

May 2008



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# Acknowledgments

The authors wish to thank David Bookbinder of Sierra Club and Denise Choy and Michael Regan of the North Carolina office of the Environmental Defense Fund for offering their expertise and providing peer review.

Sincere thanks to the Energy Foundation, the Educational Foundation of America, and the Beldon Fund for providing financial support for this project.

The authors alone bear responsibility for any factual errors. The recommendations are those of the Environment North Carolina Research & Policy Center. The views expressed in this report are those of the authors and do not necessarily reflect the views of our funders or those who provided peer or technical review.

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Design: Harriet Eckstein Graphic Design

# Table of Contents

|  |    |
|--|----|
| Executive Summary  | 1  |
| Introduction   | 4  |
| Global Warming and North Carolina                                      | 5  |
| Current Indications of Global Warming                                  | 5  |
| Projected Future Impacts of Global Warming                             | 6  |
| Global Warming Pollution in North Carolina                             | 9  |
| Global Warming Reduction Efforts in North Carolina                     | 10 |
| The Transportation Challenge   | 11 |
| Vehicle Carbon Dioxide Pollution in North Carolina: Past and Projected | 14 |
| Tools to Reduce Global Warming Pollution<br>from Cars and Light Trucks | 16 |
| Vehicle Global Warming Pollution Standards                             | 16 |
| Advanced Technology Standard   | 20 |
| Policy Recommendations   | 22 |
| Assumptions and Methodology  | 24 |
| Notes  | 27 |



# Executive Summary

**N**orth Carolina could limit its contribution to global warming over the next 15 years by implementing policies to reduce carbon dioxide emissions from cars and light trucks.

Global warming poses a serious threat to North Carolina's future. Scientists project that average temperatures in North Carolina could increase by 8° to 15°F over the next century if no action is taken to reduce global warming pollution. Warming could cause thousands of square miles in the state to be flooded, increase damage from storms, and cause air quality to worsen, as well as harm North Carolina's economy, public health and environment in a host of other ways.

Controlling global warming pollution from the transportation sector—and particularly cars and light trucks—is essential if North Carolina is to begin to reduce its emissions and its long-term impact on the climate.

Transportation-related emissions are responsible for approximately 34 percent of North Carolina's global warming pollution, the second largest source of pollution behind electricity generation. Cars and light trucks—such as pickups, mini-

vans and SUVs—are the most important sources of global warming pollution within the transportation sector, responsible for approximately two-thirds of all emissions from transportation and nearly one-quarter of North Carolina's total emissions of global warming pollution.

**Carbon dioxide pollution from cars and light trucks in North Carolina could increase by 12 percent from 2005 to 2020 unless action is taken to reduce emissions.**

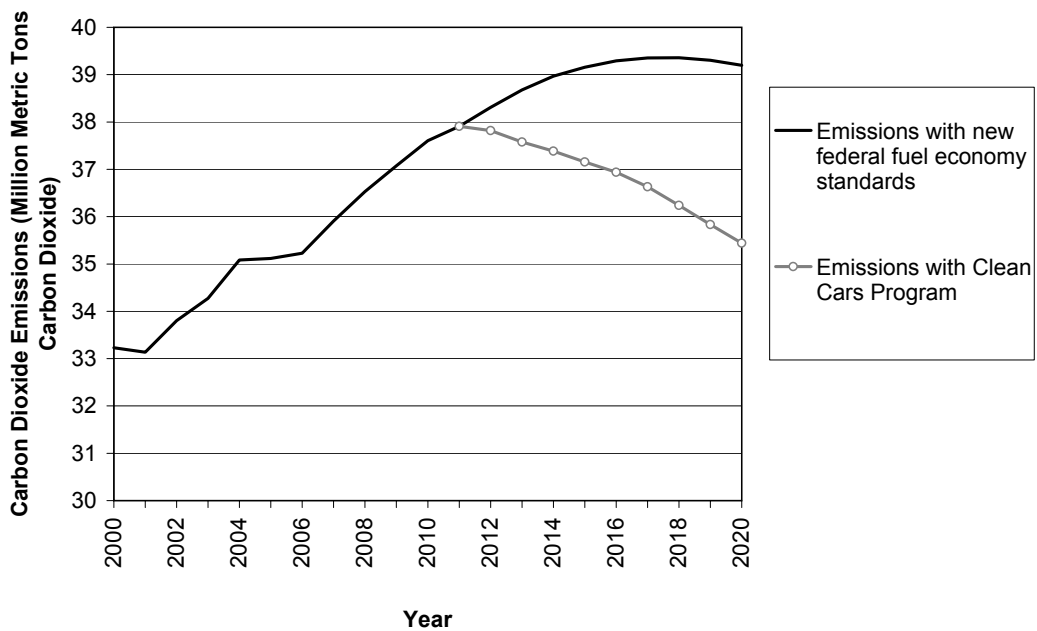
- Emissions from cars and trucks increased by nearly 33 percent between 1990 and 2005 and are projected to rise by an additional 12 percent between 2005 and 2020.
- Vehicle travel increased by 29 percent from 1996 to 2006 and is projected to grow by another 39 percent by 2020, causing global warming pollution from transportation to rise significantly.
- Slow implementation of stronger federal corporate average fuel economy (CAFE) standards for cars and light trucks also feeds the growth in North

Carolina's carbon dioxide pollution from transportation.

**North Carolina can significantly reduce carbon dioxide pollution from cars and light trucks by adopting the Clean Cars Program.**

- The Clean Cars Program establishes limits on health-damaging pollution and global warming pollution from automobiles. Using standards that grow stronger over time, the Clean Cars Program will reduce global warming pollution from cars and the lightest passenger trucks by 34 percent by 2016 and from heavier passenger trucks by 25 percent.
- By implementing the program as soon as possible, North Carolina could reduce carbon dioxide pollution from cars and light trucks by 10 percent below the levels that would be achieved under the recently improved federal fuel economy standards by 2020. (See Figure ES-1.)
- Once the program is fully implemented in 2016, consumers are projected to save \$20 per month on cars complying with the standard (with greater savings on trucks), with reduced fuel costs more than making up for the increased cost of the vehicle. These savings assume gasoline prices of just \$3 per gallon.

**Figure ES-1. Estimated North Carolina Carbon Dioxide Emissions from Cars and Light Trucks Under Policy Scenarios**



- The Clean Cars Program will pave the way for the widespread introduction of technologies like “plug-in” hybrids and fuel-cell vehicles, direct-injection engines, advanced transmissions, improved air conditioning systems, and other technologies with the potential to reduce pollution.
- Even with implementation of the Clean Cars Program, carbon dioxide pollution from cars and light trucks in 2020 would remain 1 percent higher than in 2005 because of a large projected increase in vehicle travel. Thus, North Carolina will need to adopt additional policies to stabilize and reduce emissions from the transportation sector.

**North Carolina should move quickly to adopt policies that will stabilize and ultimately reduce carbon dioxide pollution from cars and light trucks.**

- North Carolina should adopt the Clean Cars Program so that it takes effect in model year 2012.
- North Carolina should invest in public transit and adopt transit-oriented development policies that reduce vehicle travel, further helping to reduce global warming pollution from the transportation sector.



# Introduction

**G**lobal warming will have serious impacts on North Carolina's environment, economy and future quality of life.

Rising sea level could cause the state's shoreline to move inland by 2,000 feet to 2 miles, flooding thousands of square miles of coastal land. Stronger hurricanes and tropical storms, fed by warmer ocean temperatures, could wreak greater havoc on North Carolina in coming years, eroding beaches, damaging coastal property, and harming forests across the state. The financial losses caused by the impacts of global warming could total billions of dollars. Ultimately, they could change the landscape and traditions of North Carolina.

Addressing the challenge of global warming will require bold action.

To avoid the worst impacts of global warming, climate scientists agree that we need to reduce global warming pollution dramatically within our lifetimes. If we are to have a reasonable chance of keeping global

temperatures from rising by more than 2°C above pre-industrial levels, the atmospheric concentration of global warming pollutants (in carbon dioxide equivalent) must be held below 445 to 490 parts per million (ppm).<sup>1</sup>

To stabilize global warming pollution levels between 445 and 490 ppm (carbon dioxide equivalent), global emissions must peak no later than 2015 and decline by 50 to 85 percent below 2000 levels by 2050.<sup>2</sup>

The single largest step that North Carolina can take now to cut global warming pollution from the transportation sector is to adopt the Clean Cars Program. The program would reduce emissions from cars and light trucks by 10 percent from projected levels in 2020. The policy would also save money for motorists.

