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Methodology for Estimating Greenhouse Gas Emissions and Assessing Mitigation Options for Project Level Applications for On-Road Mobile Sources

Volume 2 – White Paper on New Directions in Greenhouse Gas Emissions and Climate Change

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ABOUT THIS REPORT

This report contains a white paper developed as background material for the project "Methodology for Estimating Greenhouse Gas Emissions and Assessing Mitigation Options for Project Level Applications for On-Road Mobile Sources." This is a joint project conducted by the Texas Transportation Institute (TTI), and the Houston-Galveston Area Council (H-GAC), in consultation with the Texas Department of Transportation (TxDOT) and Houston Advanced Research Center (HARC). The project was conducted through direct funding from H-GAC and leverage funding from TxDOT.

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The other project deliverables include Volume 1 of the report, which contains documentation of the research approach, methods, and findings, and a spreadsheet-based analysis tool which can be used to evaluate the effectiveness of greenhouse gas reduction strategies.

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1. INTRODUCTION

Overview

The purpose of this white paper is to clarify the current policy and legislative developments in the area of greenhouse gas emissions (GHGs) and to discuss the possible impact these policy developments could have on the transportation sector, specifically Texas.

GHGs have long been suspected to contribute to the deterioration of air quality and human health as well as cause adverse changes to the earth's climate. Globally, transportation accounts for 19 percent of global energy use and 23 percent of carbon dioxide (CO_2) emissions *(1).* In the U.S., on-road mobile sources are a major contributor of GHG, contributing nearly 30 percent of total U.S. GHG emissions. Transportation also has an impact on issues such as land use, changes in agriculture, business locations, settlement patterns, and housing – thereby causing indirect or secondary impacts on GHG/climate change issues as well *(2).* Many government policies have aimed toward reducing GHG emissions from the transportation sector. In 2009, the U.S. Environmental Protection Agency (EPA) declared that CO_2 and other GHGs constitute a threat to human health in what is termed as the "endangerment finding." This finding now paves the way for EPA to regulate GHG emissions if Congress fails to address the issue. Texas, with its heavy industrial base and extensive transportation network will possibly be greatly affected by new rules regulating GHGs. Therefore, it is necessary for state and local transportation officials in Texas to be prepared for these potential new mandates.

This white paper provides background information on GGHs as determined by the EPA and discussion on the role transportation plays in contributing to GHG emissions. Trends in anthropogenic GHG emissions for the U.S. and for Texas, and current federal, state, and local legislation toward regulation of GHG emissions are also discussed. An overview of the various types of policy and legislation options being considered in the U.S., including carbon credit, trading, and tax strategies, is also provided. The document then discusses new directions and considerations on what can be done to address and mitigate transportation-related GHG emissions for the future.

GHGs and Climate Change

The "greenhouse effect" is the heating of the earth due to the presence of GHGs. This effect is analogous to glass panes in a greenhouse, whereby heat is allowed to enter but is trapped and limited in its ability to escape. GHGs cause a similar effect in earth's lower atmosphere. Shorter wavelength solar radiation passes through the "blanket" created by GHGs, causing the earth to warm. Energy that reaches the earth's surface from the sun is then reradiated back into space as longer wave infrared radiation. However, because some of the GHGs selectively transmit some of the infrared waves back into space while blocking others, heat is trapped within the earth's lower atmosphere. As a result, some infrared waves are absorbed by GHGs and are reemitted back to the earth's surface, causing the lower atmosphere to heat up.

Many gases in earth's atmosphere exhibit these "greenhouse" properties. Some of them occur in nature (water vapor, carbon dioxide, methane, and nitrous oxide), while others are exclusively human-made (like gases used for aerosols). Given the natural variability in earth's climate, it is difficult to determine the extent to which humans are contributing to global warming. What is clear is that global temperatures are rising. According to the U.S. Department of Energy (DOE), "rising concentrations of GHGs generally produce an increase in the average temperature of the earth. Rising temperatures may, in turn, produce changes in weather, sea levels, and land use patterns"*(3).*

GHGs of Interest as Determined by the EPA

In 2007, the U.S. Supreme Court found that the EPA was now required to determine whether emissions of GHGs from new motor vehicles cause or contribute to air pollution, which may reasonably be anticipated to endanger public health or welfare. In 2009, the EPA responded to the Court decision by proposing a finding that GHGs contribute to air pollution that may endanger public health or welfare, which was termed as the "endangerment finding," as mentioned previously. In its annual GHG Emissions Inventory Report, EPA identified six principal greenhouse gases that trap heat in the atmosphere: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_20), and fluorinated gases. A detailed discussion on each of these GHGs is provided below. Black Carbon, while currently not considered as a GHG by the EPA, was also included due to the increasing focus on it as a source of global warming.

Carbon Dioxide (CO_2)

CO_2 is a colorless, odorless non-flammable gas and is one of the most important GHGs found in the earth's atmosphere. CO_2 enters the air through the burning of fossil fuels (such as oil, natural gas, and coal), solid waste, trees and wood products, along with other factors. CO_2 is removed from the air when it is absorbed by plant life as part of the normal biological carbon cycle. CO_2 is also one of the leading GHGs that result from transportation-related activities *(4)*.

Recently, one California transportation agency found that climatic changes have already been seen due to CO_2 emissions and risks lie ahead for the agriculture, transportation and energy sectors for the next 20 years *(3).* According to the National Atmospheric and Oceanic Administration (NOAA), "CO_2 was the first GHG demonstrated to be increasing in atmospheric concentration with the first conclusive measurements being made in the last half of the 20th century. Prior to the industrial revolution, concentrations were somewhat stable at 280 parts per million (ppm). Today, they are around 370 ppm, an increase of more than 30 percent" *(5).* Ultimately, the U.S. produces about 25 percent of global CO_2 emissions from burning fossil fuels and without significant changes in current trends, CO_2 emissions are expected to increase by nearly 50 percent by 2030 and 80 percent by 2050 *(1).* (U.S. CO_2 emissions will be discussed later in this report).

Methane (CH_4)

CH_4 is a colorless, odorless, flammable gas that remains in the atmosphere for approximately 9-15 years. CH_4 is over 20 times more effective in trapping heat in the atmosphere than CO_2 over a 100-year period and is emitted from a variety of natural and human-influenced sources. This gas comes from landfills, coal mines, oil and gas operations, and agriculture; it represents about 9 percent of total GHG emissions *(3).* Over the past 250 years, the concentration of CH_4 in the atmosphere has increased by 148 percent. Anthropogenic sources of CH_4 include landfills, natural gas and petroleum systems, agricultural activities, coal mining, wastewater treatment facilities, stationary and mobile combustion, and certain industrial processes. Each year, Americans add 350-500 million tons of CH_4 to the air by raising livestock, coal mining, drilling for oil and natural gas, rice cultivation, and garbage sitting in landfills. Extremely negligible amounts of CH_4 emissions are produced from transportation-related activities.

Nitrous Oxide (N_2O)

N_2O is a colorless GHG that comprises about five percent of total GHG emissions. This gas is emitted from burning fossil fuels and using certain fertilizers and industrial processes. N_2O emissions have risen by more than 15 percent since 1750. In addition, nitrogen-based

fertilizer use has doubled in the past 15 years. Nitrogen-based fertilizers provide nutrients for crops; however, when they break down in the soil, N_2O is released into the atmosphere. In terms of transportation, N_2O is released at a much lower rate than CO_2 because there are significantly greater concentrations of carbon in motor fuels than nitrogen *(3).*

Fluorinated Gases (HFCs and CFCs)

Fluorinated gases, such as Hydrofluorocarbons, are synthetic, powerful GHGs that are emitted from a variety of industrial processes. Fluorinated gases are sometimes used as substitutes for ozone-depleting substances (i.e., CFCs, HFCs, and halons). Studies have shown that some HFCs (a type of fluorinated gas) trap heat in the atmosphere, thereby contributing to global warming. The HFCs and CFCs are related to transportation due to the use of air conditioning in the vehicles, but their release is much lower than CO_2.

