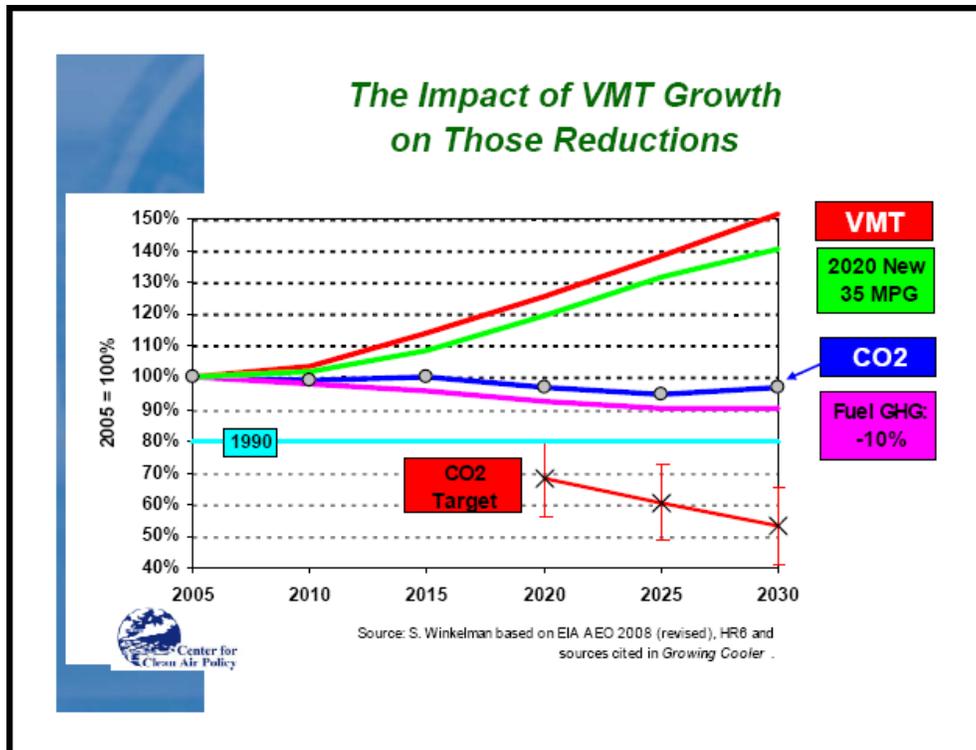


If the Commonwealth wished to use LEED-ND as a policy tool, Ms. Schilling suggested that it could provide incentives such as fast-track permitting or state support of certified projects. In addition, the certification evaluation process affords policy makers the opportunity to assess whether current codes and ordinances are creating barriers to energy-efficient growth.

Mr. Eric J. Walberg, Principal Planner, Hampton Roads Planning District Commission, spoke to the Commission about (i) linking strategic environmental planning and urban design, often referred to as green infrastructure and (ii) the emphasis on building quality communities that protect critical natural resources while having energy-efficient communities and multi-modal transportation. Mr. Walberg cited The Conservation Fund for a definition of green infrastructure: “a planned network of green spaces that benefits wildlife and people and links urban settings to rural ones.” The focus of green infrastructure is on services provided by natural systems. Mr. Walberg argued that for coastal areas in particular, the concept of green infrastructure has much to offer in terms of how to deal with sea level rise and storm surges. The Virginia Department of Conservation and Recreation’s Natural Heritage Program has provided a Virginia Conservation Lands Needs Assessment, which is relied upon as a valuable tool by the Hampton Roads Regional Planning District. The Assessment’s forests economic model underscores the economic value of forestry based in Virginia.

John V. Thomas, Ph.D., of EPA’s Office of Policy Economics and Innovation gave a presentation on urban development and climate change. Dr. Thomas argued that promoting smart growth is critical to climate change policy for two reasons. First, rapid growth, with an associated increase in vehicle miles traveled (VMT), undermines any gains achieved through improved fuel economy and low carbon fuels.





Second, rising gas prices have greatly increased public demand for high quality growth alternatives.

Vehicle miles traveled is shaped by where growth occurs (e.g., downtown areas vs. isolated subdivisions, public transit accessible suburban centers vs. auto-related town centers) and how growth occurs (e.g., better street design, mixed use development, compact neighborhood design).

According to Dr. Thomas, making smart growth work requires updating some rules and providing appropriate incentives. Rule changes could include: (i) more flexible land use regulations allowing for form-based or performance-based codes, (ii) updated parking requirements that allow for shared parking and context-specific standards, (iii) revised street design standards, and (iv) improved traffic impact assessments. Additional incentives could include: (i) support for infrastructure in key locations, (ii) streamlined development review process, (iii) public support for site planning, and (iv) density bonuses and other regulatory relief.

VII. Next Steps

The information contained in this interim report addresses three of the five tasks that comprise the Commission's charge: it provides an inventory of the amount of and contributors to Virginia's greenhouse gas emissions; it summarizes the expected impacts of climate change on Virginia's citizens, natural resources and economy; and it identifies climate change approaches being pursued by other states, regions and the federal government.

In June, the Commission formed four workgroups to address the remaining two tasks. One workgroup is focusing on climate change adaptation – that is, identifying what Virginia needs to do to prepare for the likely consequences of climate change. The remaining three workgroups are identifying the actions that need to be taken to achieve the 30 percent greenhouse gas reduction goal. One workgroup is focusing on transportation and land use actions, a second workgroup is focusing on electricity generation and other sources, and a third workgroup is focusing on the built environment. The workgroups will provide recommendations to the Commission, and those accepted by the full Commission will be included in the Commission’s final report, which will be issued in December, 2008. The Commission’s final report also will contain key findings drawn from the information the Commission has received, as well as cross-cutting recommendations on issues that are broader than those assigned to the workgroups.

Throughout its work, information regarding the Commission and its workgroups will be available on the Commission’s website: www.deq.virginia.gov/info/climatechange.html.