Adopting the Clean Cars Program is one of the first significant steps that North Carolina must take if it is to reduce its contribution to global warming.

# Global Warming and North Carolina

## Current Indications of Global Warming

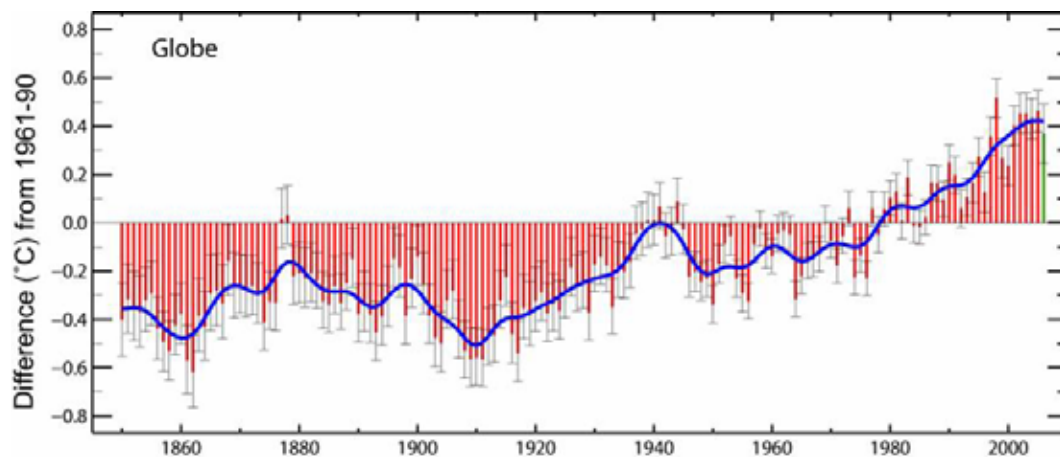
The first signs of global warming are beginning to appear in North Carolina and throughout the world. Global average temperatures increased during the 20<sup>th</sup> century by about 1.3°F (0.74°C).<sup>3</sup> (See Figure 1.) While this increase may not seem extreme, it is unprecedented in the context of the last 1,300 years of world history.<sup>4</sup>

Global warming has intensified in recent

years. In 2006, scientists at the National Aeronautics and Space Administration (NASA) reported that, since 1975, temperatures have been increasing at a rate of about 0.36°F per decade.<sup>6</sup> Nationally, six of the last 10 years (1997 to 2006) rank among the 10 warmest years on record.<sup>7</sup>

This warming trend cannot be explained by natural variables—such as solar cycles or volcanic eruptions—but is successfully predicted by models of climate change that include human influence.<sup>8</sup>

**Figure 1. Global Average Temperatures, Difference from 1961-1990 Average<sup>5</sup>**



Other indications of global warming include:

- **Melting ice.** The rise in global temperatures has resulted in thinning ice and decreasing snow cover. Glaciers are retreating around the globe and the annual extent of Arctic sea ice has declined by 2.7 percent per decade since 1978.<sup>9</sup> NASA scientists recently found a 23 percent decrease in the extent of Arctic sea ice from winter 2005 to winter 2007.<sup>10</sup>
- **Rising sea levels.** Oceans have risen with the melting of glacial ice and the expansion of the ocean as it warms. Average sea level has risen 6.7 inches in the past century.<sup>11</sup>
- **Shifting seasons.** Spring events—such as leaf unfolding, egg laying and bird migration—are occurring earlier in the year. Numerous species of plants and animals appear to be moving toward the poles in response to rising temperatures.<sup>12</sup>
- **More severe storms.** Storms may be getting more intense. For example, an increase in the fraction of rainfall occurring as heavy precipitation events has been observed, a potential result of warmer air that is able to hold more moisture.<sup>13</sup> Hurricanes appear to have become more powerful and more destructive over the last three decades, a phenomenon that some researchers link to increasing global temperatures.<sup>14</sup>

### Global Warming in North Carolina

The first signs of global warming may already be affecting North Carolina's climate and land. Over the last century, for example, the average temperature in Chapel Hill has increased by 1.2°F.<sup>15</sup>

Precipitation patterns have changed,

one possible impact of global warming. The state receives 20 percent less rain in the summer than it did 100 years ago.<sup>16</sup> At the same time, the frequency of extremely heavy rain increased 16 percent from 1948 to 2006.<sup>17</sup>

Sea level along the eastern seaboard has risen throughout the twentieth century. In Hampton Roads, Virginia, sea level increased by approximately 12 inches from 1930 to 2000.<sup>18</sup> Sea level at Charleston, South Carolina, rose 10 inches.<sup>19</sup> In North Carolina, eroding shoreline (caused in part by rising sea level) threatened the Cape Hatteras Lighthouse and led to its relocation farther from the ocean.

Hurricanes and cyclones have become more frequent and more powerful. From 1975 to 1989, only 20 percent of storms were considered Category 4 or 5, the classification given to the most severe storms. That proportion has increased to 35 percent in the period from 1990 to 2004.<sup>20</sup>

## Projected Future Impacts of Global Warming

Climate scientists warn that the world faces dire environmental consequences unless we find a way to reduce our emissions of global warming pollutants quickly and rapidly. Global warming will have serious impacts on North Carolina's natural environment and thus its economy and way of life.

### Future Global Impacts

Many scientists and policy-makers (such as the European Union) recognize a 2°C (3.6°F) increase in global average temperatures over pre-industrial levels as a rough limit beyond which large-scale, dangerous impacts of global warming would become unavoidable.<sup>21</sup> Even below 2°C, significant impacts from global warming are likely,

such as damage to many ecosystems, decreases in crop yields, sea level rise, and the widespread loss of coral reefs.<sup>22</sup>

Beyond 2°C, however, the impacts of global warming become much more severe, including some or all of the following possible impacts:

- A 0.7 to 1.9 foot sea level rise, even without accelerated break-up of ice sheets;<sup>23</sup>
- Eventual loss of the Greenland ice sheet, triggering a sea-level rise of 7 meters over the next millennium (and possibly much faster);
- Widespread extinctions of plant and animal species;
- Displacement of tens of millions of people due to sea level rise;
- Expansion of insect-borne disease;
- Increased coastal flooding and the loss of 30 percent of coastal wetlands;
- A further increase in the intensity and duration of hurricanes;
- Greater risk of positive feedback effects—such as the release of methane stored in permafrost—that could lead to even greater warming in the future.<sup>24</sup>

Should the world continue on its current course, with fossil fuel consumption continuing to rise, temperature increases of well above 2°C are likely to occur. The Intergovernmental Panel on Climate Change, in its 2007 Fourth Assessment Report, laid out a scenario in which population, economic output and fossil fuel consumption continue to grow dramatically. Under that scenario, global average temperatures by the end of the century would be approximately 7.2°F (4.0°C) higher than

in 1990, and temperatures would continue to rise for generations to come.<sup>25</sup>

## North Carolina Impacts

Global warming will have consequences for both rural and urban areas in North Carolina. North Carolina's climate is expected to grow warmer, with temperatures in the Southeast region rising by 8°F to 15°F by 2100.<sup>26</sup> Precipitation in the Southeast is predicted to increase by an average of 20 percent over the next 100 years.<sup>27</sup>

### Rising Sea Level

As global temperatures increase, ocean levels will rise due to melting polar ice caps and the expansion of surface water as it grows warmer. This will dramatically change North Carolina's coastline.

North Carolina has 3,375 miles of tidally influenced coastline, and an estimated 1.4 million acres of land that are less than five feet above sea level.<sup>28</sup> Because the state's coastal regions are so flat, a 12-inch rise in sea level may cause the shoreline to move inland by 2,000 feet to 2 miles.<sup>29</sup> Thus, an 8 to 23 inch rise in sea level in the next 100 years could result in the loss of thousands of square miles of land in North Carolina. Compounding the problem, North Carolina is sinking by 7 inches per century due to the movement of tectonic plates.<sup>30</sup>

Overall, North Carolina is the third-most vulnerable state to sea level rise.<sup>31</sup> The potentially affected area is immense, because low-lying land that is not fully submerged by higher sea levels may be partially inundated during high tides.<sup>32</sup> The region between Pamlico and Albemarle Sounds and land along the coast north of Cape Lookout is most vulnerable. (See Figure 2.)