Black Carbon

While black carbon has not yet been formally considered a GHG by EPA, recent scientific studies have indicated that "soot" is the second leading global warming contributor to human-induced global warming. Black carbon is formed through the incomplete combustion of fossil fuels, biofuel, and biomass, and is emitted in both anthropogenic and naturally occurring soot. It consists of pure carbon in several linked forms. Black carbon warms the planet by absorbing heat in the atmosphere and by reducing albedo, the ability to reflect sunlight, when deposited on snow and ice. According to some estimates, black carbon may be responsible for as much as 18 percent of the planet's warming, making it the number two contributor to climate change after CO_2 *(6)*. While CO_2 heats the atmosphere by blocking some radiation from emitting back into outer space, black carbon in the air absorbs sunlight as it comes from space, directly heating up the atmosphere. However, black carbon stays in the atmosphere for only several days, whereas CO_2 has an atmospheric lifetime of more than 100 years. This implies that black carbon mitigation techniques would have the most immediate impact on dealing with GHG emissions. Globally, transportation accounts for 25 percent of all black carbon emissions, of which diesel engines account for approximately 70 percent. The U.S. produces approximately 6.1 percent of the world's fossil fuel and biofuel soot, and on-road vehicle emissions are expected to decrease by as much as 90 percent as federal fuel efficiency requirements increase *(5)*. Globally, however, black carbon emissions are expected to increase by 77 percent over the next 20 years *(7).*

GHG Emissions and Transportation

Transportation plays a significant role in contributing to GHG emissions. In the U.S., GHG emissions come mostly from energy use. These are driven largely by economic growth, fuel used for electricity generation, and weather patterns affecting heating and cooling needs. In 2009, energy-related CO_2 emissions(e.g petroleum and natural gas, among others) represent 90 percent of total U.S. human-made GHG emissions. *(8).*

More specifically, in 2009 transportation activities accounted for 27 percent of CO_2 emissions from fossil fuel combustion in 2008. Virtually all of the energy consumed in this sector came from petroleum products. Nearly 53 percent of the emissions resulted from gasoline consumption for personal vehicle use. The remaining emissions came from other transportation activities, including the combustion of diesel fuel in heavy-duty vehicles and jet fuel in aircraft.

Many transportation officials are beginning to incorporate climate change studies into the transportation planning process. According to a report published by the Federal Highway Administration (FWHA), "there is a general scientific consensus that the earth is

experiencing a long-term warming trend" and increases in anthropogenic GHGs "may be the predominant cause for this increase" *(8)*. One Washington transportation agency referred to climate change as "the variation in the earth's global climate over time" and describes "significant changes in the variability or average state of the atmosphere". Other studies have argued that "climate change may result from natural factors or processes (such as changes in ocean circulation) or from human activities that change the atmosphere's composition (such as the burning of fossil fuels or deforestation). Some transportation agencies have also mentioned the effects of GHG emissions when considering future long and short range transportation planning. The Sacramento Area Council of Governments noted in their Environmental Sustainability Plan that the "consumption of fossil fuels such as gasoline, diesel, and natural gas by motor vehicles has been shown by scientists to lead directly to climate change" *(9)*.

Finally, because CO_2 comprises 96 percent of transportation-related GHG emissions, many agencies choose only to report CO_2 emissions in their annual inventory reports. While EPA provides complete emissions inventories on all six GHG emissions at the federal level, many states (including Texas) report only CO_2 emissions. Therefore, while total GHG emissions may be discussed in this report where data are available, it is assumed that GHG emissions are synonymous with CO_2 emissions in the transportation context.

2. TRENDS IN U.S. GHG EMISSIONS

This chapter will discuss overall U.S. trends in GHG emissions and will focus on the transportation sector in particular. Every year, the EPA prepares an emissions inventory to identify and quantify primary anthropogenic sources of GHGs. By adhering to a comprehensive set of methodologies established by the United Nations Framework Convention on Climate Change (UNFCCC), EPA conducts an estimation of all GHGs emitted in the U.S. and reports them to other national and international agencies. The process of estimating and reporting anthropogenic GHG emissions is essential for addressing climate change and understanding the sources of GHG emissions. Overall, GHG emissions in the U.S. have increased by 14 percent since 1990. CO_2 emissions (which comprise a majority of transportation GHG emissions) have increased 19 percent over the past 20 years.. Trends in overall U.S. GHG emissions, the role of the transportation sector and vehicle fuel efficiency, and the role of increasing vehicle miles traveled (VMT) will be discussed in greater detail in the following sections.

Measuring GHG Emissions

This report uses several standard units for presenting GHG emissions quantities. CO_2-equivalent (CO_2E) is a universal standard measurement used by climatologists that allows for the comparison of different GHGs based on their ability to trap heat in the atmosphere. There are many types of GHGs, and some gases are more effective at warming the atmosphere than others because they trap heat more effectively and longer. Climate scientists have estimated measures of both factors for many different GHGs that together determine the "global warming potential," or GWP of each gas. The GWP can then be used as a multiplier to compare emissions of different GHGs based on their ability to contribute to the greenhouse effect. The GWP of a GHG is relative to the warming potential of CO_2, which is set at a value of 1. Table 1 was obtained from EPA's 2010 Greenhouse Gas Inventory Emissions report and lists the global warming potential for each of the six GHGs discussed previously.

Table 1. Global Warming Potentials for Select GHGs.

Gas	GWP
Carbon Dioxide (CO_2)	1
Methane (CH_4)	21
Nitrous Oxide (N_20)	310
Flouroform (HFC-23)	11,700
Tetrafluoromethane (CF_4)	6,500
Hexafluoroethane (C_2F_6)	9200
Perfluorobutane (C_4F_{10})	7000

* GWP not provided for Carbon Monoxide(CO) or Sulfur Dioxide (S_2O)
* Source: IPCC Report, 1996

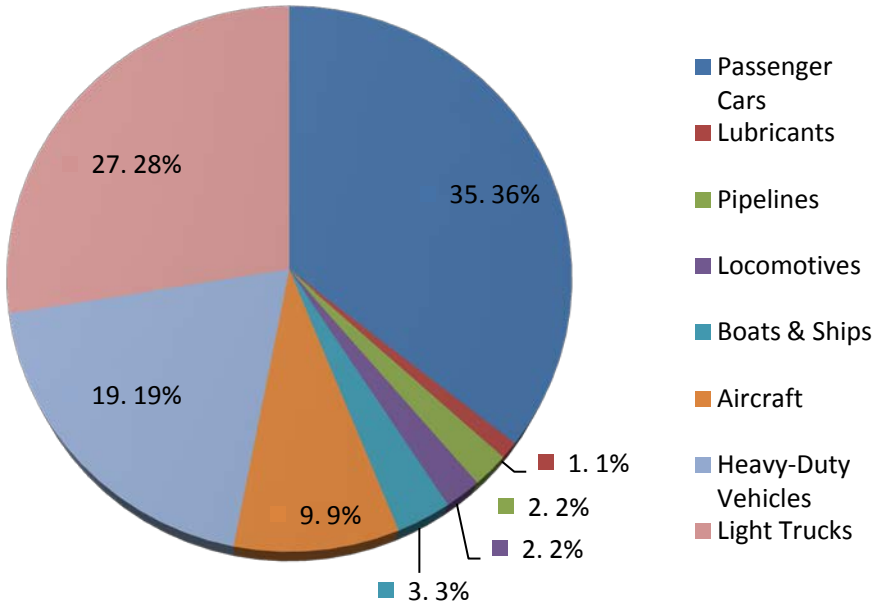
For example, the GWP value of CH_4 is 21, which means that a metric ton of CH_4 is approximately 21 times as effective at warming the atmosphere as is a metric ton of CO_2. Thus, in terms of CO_2E, a metric ton of CH_4 is the same as 21 metric tons of CO_2. Similarly, a metric ton of N_2O, which is approximately 310 times as effective at warming the atmosphere as a metric ton of CO_2, is the same as 310 metric tons of CO_2. See Appendix A for more information on methodologies used and limitations for calculating GHG emissions.

Trends in U.S. GHG Emissions - All Sectors

GHG emissions in the U.S. have grown by an average annual rate of 0.7 percent from 1990-2008. Total U.S. GHG emissions have risen by approximately 14 percent from 1990 to 2008 *(9)*. In 2008, total U.S. GHG emissions were 6.95 billion $MTCO_2E$ (metric tons of CO_2 equivalent). CO_2 from fossil fuel combustion has accounted for about 79 percent of global warming emissions since 1990, a slow growth from 77 percent in 1990 to 80 percent in 2008. Total CO_2 emissions have increased by 80 million $MTCO_2E$, or 14 percent, while CH_4 and N_20 emissions decreased by 7.5 percent and 1.3 percent, respectively. However, overall U.S. emissions from fossil fuel combustion have shown recent patterns of decline. This was due to the reduction in fuel consumption (primarily in the transportation sector) caused by rising fuel prices. From 2005 to 2006, emissions from fuel combustion decreased for the first time since 2001. However, historical indications suggest that transportation-related CO_2 emissions will increase significantly in the future *(10)*.

U.S. GHG Emissions – Role of Transportation Sector

Transportation activities accounted for 27 percent of all U.S. GHG emissions for 2008, second only to electricity generation *(10)*. Passenger cars contributed 35 percent of transportation GHGs, with light duty-trucks (which include sport utility vehicles, pickup trucks, and minivans) contributing 27 percent. Freight trucks contributed 19 percent of total transportation GHGs. The figures presented in Figure 1 include direct emissions from fossil fuel combustion as well as indirect GHG emissions from transportation-related activities (such as HFC emissions from mobile air conditioning units on vehicles).



*Source: EPA, 2006

Figure 1. Transportation-Related GHG Emissions by Source.

After experiencing a decrease from 2005 to 2006, emissions from fuel combustion grew from 2006 to 2007 but declined once again from 2007 to 2008. It is suggested by some EPA agents that this drop resulted from a decrease in demand for transportation fuels associated with the record high fuel costs and subsequent economic downturn. The increase in transportation fuel prices in 2008 led to a decrease in total VMT and a 5.7 percent decrease in transportation fuel combustion emissions *(10)*.

Transportation GHG emissions have increased by 22 percent over the past 20 years as a result of increased travel demand and relative stagnation in fuel efficiency improvements for on-road mobile sources(*14*). A detailed discussion about VMT is provided in Chapter 6 of this report.

Fuel economy among new vehicles sold in the U.S. declined from 1990-2004 due to the increasing market share of light-duty trucks (such as SUVs), which grew from about one-fifth of vehicle sales to little over one-half. Since 2004, however, increasing fuel prices have caused consumers to move increasingly toward more fuel efficient vehicles, increasing overall fuel efficiency.

A majority of the energy consumed for transportation and transportation-related activities was supplied by petroleum-based products, with 62 percent being related to gasoline consumption by passenger cars and light-duty trucks *(10)*. The primary driver of transportation-related activities was CO_2 emissions from fossil fuel combustion, which increased by 20 percent from 1990-2008. CO_2 emissions from fossil fuel combustion, coupled with other less significant GHGs associated with transportation, led to a 22 percent overall increase in GHG emissions from 1990-2008 *(10)*.

The United Nations Intergovernmental Panel on Climate Change (IPCC) advises that transportation-related CO_2 emissions must be cut by at least 50 percent by 2050 from current emission levels if some of the most severe consequences of climate change are to be avoided. Senior Transport Energy Analyst Lew Fulton argues that transportation must play a significant role in achieving these deep cuts. “Even with deep cuts in emissions from all other energy-using sectors,” Fulton argues, “transportation will need to reduce emissions significantly to stabilize atmospheric conditions of GHGs in the range of 450-550 parts per million of CO_2 equivalent by 2050” (*1*). Trends in VMT and fuel economy also could impact future CO_2 emissions and are discussed in greater detail in the following.

Trends in VMT

Over the past 20 years, total VMT has increased substantially. However, in 2008 VMT decreased 2.1 percent over the previous year due to the economic recession and increased fuel prices. According to the FHWA, total annual VMT increased from 2.1 trillion in 1990 to nearly 3 trillion in 2005. The average annual increase in VMT was approximately 3 percent per year, outpacing population growth by 1.4 percent *(11)*. The DOE estimated that VMT will grow by approximately 1percent from 2008-2030 *(12)*. At this rate, VMT would rise from 3 trillion in 2006 to approximately 4.5 trillion in 2030. VMT for light-duty vehicles is projected to rise from 2.7 trillion in 2006 to approximately 4 trillion by 2030. The DOE also predicts that while fuel efficiency will improve, growth in VMT will continue to grow and outpace these gains in efficiency. This implies that transportation-related GHG emissions are projected to increase significantly between now and 2030 *(13)*. Therefore, in addition to technological solutions to curb GHG emissions, VMT reduction is also an important component if the transportation sector is to meet its overall goal of reducing GHG emissions

by 60 to 80 percent by 2050. Chapter 6 of this report discusses in detail the policy options available for reducing VMT.

Trends in Overall Fuel Efficiency

Over the next 20 years, the DOE projects a gradual improvement in vehicle fuel economy. After accounting for new federal requirements imposed on corporate automotive manufacturers, the DOE predicts that incremental fuel improvement can be expected between now and 2030 *(13)*. Ultimately, DOE projects that average fuel economy for all light-duty vehicles (including light-duty trucks) will increase from 19.9 miles per gallon (mpg) in 2005 to 27.9 mpg in 2030, a 30 percent increase. Average fuel efficiency for new light-duty vehicles will increase by 1.3 percent per year, rising from 25.9 mpg in 2005 to 36.6 mpg in 2030. Greater increases could be seen if more stringent Corporate Average Fuel Efficiency (CAFE) standards are mandated, however. See Appendix B for a historical graph of U.S. vehicle fuel efficiency.

However, most of this fuel efficiency increase occurs by 2016, one year after the federally-imposed 35 mpg requirement on all new automobiles will take effect. From this point forward, the DOE predicts that fuel economy will remain relatively flat until 2030. Fuel efficiency might improve even more as a result of new regulations by EPA. A discussion about possible new federal fuel economy requirements and legislation is provided in Chapter 4 of this report.

3. TRENDS IN TEXAS GHG EMISSIONS

In addition to conducting an annual U.S. GHG emissions inventory, EPA has also partnered with state environmental protection agencies in order to compile state-level inventories for all 50 U.S. states *(14)*. In 2007, EPA recommended that state officials submit a comprehensive GHG emissions inventory to:

- Identify greatest sources of GHG emissions;
- Understand GHG emission trends;
- Quantify the benefits of specific activities that result in GHG reductions;
- Provide basis for developing a GHG Reduction Action Plan; and
- Set goals for and targets for future reductions.

As a result, 38 states (including Texas) recently submitted GHG emissions inventories to EPA for review. Because Texas environmental officials to date have only prepared an emissions inventory of anthropogenic CO_2, data on the other five GHGs mentioned earlier in this report is limited. However, because CO_2 emissions comprise as much as 96 percent of total transportation-related GHG emissions, GHG emissions estimates are relevant for discussion *(14)*.

Inventory data collected by Texas environmental officials show that from 1990 to 2007, overall CO_2 emissions have increased 15 percent, with transportation-related emissions increasing by 33 percent. During this same time, VMT in Texas also has increased by 3 percent per year, leading many transportation experts to believe that transportation-related GHG emissions are only expected to increase in the future. Appendix A provides a detailed description of the methodology used to compile the Texas GHG emissions inventory.

Trends in Texas GHG Emissions – All Sectors

According to EPA and EIA data, overall CO_2 emissions from fossil fuels in Texas have risen from 588 million metric tons of CO_2 in 1990 to 676 million in 2007. While significant, this 15 percent increase is lower than the total U.S. CO_2 emissions increase of 19 percent. CO_2 emissions from the electric power sector (made up mostly from coal consumption) increased from 185 $MMTCO_2$ in 1990 to 229 in 2007, a 24 percent jump. CO_2 emissions from the commercial, industrial and residential sectors saw an overall decrease in GHG emissions from 1990-2007. The transportation sector saw an overall increase of 32 percent, from 152.8 $MMTCO_2$ in 1990 to 203.5 in 2007. (*14*)

For 2007, the largest contributor to GHG emissions by economic sector in Texas was the utility sector, followed by industrial, transportation, and finally residential and commercial. In 2007, Texas emitted enough million metric tons of CO_2 into the atmosphere that it would rank seventh in the world if it were its own country. This amount is more than California and Pennsylvania combined— the second- and third-ranking states of GHG emissions in the U.S *(15)*. Adjusting for population growth in Texas, per capita CO_2 emissions remained constant during the 1990s but declined by 13 percent between 2000 and 2005 *(16)*. See Table 2 for more information on CO_2 emissions by economic sector in Texas.