The loss of coastal lands will impose large financial costs on the state through property loss and damage to coastal recreation. Researchers estimate that in some counties as much as 12 percent of property could be harmed, at a cost of

\$6.9 billion over the next 75 years.<sup>33</sup> In a blow to beach tourism, 12 of 17 popular swimming beaches along the southern coast could shrink by 40 percent or more by 2030, reducing spending by tourists.<sup>34</sup> Fourteen of the 17 beaches could be completely eroded by 2080.

Problems will arise before the ocean overtakes coastal land, as salt water seeps into freshwater supplies, penetrating aquifers and drinking-water wells. If groundwater becomes tainted with saltwater, it no longer can be used for drinking or irrigating. Rising water levels can also impair the function of septic systems, making it very

difficult to sell affected homes.<sup>35</sup>

Higher sea levels could heighten the impact of tropical storms. North Carolina has received more direct hits by hurricanes than any state other than Florida.<sup>36</sup> As sea levels rise, storms will be able to push water farther inland. In addition, more frequent and severe tropical storms could exacerbate the impacts of higher sea levels and eroded barrier islands.

### The Loss of Plant and Animal Species

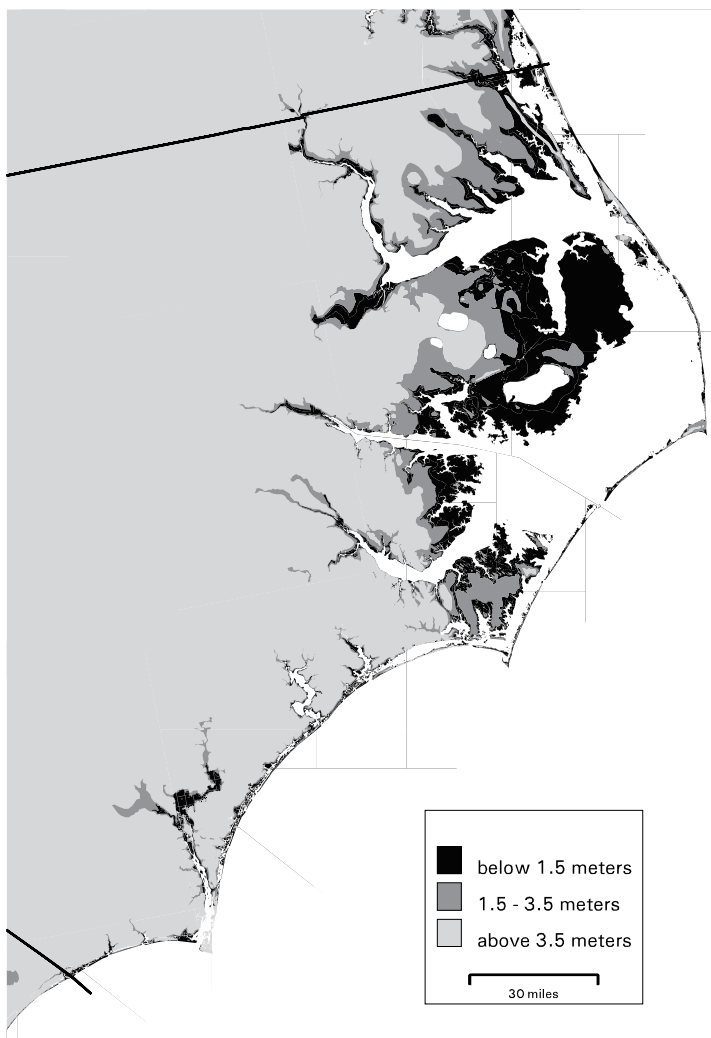
Higher temperatures and changes in precipitation will alter the mix of plants and animals that can survive in North Carolina. The replacement of Fraser fir and red spruce by pines and oaks could change the ecosystem of mountain forests.

Insect populations, such as the Southern pine beetle, may thrive as temperatures increase. Forest fires are likely to become more common, increasing by 25 to 50 percent according to one model.<sup>37</sup>

As plant types change, birds and other animals may have to move northward to find suitable habitat. By one estimate, 30 species of birds that currently spend at least part of the year in North Carolina may be forced out of the state by a changing climate.<sup>38</sup> Rising sea level may force a number of endangered or threatened species from their coastal habitat.<sup>39</sup>

The loss of coastal wetlands to rising sea level may cause a decline in bird populations. As sea level rises, beaches and wetlands are the first areas to be claimed by the ocean. Along undeveloped shoreline, wetlands migrate inland and new beaches form. Waterfront development prevents this regeneration. In North Carolina, much land along the ocean has been developed, leaving no room for new wetlands and beaches and causing the state to lose valuable wildlife habitat and recreation areas. Development just inland from current wetlands and beaches often is protected by storm walls, preventing the evolution of new coastal wetlands through the inundation of low-lying land.

**Figure 2. Map of Areas in North Carolina Vulnerable to Sea Level Rise**



### Threats to Public Health

Higher temperatures will increase weather-related illnesses and fatalities.

Higher temperatures may increase the frequency of summer heat waves, with deadly consequences. By one estimate, an increase of 3°F in the average summer temperature could cause heat-related deaths to increase by nearly 70 percent in a city such as Greensboro.<sup>40</sup> Hot summer days facilitate the formation of smog, ground-level pollution that can inflict respiratory damage. This is already a problem in North Carolina and higher temperatures may increase its severity.

The incidence of insect-borne disease may rise also, as mosquito populations thrive in warm, wet weather.<sup>41</sup> Mosquitoes in North Carolina can carry malaria and eastern equine encephalitis, which is fatal in 35 percent of cases and causes neurological damage in 35 percent of people who survive the disease.<sup>42</sup>

### Harm to Agricultural and Forest Production

Higher temperatures and increased precipitation would affect North Carolina's \$10 billion agricultural industry.<sup>43</sup> Increased hurricane intensity could also cause significant damage. A category 3 hurricane causes nearly three times as much damage to forests as a category 2 hurricane.<sup>44</sup> Damage to the agricultural sector rises with increasing storm intensity as well.

### The Need for Immediate Action

There is hope in the climate science, however. Scientists tell us that, if we act quickly and aggressively to reduce global warming emissions, there is a much greater chance of staving off the worst impacts of global warming. To have a reasonable chance of keeping global temperatures from rising by more than 2°C, the atmospheric concentration of global warming pollutants (in carbon dioxide equivalent) must not rise

higher than 445 to 490 parts per million (ppm).<sup>45</sup> Given that the concentration of global warming pollutants is already 375 ppm and rising every year, the need for action is immediate.<sup>46</sup>

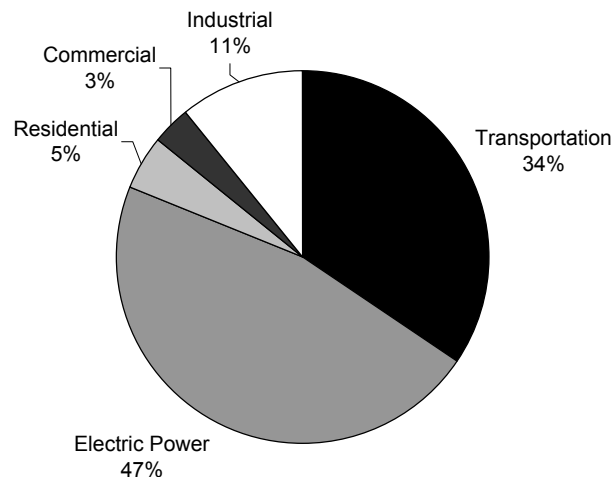
To stabilize carbon dioxide levels between 445 and 490 ppm (carbon dioxide equivalent), global emissions must peak no later than 2015 and decline by 50 to 85 percent below 2000 levels by 2050.<sup>47</sup> Because the U.S. is the world's largest global warming polluter, the degree of emission reductions required here will be greater than in less-developed countries.

Adopting the Clean Cars Program is the most effective step available right now for North Carolina to take in reducing its global warming pollution from transportation.