Table 2. Texas Carbon Dioxide Emissions from Fossil Fuel Consumption (1990-2007).

Economic Sector in Texas	1990	1990%	2000	2000%	2007	2007%
Commercial	11.6	2%	13.4	2%	10.3	2%
Industrial	225.2	38%	254.8	37%	221.1	33%
Residential	13.1	2%	13.1	2%	12.3	2%
Transportation	**152.8**	**26%**	**182.3**	**26%**	**203.5**	**30%**
Electric Power	185.5	32%	227.6	33%	229.6	34%
Total Texas CO_2 Emissions (in million metric tons)	**588.2**	**100%**	**691.2**	**100%**	**676.8**	**100%**

In terms of transportation, Texas leads the nation in consumption of asphalt and road oil, distillate fuel oil, jet fuel, liquefied petroleum gases and lubricant, bringing the state's total petroleum consumption to be the highest in the nation *(17)*. Almost half of the emissions from petroleum products result from gasoline consumption in motor vehicles. Overall, emissions from petroleum products have increased 30 percent since 1990. According to a Texas Commission on Environmental Quality (TCEQ) report published in 2002, CH_4 accounted for 7.4 percent of GHG emissions in 1999 (considered as CO_2E), down from 8.3 percent in 1995. Some of the largest contributors of CH_4 emissions into the atmosphere are from landfills and natural gas extraction. From 1995-1999, there was a significant decline in CH_4 emissions due to efforts to capture CH_4 emissions in landfills *(18*). N_2O is another small but significant contributor. From 1990-1999, N_2O emissions declined 2.7 percent and were largely due to efforts to improve air quality and reduction of nitrogen in gasoline.

Texas GHG Emissions - Role of the Transportation Sector

Overall, for 2007, transportation accounts for 30 percent of total CO_2 emissions in Texas. CO_2 emissions from transportation-related activities sector increased from 152 $MMTCO_2$ in 1990 to 203 $MMTCO_2$ in 2007, a 32 percent increase. As with the U.S., VMT in Texas has increased by an average of about 3 percent annually from 1990-2007, with double-digit increases seen in some urban areas. Texas is also experiencing above-average population growth; with millions more people only adding to increasing amounts of GHG emissions on Texas roadways in the future. Trends in VMT and future population projections are discussed in greater detail in the following.

Trends in Texas VMT

In major urban areas in Texas, VMT increased throughout the 1990s, particularly in the Austin, Dallas, and Houston regions *(16).* Between 1992 and 2005, per capita VMT increased 19 percent in San Antonio, 16 percent in Austin, 14 percent in Dallas/Ft. Worth, and 6 percent in Houston *(16)*. In recent years, both Houston and Dallas have developed light rail systems and have encouraged higher density development in the city. This, along with the employment of high-occupancy vehicle (HOV) lanes and higher gasoline prices, may have slowed the rate of growth of VMT *(17).* See Appendix E for future average vehicle fuel economy estimates for Texas. The population is also expected to increase significantly over the next 20 years. According to the Texas State Demographer, Texas' population is projected to grow to close to twice the U.S. rate, adding anywhere between 7 million and 17 million people by 2030 (*19*). This growth in population will possibly contribute to more drivers, further driving up transportation-related GHG emissions in Texas. See Appendix D for future population growth estimates in Texas.

4. GHG POLICIES AND STRATEGIES AT THE FEDERAL LEVEL

Federal policies on climate change are currently in a state of flux. In terms of legislation, there is little indication that any significant climate change policy will be enacted into law in the near future. While both the American Clean Energy and Security Act of 2009 and the American Power Act included market-based incentives for reducing GHG emissions (known as cap-and-trade), current indications are pointing toward little to no legislation that will probably have little effect on transportation. Meanwhile, the president, the Council on Environmental Quality (CEQ), the EPA, and the U.S. Department of Transportation (USDOT) are moving toward using existing laws to mandate future GHG regulations. EPA and USDOT are also seeking to significantly tighten fuel standards for passenger vehicles and landmark declarations by EPA have indicated that future mandates would reduce GHG emissions by as much as 28 percent by 2020. This chapter describes significant federal programs and legislation, including legislation that did not pass, which could potentially continue to mold federal transportation-related GHG policy for the future.

Federal Legislation on GHG Reduction

Energy Independence and Security Act (EISA) of 2007

The Energy Independence and Security Act is legislation that focuses on automobile fuel economy, development of biofuels, and increasing CAFE standards by boosting fleet wide gas mileage to 35 mpg by 2020. This law included provisions for required vehicle technology and transportation certification, conservation requirements for federal vehicle fleets, and funding for increased production of biofuels. The law set a modified Renewable Fuels Standard (RFS) that begin at 9.0 billion gallons of ethanol in 2008 and rises to 36 billion gallons of ethanol per year by 2022. (*20*). Finally, the law also sought created the Office of Climate Change and the Environment within the USDOT *(22)*. It is possible that CAFE standards will be increased and RFS standards will be modified in future climate change legislation.

HR 2454: American Clean Energy and Security Act of 2009 (Waxman-Markey Bill)

The American Clean Energy and Security Act of 2009 (also known as the "Waxman-Markey Bill") was an amended version of the Energy Independence and Security Act that was passed by the U.S. House but was not passed by the Senate. Parts of this legislation are significant because some components (such as cap-and-trade components) could be incorporated into future climate change legislation. This bill directed EPA to promulgate regulations to establish national goals for reductions in transportation-related GHG emissions and related models and methodologies. This meant that states would have been required to keep their own transportation-related GHG inventories, possibly conducted by state departments of transportation *(23)*. HR 2454 also sought to prohibit the Secretary of Transportation from certifying compliance if a Metropolitan Planning Organization (MPO) failed to develop, submit, or publish its GHG emissions targets or strategies *(24)*. As a result, this bill required that, within one year after final rules are promulgated under the relevant section of the Clean Air Act, each metropolitan planning organization must develop reduction targets for surface transportation related emissions. Finally, HR 2454 would have required EPA to establish a financing program to competitively award funding to "enable eligible entities to make such loans and leases available to entities for the purpose of adopting low-GHG technologies or strategies for the mobile source sector."

S 1733: American Power Act (Kerry-Lieberman Bill)

Introduced on the Senate floor in May 2010, the American Power Act (also known as the Kerry-Lieberman Bill) was another of Congress' efforts at mitigating climate change by setting a "cap" on GHG emissions in the U.S. In terms of transportation, key features of this bill include:

- New transportation planning requirements;
- Highway Trust Funding for clean vehicle alternatives;
- Allocation of additional transportation funding from energy cap-and-trade;
- Promotion of "clean" vehicle jobs; and
- Promotion of Compressed Natural Gas (CNG) as a vehicle fuel alternative.

This latest climate change bill would have greatly affected transportation funding and have tied grant requirements to GHG reduction projects. In terms of transportation funding, S. 1733 would have provided a total of $1.875 billion in transportation grants, requiring up to 10 percent to be granted to MPOs for planning. The other 90 percent would be distributed to state DOTs and MPOs for projects that reduce GHG emissions. In addition, this bill allocates $2.5 billion to the Federal Highway Trust Fund for projects that are consistent with new requirements regarding planning for reduction in GHG emissions *(25)*. More specifically, the Kerry-Lieberman Bill included extensive new statewide and metropolitan planning requirements, such as:

- Setting targets for GHG emission reductions;
- Adopting strategies for achieving those targets in transportation plans;
- Submitting long-range strategies on how to mitigate GHG emissions to USDOT and EPA for review; and
- Gaining approval from USDOT that these strategies will meet GHG reduction targets.

In addition, the Kerry-Lieberman bill would have required EPA to issue regulations defining processes for state and local transportation agencies to set GHG reduction targets. States and MPOs would only be able to compete for funding under the new grant program if they have an approved plan for reducing GHG emissions. States whose plans were not approved could not compete for those grants. In addition to including funding for programs to incentivize cleaner vehicles (such as funding for research and development and consumer incentives for non-GHG emitting vehicles), the bill would have also curbed the authority of EPA to regulate GHGs under the Clean Air Act.