## Global Warming Pollution in North Carolina

Carbon dioxide emitted from fossil fuel use is the leading cause of global warming. In 2004, consumption of fossil fuels in North

**Figure 3. North Carolina Sources of Global Warming Pollution in 2004<sup>52</sup>**



Carolina released 152 million metric tons of carbon dioxide (MMT $\text{CO}_2$ , see note on units, next page).<sup>48</sup> If North Carolina were a separate country, it would rank 28<sup>th</sup> in the world in total emissions, ahead of nations such as Belgium and Austria.<sup>49</sup>

The transportation sector is responsible for approximately 34 percent of North Carolina's releases of carbon dioxide.<sup>50</sup> (See Figure 3.) Cars and light trucks—such as pickups, minivans and SUVs—are the most important sources of global warming pollution within the transportation sector, responsible for two-thirds of all

transportation-sector emissions and nearly one-quarter of North Carolina's total emissions of global warming pollution.<sup>51</sup>

## Global Warming Reduction Efforts in North Carolina

North Carolina has already adopted one program that will curb its global warming emissions. Last year, North Carolina enacted a requirement that an increasing

### Other Global Warming Pollutants

This report focuses on transportation-related emissions of carbon dioxide—the leading pollutant responsible for global warming and the global warming gas released in the largest quantities by cars and trucks. Cars and trucks produce other global warming pollution, however, that must be considered in any emission reduction strategy.

- **Methane** – Methane gas is likely the second most important contributor to global warming. Cars and light trucks produce methane in their exhaust, but it is thought that they are only minor emitters of methane and that pollution will be reduced in the future through improved emission control systems.<sup>53</sup>
- **Nitrous Oxide** – Nitrous oxide is also produced in automobile exhaust, with mobile sources estimated to contribute about 13 percent of U.S. nitrous oxide emissions in 2002.<sup>54</sup> As with methane emissions, improved pollution control measures may reduce nitrous oxide emissions in the future.
- **Hydrofluorocarbons (HFCs)** – HFCs are extremely potent global warming gases, yet tend to be released in only very small quantities. HFCs are often used as coolants in vehicle air conditioning systems and can escape from those systems into the environment.
- **Black Carbon** – Black carbon is a product of the burning of fossil fuels, particularly coal and diesel fuel. Recent research has suggested that, because black carbon absorbs sunlight, it may be a major contributor to global warming, perhaps second in importance only to carbon dioxide. Research is continuing on the degree to which black carbon emissions contribute to global warming, and it is difficult to judge exactly how large a role black carbon might play in the U.S.'s contribution to global warming.<sup>55</sup>

## A Note on Units

**B**ecause various gases contribute to global warming, and the potency of the warming effects of those gases varies, inventories of global warming pollution typically use units that communicate emissions in terms of their global warming potential.

In this report, we are measuring emissions of carbon dioxide only and thus report emissions in terms of carbon dioxide. Other documents may communicate pollution in terms of “carbon equivalent.” To translate carbon equivalent to carbon dioxide, one can simply multiply by 3.66.

percentage of the state’s electricity needs should be met with clean, renewable energy sources or by energy efficiency.<sup>56</sup> By 2021, 12.5 percent of customer demand met by investor-owned utilities must come from renewables or efficiency. Municipal and cooperatively owned utilities must meet a lower requirement.

While this standard will help to reduce North Carolina’s global warming pollution from the electric sector, it does nothing to reduce emissions from transportation. North Carolina should next begin to address the challenge of emissions from the transportation sector.

## The Transportation Challenge

The challenge of reducing global warming pollution from cars and trucks is formidable, and growing increasingly so with each passing year.

Three factors—increasing vehicle miles traveled, stagnant fuel economy standards that were only recently updated, and large numbers of light trucks and SUVs—in the transportation sector make the challenge of reducing global warming pollution in North Carolina even greater.

## Increasing Vehicle Miles Traveled

North Carolina residents are traveling more miles in their cars and light trucks than ever before. Between 1996 and 2006, the number of vehicle-miles traveled (VMT) annually on North Carolina’s roads increased from 78.7 billion miles to 101.2 billion miles—an increase of 29 percent.<sup>57</sup> (See Figure 4.) VMT has been increasing faster than population growth. In 2006, the average North Carolinian drove nearly 2,000 miles more than in 1990. If VMT growth continues at the same annual rate, by 2020, VMT will increase 39 percent to 145 billion miles.

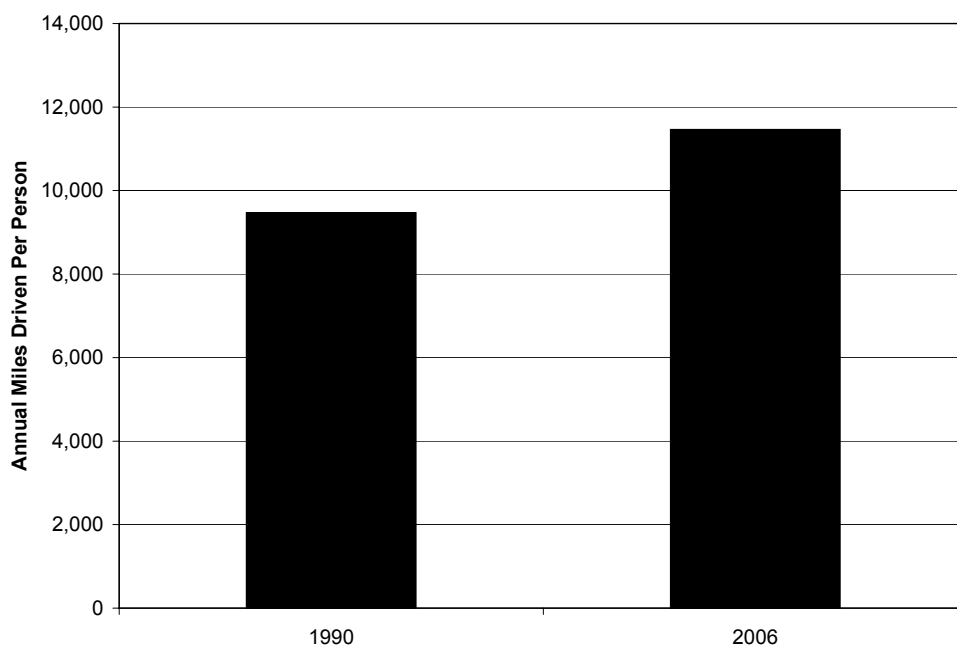
## Stagnant Fuel Economy Standards

The imposition of federal Corporate Average Fuel Economy (CAFE) standards beginning in 1975 led to dramatic improvements in the fuel efficiency of American cars and light-duty trucks. The CAFE standards required a gradual increase in fuel economy during the 1970s and 1980s, topping out at an average fuel economy for new cars of 27.5 miles per gallon (mpg) by 1990 and 20.7 mpg for light trucks by 1996.<sup>59</sup> The standard for light trucks has since been increased to 22.2 mpg.

In the decade-and-a-half following enactment of the CAFE standards, the “real



**Figure 4. North Carolinians Are Driving More Miles Every Year<sup>58</sup>**



world” fuel economy of passenger cars nearly doubled—from 13.5 mpg in 1975 to 24.1 mpg in 1988. Similarly, light trucks experienced an increase in real-world fuel economy from 11.6 mpg in 1975 to 18.3 mpg in 1987.<sup>60</sup>

However, the trend in the 1990s was toward less fuel-efficient vehicles as automakers focused on producing more powerful cars instead of more efficient ones. To make matters worse, changes in driving patterns, including higher speeds and increased urban driving, further depressed fuel economy. An EPA analysis of fuel economy trends found that the average real-world fuel economy of light-duty vehicles sold in 2004 was lower than the average fuel economy of vehicles sold in 1981. (See Figure 5.) Though fuel economy has stabilized for the past several years and even started to increase slightly, in many cases Americans get fewer miles per gallon from their new vehicles today than they did during the Reagan administration.

In December 2007, Congress updated

CAFE standards for cars and light trucks. By 2020, the fuel economy of new cars and light trucks must average 35.0 mpg. The full phase-in schedule for the standards has yet to be determined, but a proposed schedule suggests that the fleet average will be just 30.6 mpg in 2015.<sup>62</sup> This figure includes an adjustment for a loophole that allows automakers to earn credit toward meeting fuel economy standards for producing vehicles that are capable of running on alternative fuel, even though most vehicles never use anything but gasoline.

While any increase in fuel economy standards is a welcome improvement, Congress could have established far higher standards that would have achieved greater global warming pollution reductions.

### **Large Numbers of SUVs and Light Trucks**

While the fuel economy of the average car and light truck has stagnated over

the past two decades, the average fuel economy of the entire new-car fleet has declined—thanks to the dramatic shift toward sport utility vehicles (SUVs), vans and light trucks.