Recent reports suggest, however, that Senate leaders will soon introduce a scaled-down version of S. 1733. This revised "utility and electricity-focused" bill would also prevent EPA from regulating GHGs as criteria pollutants, again reducing the impact of the endangerment finding (*26*). There are early indications that this revised bill would not include "caps" on transportation-related fuels. However, there is no indication whether states and MPOs would be required to set GHG reduction targets or whether federal grants would require GHG reduction techniques be incorporated into transportation plans.

Federal Programs and Actions

2009 EPA Endangerment Finding and "Cause or Contribute" Finding

The 2009 endangerment finding is widely considered to be the most significant federal policy action toward addressing GHG emissions to date. EPA's role as a key principal regulator of transportation-related GHG emissions has steadily increased in recent times. In 2007, EPA

was granted additional authority to regulate transportation-related GHG emissions when the U.S. Supreme Court held that GHGs are in fact air pollutants covered under Clean Air Act legislation and that the EPA is responsible for regulating transportation-related GHG emissions in the U.S *(27)*. In response to the 2007 Supreme Court ruling, EPA issued its "endangerment finding" in 2009 declaring that the six GHGs in the atmosphere mentioned in Chapter 1 of this report "threaten the public health and welfare of current and future generations." In effect, this new endangerment finding forces EPA regulators to establish GHG emissions standards for new motor vehicles. Some argue that by setting GHG emissions standards, EPA will be able to further increase fuel economy standards and bypass pending Congressional legislation. However, some transportation officials have dismissed the potential impacts of this EPA finding and claim that future emissions standards will only be binding for a couple of years. Ultimately, the impacts resulting from the endangerment finding remain unclear. Trade unions and corporations in 17 states (including Texas) have filed legal petitions for EPA to reconsider and remand its finding while 18 other states (including California) have pledged their support. After months of serious consideration, in July 2010 EPA upheld its initial ruling *(28)*. As a result, it is likely that EPA will begin to establish and enforce GHG emissions standards in the future. These proposed regulations and standards are discussed in greater detail in the following.

Final Rulemaking on Light-Duty Vehicle GHG and CAFE Standards

Despite disputes by some state officials over the endangerment finding, EPA agents are moving forward with GHG emissions regulations in the transportation sector. In April 2010, EPA partnered with the USDOT to establish new federal rules that set the first-ever national GHG standards and will significantly increase the fuel economy of all new passenger cars and light trucks sold in the U.S. Beginning with 2012 model year vehicles, this rule will require automakers to improve fleet-wide fuel economy and reduce fleet-wide GHG emissions by approximately 5 percent every year. The National Highway Traffic Safety Administration (NHTSA) has established fuel economy standards that strengthen each year reaching an estimated 34.1 mpg for the combined industry-wide fleet for model year 2016. Current EPA standards will require that by the 2016 model-year, manufacturers must achieve a combined average vehicle emissions level of 250 grams of CO_2 per mile for new vehicles. The EPA standard would be equivalent to 35.5 mpg if all reductions came from fuel economy improvements. Ultimately, this program is expected to reduce CO_2 emissions by about 960 million metric tons over the lifetime of the vehicles regulated, equivalent to taking 50 million cars and light trucks off the road in 2030 *(28)*.

Presidential Memorandum on Regulating Heavy-Duty Vehicle Emissions

In addition to establishing GHG emissions standards for light-duty vehicles, in May 2010 President Obama directed EPA and NHTSA to begin work on a joint rulemaking body to establish the first ever standards for fuel economy and GHG emissions from medium and heavy-duty trucks. The president requested that EPA and NHTSA develop a coordinated program to set further standards to improve fuel efficiency and reduce GHG emissions for passenger cars and light-duty trucks for model years 2017 and later. Both light-duty and heavy-duty emissions standard programs have the goal of taking coordinated steps to deliver cleaner vehicles, through a coordinated federal program that is also harmonized with applicable state requirements. In effect, car and truck manufacturers will be able to build a single, national fleet of new, clean vehicles. EPA's preliminary analysis indicates that the heavy-duty standards under consideration have the potential to reduce carbon emissions by approximately 250 million metric tons and save over 500 million barrels of oil over the life of vehicles produced in the first five years of the program *(28)*. In addition, the National

Academy of Sciences (NAS) issued a report claiming that this program could reduce tractor trailer GHG emissions by up to 20 percent. *(29)* Currently, the regulations are under review and on September 30, 2010, EPA and NHTSA issued a Notice of Intent to announce plans for setting stringent light-duty vehicle standards for model year 2017 and beyond. This proposed rulemaking is expected to be issued by September 2011.

E.O. 13514: Federal Leadership in Environmental, Energy, and Economic Performance

Presidential executive order 13514 calls for energy reduction and increased environmental performance requirements for federal agencies. This executive order includes a GHG emissions reduction target for federal government operations, of 28 percent by 2020. The order required each federal agency to submit their GHG reduction target from a 2008 baseline to the Council on Environmental Quality by Jan. 4, 2010. The resulting federal government-wide GHG emissions reduction target is expected to reduce energy use by the equivalent of 205 million barrels of oil and taking 17 million cars off the roads by 2020. Federal agencies plan to meet the target by measuring their current energy and fuel use, improving energy efficiency, and switching to cleaner energy sources. In terms of petroleum reduction, this order calls for reduction in petroleum consumption by 2 percent per year through FY2020.

Draft NEPA Guidance on Effects of Climate Change and GHG Emissions

The CEQ has issued draft guidelines for considering climate change in environmental documents *(30)*. The guidance proposes that if a proposed action is reasonably anticipated to cause direct emissions of 25,000 metric tons or more of CO_2 emissions on an annual basis, "agencies should consider this an indicator that a quantitative and qualitative assessment may be meaningful to decision makers and the public". In terms of transportation, the CEQ advises that climate change effects should be considered in the analysis of government-sponsored projects that are located in areas considered vulnerable to effects of climate change within the project's anticipated lifetime—such as long-term development of transportation infrastructure on a coastal barrier island *(20)*. Therefore, these guidelines could have particular consequences for transportation projects along the Texas Gulf Coast. See Table 3 for a summary of actions concerning transportation-related GHG emissions at the federal level.

Table 3. Summary of Federal Actions for Transportation-Related GHG Emissions.

Strategy or Policy	Status	Description
Energy Independence and Security Act of 2007	Enacted into Law	This law focuses on automobile fuel economy, development of biofuels, and energy efficiency in public buildings and lighting.
American Clean Energy and Security Act of 2009 (Waxman-Markey Bill)	Did not pass Senate	Contains carbon "cap and trade" requirements, transportation planning requirements for state DOTs and MPOs, funding for climate adaptation, and clean technology provisions.
NEPA Guidance on Effects of GHG Emissions	Draft Guidelines	This guidance proposes that if a proposed action by a federal agency is reasonably anticipated to cause direct emissions of 25,000 or more metric tons of $C0_2$ equivalent, the agency should identify alternative actions.
E.O. 13514: Federal Leadership in Environmental Performance	Issued	Executive Order issued by President Obama that includes a GHG reduction target for federal government operations by 28 percent by 2020.
EPA Endangerment Finding for GHG Emissions	Submitted	EPA found that the current and projected concentrations of six key GHGs threaten public health and human welfare; initial step toward EPA regulation of transportation-related GHG emissions.
EPA Cause or Contribute Finding	Submitted	EPA found that emissions from new motor vehicles contribute to the GHG pollution which threatens public health and welfare.
American Power Act (Kerry-Lieberman Bill)	Not enacted into Law	This bill includes transportation planning, Highway Trust funding, and will result in a "cap" on the production of oil; this bill is unpopular among transportation groups because it would place a "tax" on transportation fuels while diverting very little revenue toward transportation.
Final Rulemaking on Light-Duty Vehicle GHG and CAFE Standards	Final Issued EPA Rule	Joint final rule issued by the EPA and the NHTSA to establish GHG emissions standards from light-duty motor vehicles.
Proposed Rulemaking on Heavy-Duty Truck GHG Emissions	Final Regulatory Impact Analysis Issued	President Obama directed EPA and NHTSA to initiate rulemaking to establish standards for fuel economy and GHG emissions from medium and heavy-duty trucks; regulations set to begin for truck model years 2014-2018.