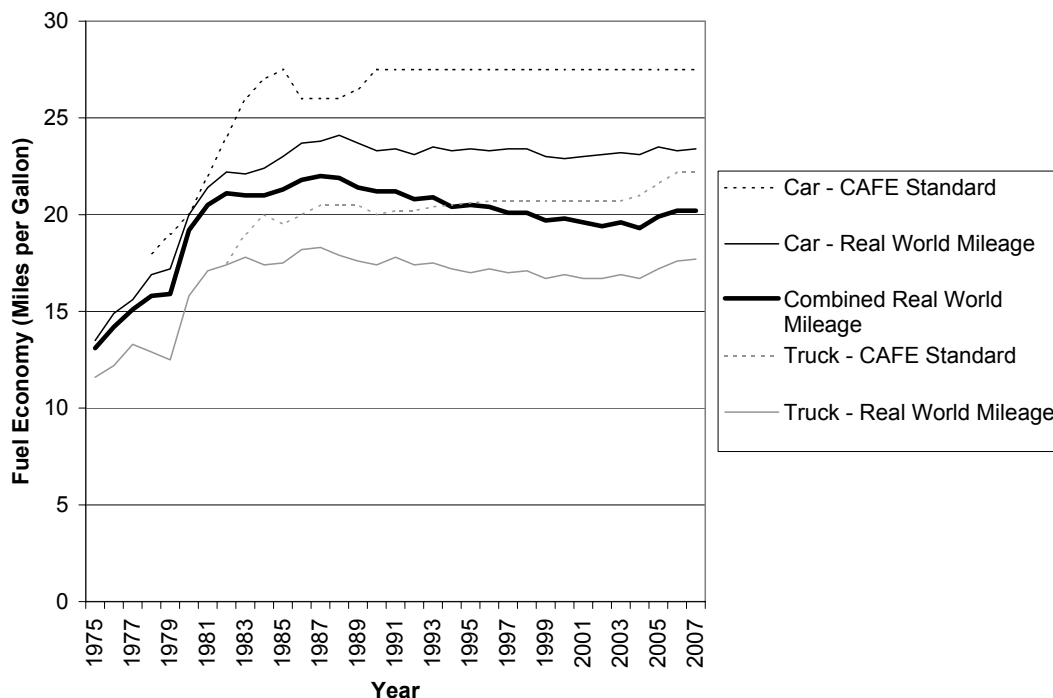
In 1975, when the first federal CAFE standards were enacted, SUVs made up 2 percent of the light-duty vehicle market, vans 5 percent, and pickup trucks 13 percent. By model year 2007, however, SUVs accounted for 29 percent of light-duty vehicle sales, vans 6 percent, and pickup trucks 14 percent. The light-duty market share of passenger cars and station wagons dropped over the same period from 81 percent to 51 percent.<sup>63</sup> (See Figure 6.)

This shift toward larger vehicles has caused the average fuel economy of the entire new light-duty vehicle fleet to dip as low as 19.3 mpg in 2004—lower than at any time since 1980 and down by 12 percent from the historical peak in 1987 and 1988.<sup>65</sup>

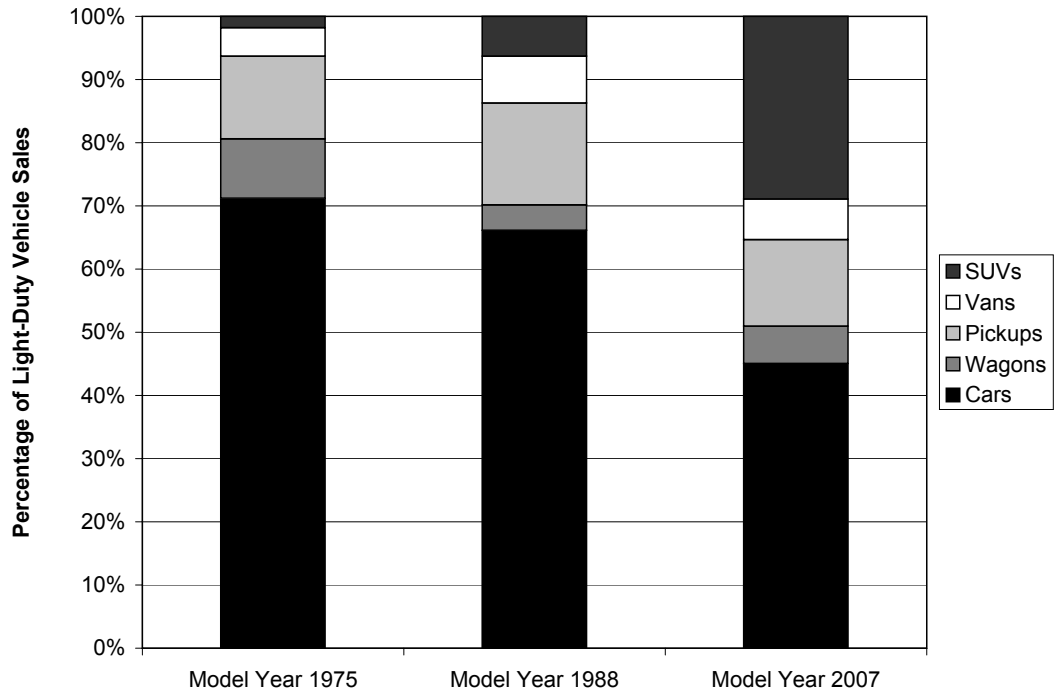
Recent increases in gasoline prices have slowed sales of SUVs, but it is too early to determine if the long-term shift toward SUVs and light trucks will change significantly. (Manufacturers have promoted “cross-over” vehicles—or SUVs that look like large cars—as an alternative to SUVs, but because these vehicles often are classified as light trucks, their fuel economy is not necessarily better than that of conventional SUVs.) Even if the number of SUVs and light trucks begins to decline, it will be many years before the mix of vehicles on the road changes significantly.

The combination of these three factors—more miles traveled, increasingly in trucks and SUVs, with stagnant fuel economy across the entire vehicle fleet—poses a great challenge to North Carolina policy-makers as they attempt to reduce global warming pollution from the transportation sector.

**Figure 5. Average Fuel Economy for New Light-Duty Vehicle Fleet Stagnant<sup>61</sup>**



**Figure 6. Light-Duty Vehicle Mix Shifts from Cars to Trucks, Vans and SUVs<sup>64</sup>**



## Vehicle Carbon Dioxide Pollution in North Carolina: Past and Projected

Based on North Carolina-specific fuel consumption data compiled by the U.S. Energy Information Administration (EIA), cars and light-duty trucks released approximately 26.3 million metric tons of carbon dioxide into the atmosphere in 1990. By 2005, those emissions had increased by 33 percent, to 35.1 MMTCO<sub>2</sub>, and cars and trucks were responsible for close to one-quarter of North Carolina’s emissions of global warming pollution.

Any attempt to project North Carolina’s future global warming pollution depends greatly on the assumptions used. The “Assumptions and Methodology” section at the conclusion of this report describes in detail the assumptions used to develop the

following projections. Simply put, the “reference case” for carbon dioxide emissions (based largely on data and projections by state and federal government agencies) assumes continued growth in vehicle travel, an improvement in vehicle fuel economy to comply with new federal CAFE standards, and no increase in the percentage of vehicles that are trucks and SUVs.

Based on these assumptions, carbon dioxide emissions from the North Carolina light-duty vehicle fleet are projected to increase by 7 percent over 2005 levels by 2010, followed by a further 5 percent increase between 2010 and 2020. In other words, by 2020, carbon dioxide emissions from cars and light trucks could be 49 percent greater than 1990 levels in the absence of action to reduce emissions.

An increase of such magnitude would severely challenge North Carolina’s ability

to stabilize and eventually reduce global warming pollution from the transportation sector and the state as a whole.

However, this path toward increasing carbon dioxide pollution from cars and light trucks is not inevitable. Public policies that require or encourage the purchase of

more fuel-efficient or advanced technology cars can make a significant dent in North Carolina's future emissions of global warming pollution while potentially saving money for drivers. One of the most powerful policy options is setting limits on vehicle global warming pollution.

## Transportation and Global Warming: A Primer

A gallon of gasoline contains a set amount of carbon, nearly all of which is released to the atmosphere when it is burned. Some of the carbon is released in the form of hydrocarbons; most of it is released in the form of carbon dioxide. For each gallon of gasoline burned in a vehicle, about 19.6 pounds of carbon dioxide is released to the atmosphere. In addition, the consumption of gasoline creates significant additional "upstream" emissions of carbon dioxide resulting from the extraction, transportation, refining and distribution of the fuel. Other fuels have greater or smaller amounts of carbon in a gallon (or its equivalent).

Unlike other vehicular air pollutants that result from the incomplete combustion of fossil fuels or from fuel impurities, carbon dioxide is a natural result of the combustion process. As a result, there are three main ways to limit carbon dioxide pollution from motor vehicles:

1. Drive more efficient vehicles.
2. Reduce the number of miles traveled.
3. Switch to fuels with lower life-cycle global warming impacts, such as electricity generated from renewable sources or ethanol made from crop waste.

Vehicles also emit small amounts of other global warming gases, such as methane and nitrous oxide, as well as hydrofluorocarbons from the use of the air conditioning system. Control of some of these emissions is possible through means other than reducing fuel use or substituting low-carbon fuels.

# Tools to Reduce Global Warming Pollution from Cars and Light Trucks

**N**orth Carolina has many potential tools available to reduce emissions of global warming pollution from the transportation sector. In addition to greater efforts to promote alternatives to driving, the state should use the most powerful tool it has available now for cutting emissions from transportation: adopting global warming pollution standards for cars and trucks.

The Clean Air Act gives most states two options for control of motor vehicle emissions identified as pollutants under the Act: states may choose to comply with federal emission standards or adopt the more protective standards—known as the Clean Cars Program—pioneered by the state of California, the only state empowered by the Clean Air Act to devise its own emission regulations.

Fourteen states—Maryland, New Jersey, Pennsylvania, New York, Massachusetts, Connecticut, Rhode Island, Vermont, Maine, Arizona, New Mexico, Oregon, Washington and California—have adopted the Clean Cars Program, including the vehicle global warming emission standards, and others—including Florida, Utah, and

Colorado—have gubernatorial commitments in place to adopt the standards.

As discussed below, adoption of the Clean Cars Program would significantly reduce emissions of global warming gases from cars and trucks, providing important assistance in North Carolina's efforts to curb global warming pollution.

The Clean Cars Program has two parts, analyzed separately below. One component requires that vehicles reduce global warming pollution. The other part promotes vehicles that have lower emissions of toxic and smog-forming pollution and encourages development of new technologies that have the potential to reduce greenhouse gas pollution.

## Vehicle Global Warming Pollution Standards

In July 2002, California adopted the first law to control carbon dioxide emissions and other global warming pollution from automobiles. The law requires the Califor-

nia Air Resources Board (CARB) to adopt limits that “achieve the maximum feasible and cost-effective reduction of greenhouse gas emissions from motor vehicles.” Limits on vehicle travel, new gasoline or vehicle taxes, or limitations on ownership of SUVs or other light trucks cannot be imposed to attain the new standards.<sup>70</sup> In September 2004, CARB adopted rules for implementation of the global warming pollution standards.

In developing the global warming pollution standards, the CARB staff reviewed several analyses of the types of technologies

that could be used to achieve “maximum feasible and cost-effective” reductions in global warming pollution from vehicles. CARB’s proposal estimates that near-term technologies could reduce average global warming pollution from cars and the lightest light trucks by 25 percent and from heavier light trucks by 18 percent. Over the medium term (2013 to 2016), cost-effective reductions of 34 percent for cars and smaller light trucks and 25 percent for heavier light trucks are feasible.<sup>71</sup> Preliminary discussion by CARB suggests that by 2020, global warming pollution from

## The Bush Administration’s Challenge to the Clean Cars Program

The Clean Air Act allows California—and other states with pollution problems—to adopt vehicle emission standards that are more protective than federal standards. However, before California can implement a new policy, the U.S. Environmental Protection Agency must review California’s proposed standard to ensure that it is not “arbitrary and capricious” and that the state faces “compelling and extraordinary conditions” that require stronger standards.<sup>66</sup> So long as the state satisfies these criteria, the Clean Air Act indicates that EPA should grant California a “waiver” from federal rules to implement its new standards.

Historically, EPA has approved more than 40 waivers giving California permission to pursue stronger environmental protections.<sup>67</sup> In December 2007, however, EPA denied a waiver for California and other states to implement the global warming pollution standards of the Clean Cars Program. The EPA administrator issued its denial despite a recommendation from EPA staff that the agency grant California the waiver and would be likely to lose a lawsuit if the agency rejected the waiver and California sued.<sup>68</sup>

California and other states are challenging the EPA’s decision in court. Implementing the Clean Cars Program is the best way to reduce global warming pollution from cars and light trucks and is central to many states’ efforts to reduce their global warming pollution. In the 14 states that have adopted the standards, the Clean Cars Program will reduce emissions by 34.2 million metric tons of carbon dioxide in 2020.<sup>69</sup>

By admission of EPA’s own legal staff, the Clean Cars Program is likely to be upheld by the courts, and EPA’s waiver-denial rebuked. In this case, North Carolina would be able to implement the program two years from the time it is adopted by state policy makers, as early as 2011.

cars and the lightest trucks will be reduced by 36 percent and pollution from heavier trucks will be cut by nearly half.<sup>72</sup>

One of the central requirements of the standards is that they be cost-effective. CARB has adhered to that requirement and added a margin of error to ensure that the standards meet that requirement.

The technological changes needed to achieve the reductions that CARB has required (such as five and six-speed automatic transmissions and improved electrical systems) will likely result in modest increases in vehicle costs that would be more than recouped over time by consumers in the form of reduced fuel expenses. CARB projects that cars and the lightest light trucks attaining the 34 percent reduction in global warming pollution required by 2016 would cost an average of \$1,064 more for consumers, while heavier light trucks achieving the required 25 percent reduction would cost about \$1,029 more.<sup>73</sup> (These cost increases are relative to cars and light trucks sold today, not the more efficient vehicles that will be manufactured to comply with the new federal fuel economy standards.)

However, the agency also estimates that the rules will significantly reduce operating costs for new vehicles. Though consumers will face higher monthly loan payments when purchasing vehicles that comply with the global warming pollution standards, those increased costs will be more than offset by lower operating expenses. For example, a consumer who buys a new

car in 2016 will save \$20 per month due to lower operating expenses compared to a car available today, despite higher loan costs and assuming gas costs \$3 per gallon. After the loan is paid off, the consumer will save \$41 per month versus a car purchased under old federal fuel economy standards. Drivers who purchase a light truck or who pay for the vehicle in cash will experience greater savings.<sup>74</sup> (See Table 1.)

CARB also projects that the net impact of the standards to the state's economy will be positive, suggesting that North Carolina could save money while at the same time reducing the state's overall emissions of global warming gases.<sup>76</sup>

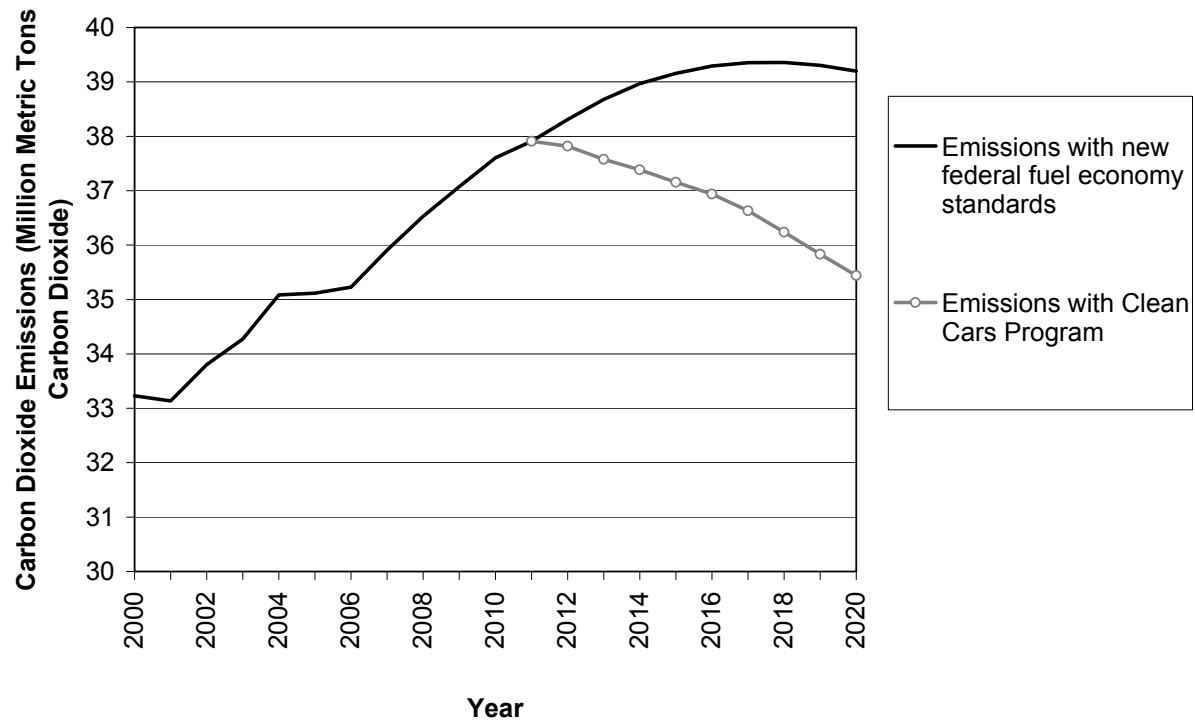
Assuming that North Carolina adopts the standards beginning with the 2012 model year and that emissions standards after 2016 continue to be strengthened, the resulting reductions in global warming pollution would be significant. Compared to the reference case projection for 2020, the emission standards would reduce light-duty carbon dioxide emissions by 10 percent in 2020—for a total reduction of 3.8 MMTCO<sub>2</sub>. (See Figure 7.)