Other Policies and Programs at the Federal Level

Federal "Livability" Initiatives to Reduce GHG Emissions

While current federal “livability” initiatives are not policies intended to directly reduce transportation-related GHGs, it is likely that significant reductions will result. Livable communities are defined as places where transportation, housing and commercial development investments are coordinated to serve the people living in those communities (*31*). Federal livability outcomes, as described in the USDOT’s Draft 2010-2015 Strategic Plan, include:

- Increased access to convenient and affordable transportation choices;
- Improved public transit experience;
- Improved networks that accommodate pedestrians and bicycles; and
- Improved access to transportation for special needs populations and individuals with disabilities.

In an effort to reduce public over-reliance on personal motor vehicles, USDOT is currently in the process seeking to reduce GHG emissions by incorporating “livability” concepts into its multi-year transportation planning agenda. By incorporating livability concepts into transportation planning, USDOT predicts that non-motorized improvements, including construction of pedestrian and bicycle transportation networks through dedicated rights-of-way, have potential for reducing GHG emissions. These measures would reduce GHGs by

0.2-to-0.6 percent by 2030, at moderate investment costs (less than $200 per ton of CO_2E emissions reduced), or a net savings when reduced vehicle operating costs are considered *(32)*.

President Obama has also sought to push "livability" concepts into metropolitan planning processes by proposing a plan to form a collaborative effort between the Department of Housing and Urban Development (HUD), USDOT, and the EPA to help foster planning for more livability. One of the main goals for this interagency agreement includes promoting "a wide variety of transportation options… in order to reduce GHG emissions" *(32)*. Additional federal funding is being attached toward projects that promote federal "livability" initiatives. These programs could include up to $527 billion in grants, and could be issued to fund transportation investments at the state and local level through this partnership *(33)*.

5. POLICIES AND STRATEGIES AT THE STATE LEVEL

In addition to federal policies and programs, several states are also taking steps to reduce GHG emissions. Texas is the first state in the U.S. to promote mileage-based car insurance as well as cash incentives for people seeking to purchase newer, more fuel efficient vehicles. Washington, Hawaii, and Minnesota have all proposed statewide GHG emissions reductions targets for the transportation sector specifically. Currently, 15 states are working to establish GHG automobile standards and two are in the process of working toward low carbon fuel standards (*34*). While many states are working to develop GHG emissions reduction strategies, no state in the U.S. has been more proactive than California in terms of developing new GHG policies. Because EPA agents have indicated that they will likely follow California's lead and because Texas is similar in size, population and modal composition, California's GHG reduction programs could provide useful insight for Texas transportation officials. Therefore, California policies and programs will be discussed in greater detail in the sections that follow. See Appendix F for a complete listing of significant GHG programs and policies proposed by state government officials.

Texas GHG Emissions Programs, Actions, and Legislation

As the seventh-largest source of transportation-related GHG emissions in the world, Texas is taking steps to reduce its GHG emissions through innovative programs and initiatives. Enacted into law in 2001, the Texas Emissions Reduction Plan (TERP) is a program designed to provide financial incentives to eligible individuals, businesses, or local governments to reduce emissions from polluting vehicles and equipment. The TERP provides state grants to fund the incremental costs of new engines and retrofit technologies for vehicles. It also provides rebates for purchasing vehicles that burn cleaner fuels and grants to develop technologies that will reduce emissions. In addition, the AirCheckTexas Repair & Replacement Assistance Program was created to help low-income Texas residents receive automobile upgrades and in turn reduce GHG emissions. In 2009, legislation was passed that required the Texas Commission on Environmental Quality (TCEQ) to establish an inventory of voluntary actions to reduce CO_2 emissions. See Table 4 below for a summary of policy actions in Texas.

Table 4. Actions Concerning Transportation-Related GHG Emissions in Texas.

Year	Policy	Status	Description
2001	Texas Emissions Reduction Plan	Enacted into Law	Reduces NOx and VOC emissions in Texas counties that do not meet federal air quality requirements or are adjacent to counties not meeting the requirements. Provides state grants to retrofit technologies for vehicles. Provides rebates for purchasing vehicles that burn cleaner fuels and grants to develop technologies that will reduce emissions, including CO_2 emissions.
2001	LIRAP (AirCheck Texas)	Enacted into Law	Helps low-income individuals receive automobile upgrades that will reduce GHG emissions
2002	Mileage-Based Car Insurance	Adopted	Texas Department of Insurance Commissioner approved rules to enable insurers to offer automobile insurance plans that allow consumers to purchase insurance coverage on a per-mile basis.
2007	SB 124, HB 344, HB 548	Not Enacted into Law	Improves controls on motor vehicle emissions through the implementation of a TCEQ low-emission vehicle program
2007	HB 375	Not Enacted into Law	Develops state agency for increasing the availability of low-emission automotive fuels of Texas drivers
2007	HB 1335	Not Enacted into Law	Relating to Texas emissions reduction plan, including a motor vehicle purchase or lease incentive program
2009	HB 1796	Enacted into Law	Requires the TCEQ to establish an inventory of voluntary actions to reduce CO_2 emissions.

GHG Emissions Programs, Actions, and Legislation in Other States

Although the federal government has not passed any significant climate change legislation to date, there is a great deal of climate change activity occurring at the state and local levels—including state departments of transportation, MPOs and multi-state regions. Many states have approved legislation seeking to mitigate transportation-related GHG emissions. For example, the Washington state legislature has recently passed a law that aims to reduce VMT that will in turn reduce GHG emissions. Hawaii and Minnesota have both passed laws establishing state-wide emissions targets for the transportation sector. Wisconsin and West Virginia have both begun to implement either mandatory or voluntary reporting of GHG emissions from major sources *(35)*.

California GHG Programs and Actions

During the past several years, California Governor Schwarzenegger and the Legislature have taken several important climate policy actions. These initiatives were intended not only to reduce the state's GHG emissions but also to spur national and international efforts to counter global climate change as well as provide a model for doing so. Each California legislative action is discussed in greater detail in the Electric Power Research Institute's report entitled "Program on Technology Innovation: Economic Analysis of California Climate Initiatives: An Integrated Approach" and is available online *(36)*.

Executive Order (EO) S-3-05

Signed into law on June 1, 2005, executive order S-3-05 established climate change reduction targets for California. This was the first move by any state legislation toward directly mitigating GHG emissions. In addition, this order created the Climate Action Team, a board of experts

charged with coordinating statewide efforts to implement global warming emission reduction programs and drafting the state's first Climate Adaptation Strategy *(37*).

California Global Warming Solutions Act of 2006 (AB 32)

The passage of California's Global Warming Solutions Act of 2006 (Assembly Bill 32) represents one of the most ambitious state-level regulatory actions taken to address climate change by reducing GHG emissions. This bill requires a reduction of GHG emissions to 1990 levels by 2020 and 80 percent below 1990 levels by 2050 as mandated by EO-S-3-05. The California Air Resources Board (CARB) is currently developing a plan to achieve the emission targets set forth by this law *(38).* More specifically, transportation-related GHG reductions goals from this landmark California legislation include:

- Require 25 percent reduction of GHG emissions to 1990 levels by 2020;
- Replace 20 percent of on-road transportation petroleum fuels with alternative fuels by 2020; and
- Decrease 10 percent by 2020 carbon intensive vehicle fuels through a new low-carbon fuel standard.

This bill also seeks three key strategies to address these reduction targets. These strategies include: 1) promotion of cleaner cars and trucks through tighter emissions standards; 2) promotion of the Low-Carbon Fuels Standard, and 3) allocating more funding toward projects that reduce travel demand.

Executive Order S-20-06

In 2006, the Governor signed EO S-20-06, directing the development of an emissions trading system as part of the implementation of AB 32. Executive Order S-20-06 named Cal/EPA as the state leader for implementation of AB 32, and directed the Air Resources Board (ARB) to work with Cal/EPA to develop regulatory measures and market-based mechanisms on a concurrent and expeditious schedule. In particular, they were ordered to develop a market-based compliance program permitting trading with the European Union and the northeast states' Regional Greenhouse Gas Initiative. He also ordered the ARB to create a Market Advisory Committee composed of national and international experts to make recommendations on design of a market-based compliance program.