Adopting the Clean Cars Program can contribute significantly to efforts to reduce global warming pollution from North Carolina's transportation sector. With both components in effect, emissions from light-duty cars and trucks would be 1 percent greater in 2020 than they were in 2005, compared to 12 percent greater if no action is taken.

**Table 1. Net Savings for a Consumer Under Global Warming Pollution Standards in 2016 Versus Buying a Vehicle That Complies with Old Federal Fuel Economy Standards<sup>75</sup>**

|  | <b>Car</b> | <b>Light-Truck or SUV</b> |
|--|------------|---------------------------|
| Annual Net Savings while Repaying Loan | \$245      | \$320                     |
| Annual Net Savings after Loan          | \$490      | \$560                     |
| Time to Recoup Higher Cost of Vehicle  | 2.2 years  | 2.5 years                 |

**Figure 7. Reductions in Carbon Dioxide Emissions Under Global Warming Pollution Standards (Light-Duty Vehicles)**



## Global Warming Pollution Standards Versus Fuel Economy Standards

The global warming pollution standards within the Clean Cars Program cover multiple pollutants, including carbon dioxide from fuel combustion and air conditioner use, methane and nitrous oxide from the tailpipe, and hydrofluorocarbons that are used in air conditioners. To produce vehicles that comply with the Clean Cars Program, automakers can adjust vehicle operation to reduce emissions of any combination of these pollutants. (In this report, we look at emissions of carbon dioxide, the most common pollutant, only.)

In contrast, the federal government’s vehicle fuel economy standards regulate how much gasoline or diesel a vehicle may use to travel a mile. To comply with federal standards, car manufacturers must produce more efficient vehicles.

Because the California regulations and federal standards control different aspects of vehicle performance, comparing the two standards requires some approximation. The California Air Resources Board estimates that in 2015, federal fuel economy standards will require vehicles to average 30.6 miles per gallon.<sup>77</sup> In contrast, the global warming pollution standards will equal 31.4 miles per gallon. By 2020, the federal standard will rise to 35 miles per gallon, versus 42.5 miles per gallon for the global warming pollution standard.<sup>78</sup>



## Advanced Technology Standard

In addition to requiring strict limits on global warming pollution, the Clean Cars Program includes standards to reduce smog-forming and other hazardous pollutants. Though stricter than federal tailpipe emission standards, the program achieves its goals in a similar way: by establishing fleet-wide limits on tailpipe emissions of toxic and smog-forming pollutants.

Unlike federal standards, however, the Clean Cars Program includes an advanced-technology standard, which requires the sale of advanced-technology vehicles such as hybrids that have even lower emissions. Eventually, the program calls for the sale of zero-emission vehicles, such as full-function electric vehicles. In addition, some of the technological changes encouraged by the advanced technology requirement help to lay the groundwork for new technologies that can reduce emissions of global warming pollutants.

By adopting the Clean Cars Program, North Carolina can expect to have increasing percentages of advanced-technology vehicles on the road over the next decade and more. The three main components of the advanced technology standard are described below.<sup>79</sup>

### Zero-Emission Vehicles

“Pure” zero-emission vehicles are those—like battery-electric and hydrogen fuel-cell vehicles—that release no toxic or smog-forming pollutants from their tailpipes or fuel systems. They also have the potential to release far fewer global warming gases than today’s vehicles. (Note, however, that fuel-cell vehicles have zero emissions only when the electricity used to create the hydrogen is generated from renewable sources such as wind or solar power.)

The current emphasis of the program is on the long-term development of hydrogen

fuel-cell and other zero-emission vehicles rather than the near-term deployment of battery-electric vehicles. The current advanced technology standard requires the sale of very few pure zero-emission vehicles over the next decade but it does provide an incentive for automakers to continue research and development work on technologies that could provide zero-emission transportation in the future.

### Clean Conventional Vehicles

The majority of vehicles that automakers produce to comply with the technology standard will be conventional gasoline vehicles that are engineered to produce dramatically lower emissions of air toxics and smog-forming pollutants and have longer-lasting emission-control systems.

### Advanced Technology Vehicles

The advanced technology requirement includes provisions to encourage the sale of exceptionally low-emitting vehicles that also run on a cleaner alternative fuel, such as compressed natural gas, or that use advanced technologies, such as hybrid-electric drive.

Hybrid-electric vehicles are the most likely technology to be used to comply with the advanced technology vehicle component. Hybrids have proven to be very popular with consumers, especially in an era of higher and rapidly fluctuating gasoline prices. Sales of hybrid vehicles have increased steadily since their introduction to the domestic market in December 1999. About 330,000 hybrids were sold in the U.S. in 2007, a 34 percent increase over sales in 2006.<sup>80</sup>

Today, the degree of global warming gas reductions from advanced technology vehicles varies greatly. Some hybrid-electric vehicles and alternative-fuel vehicles—such as hybrid pickup trucks to be sold by General Motors and DaimlerChrysler—have

nearly the same global warming emissions as conventional vehicles. Others, like the Toyota Prius, offer substantial reductions in global warming emissions.

The advanced technology standard does provide additional credit to hybrid-electric vehicles that attain a greater share of their power from an electric motor (generally allowing them to achieve lower carbon dioxide emissions), but these credits are not directly tied to global warming pollution.

### **Impact of the Advanced Technology Standards**

In the short term, the advanced technology standards can help to cut emissions of toxic and smog-forming pollution in North Carolina. The full benefits of the program, however, accrue over the long run, as new technologies are developed to comply with the program. At its heart, the advanced technology standard attempts to jump-start advanced technology vehicle development and the adoption of these technologies in the mainstream auto market.

An example of the potential power of the program to hasten technological change is the development of hybrid vehicles. Adoption of the original program sparked public and private-sector research efforts into the development of advanced batteries and electric-drive technologies. While the generation of full-function electric vehicles that resulted from that research—such as Honda’s EV-Plus and General Motors’s EV1—were not sold in large quantities, the research effort drove advances in electric vehicle technology that facilitated the birth of the popular hybrid-electric systems that now power hundreds of thousands of vehicles worldwide and have laid the groundwork for recent advances in fuel-cell vehicle technology.<sup>81</sup>

Similarly, the current form of the advanced technology standard is designed to encourage continued investment in hybrid-electric and hydrogen fuel-cell vehicle development and may lead to the development of new types of vehicles (such as “plug-in hybrids” that combine the benefits of battery-electric and hybrid-electric vehicles) with significant benefits for the climate.

# Policy Recommendations

**A**ttaining reductions in carbon dioxide emissions will require significant actions to reduce emissions from light-duty vehicles. No one policy will solve the problem. North Carolina will need to pursue a range of policies to address the current lack of standards for vehicle global warming pollution and increasing vehicle miles traveled.

## Adopt the Clean Cars Program

The first step North Carolina should take is to adopt the Clean Cars Program for implementation in model year 2012, establishing vehicle global warming pollution standards. The standards will limit growth in emissions from light-duty vehicles.