Assembly Bill 1493 (Pavley Amendments)

In 2002, the California Legislature passed AB 1493 (Pavley Global Warming Bill), a law that requires reductions in GHG emissions from light-duty vehicles. CARB is responsible for setting the standards, which would apply to new vehicles starting in the 2009 model year. The standard requires that new vehicles, on average, achieve an emissions reduction of 30 percent by 2016 and covers CO_2, NH_4, N_2O, and hydrofluorocarbon emissions *(39).* AB 1493 requires CARB to set emission standards for GHGs but without setting a mandate for specific technology. Finally, AB 1493 requires CARB to consider economic impacts, including impacts on jobs, businesses (including agriculture), and California business competitiveness with other states and requires ARB regulations to provide "maximum flexibility" for consumers *(33).*

California Vehicle Emissions Regulations

In 1990, California sought to lead the nation by regulating emissions from motor vehicles. This legislation created the Low-Emission Vehicle (LEV) program. This plan included two sections: an LEV, and a zero-emissions vehicle standard (ZEV), and a quota designed to stimulate the creation of newer technologies. In 1998, CARB revised their original LEV program to expand and enhance their restrictions on vehicle emissions, known as LEV-II. In this revision, they expanded the program to cover all SUVs and trucks. Specifically, this program created six different categories for low-emissions vehicles:

- TLEV—Transitional Low-Emission Vehicle Early standard, phased out in 2004;
- LEV—Low-Emission Vehicle. This standard was the required average for all light duty vehicles for model years 2004 and beyond;
- ULEV—Ultra-Low-Emission Vehicle. Vehicles with this designation are 50 percent cleaner than the average new model-year vehicle;
- SULEV—Super Ultra-Low-Emission Vehicle. Vehicles with this designation are 90 percent cleaner than the average new model-year vehicle and
- ZEV—Zero-Emissions Vehicle. Electric and hydrogen-fuel-cell vehicles that have zero harmful tailpipe emissions and are 98 percent cleaner than the average new model-year vehicle.

6. GHG POLICIES AT THE LOCAL LEVEL

In addition to federal and state government officials to reduce GHG emissions, there has been significant progress made by local officials as well. Local transportation authorities are working to incorporate GHG reduction strategies in planning and operation phases of transportation projects, and implementing these actions as part of community-based initiatives. Some cities have taken proactive steps to reduce GHG emissions through promotion of transit, use of alternative fuels, or through public education campaigns. Lacking leadership at the federal level, some large cities (such as Seattle and San Francisco) have taken it upon themselves to confront the issue of climate change in their own communities. The U.S. Mayors Climate Protection Agreement, the Sierra Club's Cool Cities and the International Council on Local Environmental Initiatives' Cities for Climate Protection have been launched to formalize cities' global warming reduction efforts.

Climate Change Agreements and Programs

U.S. Conference of Mayors Climate Change Agreement

The U.S. Conference of Mayors Agreement is the most significant policy initiative undertaken at the local level that addresses GHG emissions and climate change. In response to perceived inaction of federal and state officials to Kyoto Protocol initiatives, Seattle Mayor Greg Nickels launched the U.S. Conference of Mayors Climate Change Agreement initiative to advance Kyoto Protocol initiatives through leadership and action by at least 141 American cities, including 32 in Texas *(40)*. Under the Agreement, participating cities commit to take following three actions:

- Strive to meet or beat the Kyoto Protocol targets in their own communities;
- Urge their state governments, and the federal government, to enact policies and programs to meet or beat a 7% reduction in GHG emissions from 1990 levels by 2012; and
- Urge the U.S. Congress to pass the bipartisan greenhouse gas reduction legislation.

Sierra Club Cool Cities Program

Sierra Club's Cool Cities Program, led by volunteers around the country, is a collaboration of community members, organizations, businesses, and local leaders to implement clean energy solutions that save money, create jobs, and help curb global warming. Since 2005, over 1000 city and county leaders have made a commitment to cut their community's carbon footprint through this program. There are over 10 Texas cities enrolled in this program.

International Council on Local Environmental Initiatives' Cities for Climate Protection

The International Council on Local Environmental Initiatives (ICLEI) is an international association of local governments as well as national and regional local government organizations who have made a commitment to sustainable development. ICLEI provides technical consulting, training, and information services to build capacity, share knowledge, and support local government in the implementation of sustainable development at the local level. The ICLEI is tasked with providing an effective and cost-efficient way to achieve local, national, and global sustainability objectives. Over 1200 cities, towns, counties, and their associations worldwide

comprise ICLEI's growing membership. ICLEI works with these and hundreds of other local governments through international performance-based, results-oriented campaigns and programs.

U.S. Municipal-Level Programs and Actions

Large City Initiatives

There are several examples of large cities and states seeking to reduce GHG emissions through transportation initiatives. For example, in 2004, city leaders in Denver, CO began Fast Tracks, one of the most ambitious transit initiatives in U.S. history. Voters in the eight-county Denver region authorized a sales tax to help fund the Regional Transportation District's 12-year expansion plan that includes 119 miles of light and commuter rail, 31 park-and-rides, 57 transit stations, expanded bus service, and redevelopment of a downtown multimodal center. Pedestrian and bike-friendly environments that encourage residents to live and work in close proximity to transit stations also help to reduce GHG emissions. With these rail centers complete, ridership reached an average of 62,000 daily in 2007, compared with 44,000 just one year prior. With 32 percent of these new riders never having used alternative transit before, these new trips equates to approximately 60,249 less metric tons of CO_2 emitted in one year *(40)*.

San Francisco has begun a citywide program that recycles restaurant grease to power the city's 1,500 city owned buses. City officials collect grease waste from restaurants; the grease waste is then converted into biodiesel fuel to be used for city buses. In just three months, this program has partnered with over 250 restaurants to divert cooking oil toward fueling city buses. According to EPA, this program results in 13.3 million pounds of CO_2 diverted from the skies each year *(40)*.

Seattle has recently begun a grassroots climate protection campaign that could significantly reduce transportation-related GHG emissions. Launched in 2007, Seattle Climate Action Now (CAN) is a city-led effort but is grounded in partnerships with local businesses, organizations and individuals. This program enables citizens to develop their own climate action plan and in the process shifts specific behaviors that result in GHG reductions. CAN makes use of existing networks and organizations to "mobilize the entire community." The GHG mitigation campaign uses a three-pronged engagement strategy: a web portal featuring a resource and partner directory, action planning tool; Community Action Now engagement events; and strategic partnerships and collaborations with Seattle-based organizations and businesses. In terms of transportation, the program is seeking to educate Seattle residents on alternative transportation methods and encourage residents to "ditch the car" one day a week *(41)*.

Small City Initiatives

Several small cities are also actively seeking to reduce transportation-related GHG emissions. Carmel, IN is seeking to reduce its transportation-related GHG emissions by incorporating traditional neighborhood planning principles in order to make Carmel a more "walkable" community. New developments in Carmel are asked to implement pedestrian-friendly design practices (such as increasing residential density, improving connectivity and building close to the street) *(41*).

Finally, Chapel Hill, NC has also sought an innovative way to reduce its transportation-related GHG emissions. City leaders, in conjunction with the University of North Carolina and neighboring Carrboro, worked to offer a fare free transit system on a community-wide basis. Since the program began, annual ridership has grown from 3 million in 2001 to almost 6.5

million riders in 2008. This program is unique because while many university transit systems provide fare free service to all its students, this program sought to include community residents as well. To incorporate the community, transit leaders increased transit service by 20 percent and developed routes to all areas of the community. This increase in ridership has led to a reduction of VMT in the area and improved air quality. This has also allowed Chapel Hill to become a truly sustainable community where private vehicle ownership is not required.

Texas Municipal-Level Programs and Actions

Several Texas cities have been proactive toward reducing transportation-related GHG emissions. City of Houston officials have recently pledged to conduct a GHG emissions inventory, develop emissions reductions targets and adopt an action plan to reduce emissions. More than 250 hybrid vehicles have been purchased for city employees, and new efforts have been made to coordinate stop lights and promote greater carpooling use to reduce transportation-related GHG emissions. City of Austin officials have also completed a GHG inventory for all City departments and are working to develop a comprehensive climate action plan within the next few years. However, most municipalities in Texas are waiting for federal and state policy makers to act before any new GHG policies and programs are adopted. Therefore, little is discussed further in terms of global warming initiatives undertaken at the local level by Texas cities.