## Reduce Per-Mile Emissions from Vehicles

The Clean Cars Program is the biggest step North Carolina can take now to

reduce global warming emissions from vehicles. Other policies can provide additional benefits.

## Promote Low-Carbon Fuels

Fuels such as electricity and biofuels can have lower global warming emissions than petroleum fuels. Some fuels have lower emissions than others—cellulosic ethanol is less polluting than corn-based ethanol, for example. A statewide low-carbon fuel standard, such as one adopted by California, would promote fuels that provide the greatest global warming benefit.

## Reduce Growth in Vehicle Travel

### Improve Transit Service

Better bus and rail service could reduce the amount citizens need to drive. Existing bus service could be improved with more frequent service and extended hours. In relatively low-density neighborhoods and shopping areas, small shuttle buses can

carry passengers to major bus lines that are beyond walking distance. Smaller cities and towns that do not have transit should establish service. Carpools and vanpools can help serve areas not accessible to transit.

Employers can help organize and promote ride-sharing programs by pairing drivers with similar commutes, offering preferred parking to carpools, and providing a ride home if an employee has a mid-day emergency or needs to stay at work late.

### **Expand Walking and Biking Options**

Many trips can be completed on foot or bicycle instead of in a car, but the lack of safe routes for walking or cycling deters people. Sidewalks with pedestrian amenities such as benches and trees, and shops oriented toward customers on foot rather than in cars can encourage more people to walk. Changes to road design can slow traffic, making it easier and safer for pedestrians and cyclists to cross busy intersections.

### **Link Insurance to Miles Driven**

For almost all drivers, insurance is a “fixed cost,” meaning that they pay the

same amount each year regardless of how much they drive. As a result, when drivers consider the cost of driving extra miles, insurance expenses do not come into play. Offering insurance on a cents-per-mile basis can encourage car owners to drive less by making apparent the full costs of each mile driven.

Private insurers could offer cents-per-mile insurance that allows drivers to purchase insurance by the mile. Drivers would have a direct financial incentive to drive less. Such insurance also can provide a benefit to senior citizens and others who drive less than average.

### **Promote Smart Growth**

Compact development can reduce how much people need to drive. Many existing developments in North Carolina are spread out, placing jobs and shops out of easy walking distance of homes. New housing and shopping projects could be constructed to encourage trips on foot or bike or by transit, allowing residents the option of not driving. For example, transit-oriented development concentrates homes and shops near transit hubs to facilitate the use of transit.

# Assumptions and Methodology

**P**rojections of future global warming pollution from automobiles depend a great deal on the assumptions used. This section details the assumptions we made about future trends and explains the methodology we used to estimate the impact of various programs.

## Historic Light-Duty Vehicle Carbon Dioxide Emissions

Carbon dioxide emissions from light-duty vehicles (cars and light trucks) in North Carolina in 1990 and 2000-2004 were based on state-specific motor gasoline usage data from the U.S. Department of Energy, Energy Information Administration (EIA), State Energy Data.<sup>82</sup> Fuel consumption data for the transportation sector in BTU was converted to carbon dioxide emissions based on conversion factors from EIA, Annual Energy Outlook 2003, Appendix H and EIA, Emissions of Greenhouse Gases in the United States 2001, Appendix B. The proportion of transportation-sector gasoline emissions

attributable to light-duty vehicles was estimated by dividing energy use by light-duty vehicles by total transportation-sector motor gasoline use as reported in EIA, *Annual Energy Outlook 2007*.

## Projected Light-Duty Vehicle Carbon Dioxide Emissions

### Vehicle-Miles Traveled

Historic vehicle-miles traveled data for North Carolina were obtained from Hardee Cox, Road Inventory Information Section, North Carolina Department of Transportation, personal communication, 18 March 2008. Projected VMT was calculated on the assumption that the average annual growth rate from 1996-2006 will continue in the future.

### VMT Percentages by Vehicle Type

To estimate the percentage of vehicle-miles traveled accounted for by cars and light-duty trucks, we calculated VMT splits by vehicle type for 2000 through 2006 from

the Federal Highway Administration, Highway Statistics series of reports and estimated future VMT splits.

To calculate North Carolina-specific data on VMT splits, we obtained annual registration data from Highway Statistics, Tables MV-1 and MV-9 for 2000 through 2006. We then multiplied the number of registered vehicles by the average miles driven per vehicle type, as reported in FHWA Table VM-1. From this, we obtained a VMT split between cars and light-duty trucks.

EPA's projections of the VMT split among cars and light-duty trucks assign significantly more VMT to light-duty trucks than has been the case over the past several years, according to FHWA data. Recent rises in fuel prices have prompted more consumers to purchase cars instead of trucks than has been the case for several years and North Carolina's fleet mix was relatively stable from 2000 to 2006. We assumed that the fleet mix will remain steady, with continued marketing of crossover vehicles and SUVs counterbalanced by rising gas prices.

VMT in the light-truck category were further disaggregated into VMT by "light" light trucks (in the California LDT1 category) and heavier light trucks (California LDT2s), per EPA, *Fleet Characterization Data for MOBILE6: Development and Use of Age Distributions, Average Annual Mileage Accumulation Rates, and Projected Vehicle Counts for Use in MOBILE6*, September 2001.

### **VMT Percentages by Vehicle Age**

Vehicle-miles traveled by age of vehicle were determined based on VMT accumulation data presented in EPA, *Fleet Characterization Data for MOBILE6: Development and Use of Age Distributions, Average Annual Mileage Accumulation Rates, and Projected Vehicle Counts for Use in MOBILE6*, September 2001.

### **Vehicle Carbon Dioxide Emissions**

Per-mile carbon dioxide emissions from vehicles were based on assumed levels of carbon dioxide emissions per gallon of gasoline (or equivalent amount of other fuel), coupled with assumptions as to miles-per-gallon fuel efficiency.

For conventional vehicles, a gallon of gasoline was assumed to produce 8,869 grams (19.6 pounds) of carbon dioxide. This figure is based on carbon coefficients and heat content data from EIA, *Emissions of Greenhouse Gases in the United States 2001*, Appendix B. Fuel economy estimates were based on data presented in EIA, *Assumptions to the AEO 2007*, and multiplied by a degradation factor obtained from EIA, *Assumptions to the AEO 2007*. (The degradation factor represents the degree to which real-world fuel economy falls below that reported as a result of EPA testing.)

The data in AEO 2007 were compiled in early 2007 before Congress passed legislation updating CAFE standards to a 35 mpg fleetwide average by 2020. EIA has not yet released data on the likely phase-in of this standard, so we drew upon an estimate prepared for California Environmental Protection Agency, Air Resources Board, *Comparison of Greenhouse Gas Reductions for the United States and Canada Under U.S. CAFE Standards and California Air Resources Board Greenhouse Gas Regulations*, 25 February 2008. Using the underlying data for the report, we calculated the annual percentage reduction in emissions for passenger cars and light duty trucks, respectively, in California, and applied those same percentage reductions to the appropriate category of vehicles in North Carolina.

To calculate savings of the Clean Cars Program's global warming gas emission standards, we used data prepared for CARB, *Comparison of Greenhouse Gas Reductions*. We calculated the percentage reduction in emissions expected each year in California for cars and the lightest light trucks, and for heavier light trucks. We

then applied those percentage reductions to projected emissions from vehicles in North Carolina and tallied emissions from all vehicles to create a fleet-wide projection.

### **Fleet Emissions Projections**

Based on the above data, two scenarios were created: a reference case scenario based on implementation of the new federal fuel economy standards and a Clean Cars Program scenario based on the percentage emission reductions envisioned by CARB staff in their 25 February 2008 document. Each scenario began with data from 2005 and continued through 2020.

Projected emissions were based on the year-to-year increase (or decrease) in emissions derived from the estimation techniques described above. These year-to-year changes were then applied to the 2004 baseline emission level to create projections through 2020.

### **Mix Shifting**

We assumed that neither of the policies under study would result in changes in the class of vehicles purchased by North Carolina residents, or the relative amount that they are driven. In addition, we assumed that the vehicle age distributions assumed by EPA remain constant under each of the policies. In other words, we assumed that any increase in vehicle prices brought about by the global warming emission standards would not dissuade consumers from purchasing new vehicles or encourage them to purchase light trucks when they would otherwise purchase cars (or vice versa). Mix shifting impacts such as these are quite complex and modeling them was beyond the scope of this report, but they do have the potential to make a significant impact on future carbon dioxide emissions.

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