7. POLICY ACTIONS FOR TRANSPORTATION GHG REDUCTIONS

This chapter discusses various policy-related options that the Texas Department of Transportation (TxDOT) and its partner agencies can pursue, or are currently pursuing, in order to reduce transportation-related GHG emissions. There are many policy options available for state and local transportation officials seeking to reduce GHG emissions. Reducing state VMT, improving vehicle performance, improving transportation systems management, offering vehicle incentives and fee bates and increased education are all policy initiatives undertaken by states over the past 20 years. A total of 33 states have developed state climate action plans with several other states in the process of development. Some of these plans have been formally adopted by the respective governor or state legislature, while others were prepared as reports without any official action taken. Various approaches to reducing transportation-related GHG emissions by state transportation officials are provided in greater detail in the following.

Approaches to Reducing GHG Emissions

Reducing VMT

The first strategy proposed by some states to reduce GHG emissions is to reduce overall VMT. As discussed in Chapter 2, total VMT growth has increased much greater than population growth over the past several decades. Even a small difference in VMT growth rates could make an enormous difference on the total amount of VMT on the roads by 2050. One way states plan to reduce VMT is through promotion of transit, ridesharing and commuter choice programs. Transit service provides an alternative to auto travel and could be an effective way to reduce GHG emissions. However, according to a Pew Center report, "significantly reducing national GHG emissions via increased use of transit would require significant effort. All modes of transit account for only 1 percent of passenger-miles traveled in the U.S. today *(42)*. Therefore, even significant investment in transit service would moderately reduce the impact of GHG emissions. However, because of the role transit plays in helping to maintain mobility in densely populated metropolitan areas, transit could encourage more densely populated areas to develop. As a result, states such as New York have incorporated transit into their long-term GHG reduction planning process.

Commuter choice programs could also be a viable solution for reducing VMT for the future. According to a recent "Commuting in America" study, telecommuting has been on the rise in recent years. Between 1980 and 2000, the number of people telecommuting almost doubled, from 2.1 million in 1980 to 4.1 million in 2000. Telecommuting can be a highly effective cost strategy when taking into account the low cost for promotion versus the high benefits realized from reducing GHG emissions. Telecommuting is even receiving unprecedented attention in Washington, D.C. with the White House officials calling for policy changes to help expand a work arrangement widely seen by many transportation officials as a solution to pressing national problems *(43)*. Furthermore, the Vermont DOT has sought in its climate action plan to "improve the state's telecommunications network to encourage telecommuting and thus reduce commute miles" *(44)*.

Finally, several states have sought to promote ridesharing as a possible solution. Ridesharing programs include: promotion of park-and-ride facilities; HOV lanes; rideshare matching programs, and carpool/vanpool incentives *(45)*. Wisconsin has a state vanpool program whereby

people can sign-up in a rideshare database and find rides that best suit them. State employees that offer rides can even be eligible for payroll incentives *(46)*. Ultimately, many states plan to seek or have already sought promotion of alternative modes of transportation as a solution to reducing GHG emissions.

Promotion of pay-as-you-drive auto insurance, efficient development patterns, and setting VMT and GHG goals in planning insurance are some other techniques used by state policymakers. Currently, Texas is leading the effort by becoming the first state in the U.S. to offer motorists pay-by-the-mile auto insurance as a way to address GHG emissions. A report by the Brookings Institute estimated that if all Americans bought pay-as-you-drive auto insurance, driving would decline by eight percent nationwide, translating into a savings of about $50 billion a year in car-related damage. In addition, total U.S. CO_2 emissions would decline by as much as 2 percent, with oil consumption dropping by as much as 4 percent *(47)*. As a result of Texas' leadership, the Maryland Climate Commission has recommended pay-as-you-drive insurance as one of the most significant ways to cut traffic-related GHG emissions. Some states have also sought to integrate VMT and GHG reduction goals into their transportation planning process. In 2007, Washington state legislators created the Transportation Implementation Work Group (IWG) to design legislative and executive branch actions capable of achieving significant reductions in transportation-related GHG emissions. One of the goals of the IWG is to recommend tools and best practices to the state legislature to reduce state VMT by 18 percent between now and 2020 *(47)*. South Carolina and Virginia have also established similar VMT and GHG reduction goals.

Finally, promotion of passenger rail service and bike and pedestrian infrastructure could also be an effective solution toward reducing state VMT. Just last year, over $8 billion in federal funds were distributed to states such as Florida and North Carolina for passenger high-speed rail projects. Other states such as Iowa and Michigan have also pursued rail projects in an attempt to get people out of their motor vehicles and into high-speed trains, which have a lower emissions-per-passenger ratio. Promotion of bike and pedestrian infrastructure is also a great way to reduce GHG emissions. Vermont is seeking to promote bicycle use by "improving the safety of pedestrian and bicycle travel through education and increasing the quality and availability of facilities" *(44)*. Other states, such as Maryland, Minnesota, and Washington are also seeking to promote pedestrian and bicycle use in urban areas to reduce GHG emissions.

Vehicle Improvement

Vehicles improvement could also be sought as a potential solution by state officials for reducing GHG emissions. According to one report by Harvard University's Befler Center, "the most effective policy for reducing CO_2 emissions and oil imports from transportation is to spur the development and sale of more efficient vehicles with strict efficiency standards." The report further mentions that "without addressing both of these, CO_2 emissions from the U.S. transportation sector will continue to grow" *(48)*. With the likely failure of any future climate change legislation by Congress, one of the most effective strategies transportation officials could undertake to reduce GHG emissions could be to invest in alternative vehicles. There are trade-offs to this option, however. While stringent new vehicle emissions standards could be the most effective strategy at reducing GHG emissions, this option has proven to be very difficult politically to implement. Therefore, careful analysis by Texas transportation officials on the potential benefits and costs for each GHG reduction technique will need to be weighted before decisions are made.

Heavy-duty vehicle idling regulations could also be a potential solution toward reducing GHG emissions. Currently, 23 states (including Texas) have idling restrictions that limit the amount of time a heavy-duty truck can run while not moving. Several municipalities in Texas already have adopted five-minute idling restrictions, with other states imposing regulations on light-duty trucks and cars as well. The Heavy-Duty SmartWay program is another option available to state transportation leaders. The SmartWay Transport Partnership is a voluntary, public-private partnership with the freight industry. Heavy-duty diesel vehicles are major consumers of fossil fuels and major contributors to air pollution. SmartWay promotes a variety of strategies designed to reduce energy consumption and vehicle emissions that also lead to a reduction in costs for truck and rail freight operators. One strategy is to incorporate technologies on heavy-duty diesel trucks that reduce fuel use and emissions. EPA has recommended use of the following technologies: single-wide tires, automatic tire inflation, advanced trailer aerodynamics, N_2O re-flash, lube viscosity, mobile idle reduction technologies, and emissions control technologies such as diesel oxidation catalysts, crankcase filters and diesel particulate filters. EPA also anticipates that these technologies may be most effective if utilized together in an overall kit design. Currently, five states have implemented this program into their state climate action plans and even some MPOs in Texas have sought this innovative program *(49*).

The promotion of alternative fuel vehicles by state agencies is also being pursued by 17 states. Alternative fuel vehicles include electric vehicles, flexible fuel vehicles, CNG-powered vehicles, propane vehicles and biodiesel vehicles. Currently, Alabama is pursuing policies that require state or local agency's fleets to contain a certain percentage of alternative fuel vehicles (AFVs). California is pursuing policies that encourage the development of alternative fuel refueling stations. Rhode Island and Tennessee are pursuing policies that promote demonstration projects and research and development concerning the use of AFVs, such as fuel cell technology in cars. Ultimately, states are looking at innovative ways to reduce GHG emissions through promotion of AFV policies.

Low resistance tire programs could also help to reduce GHG emissions. In 2003, the California legislature directed the California Energy Commission to develop and implement a Fuel Efficient Tire Program comprised of both a consumer information program and minimum efficiency standards. The Commission is currently in the process of developing rules and regulations that will mandate tire manufacturers to report the fuel efficiency of all passenger and light truck tires available for sale in California and make this information available through a consumer information program for buyers and sellers of tires. It is estimated that if all California drivers switched to these new “low-resistance” rolling tires, it would result in statewide savings of 252 million gallons of fuel, $882 million, and 2.7 million metric tons less CO_2 emissions annually *(50).*

Recently, many states have sought to adopt California’s LEV standards as a way to reduce transportation-related GHG emissions (see Chapter 6 for more detail on California’s LEV program). California’s LEV standards are considered the benchmark for reducing smog-forming and heat-trapping emissions from vehicles. In 2009, President Obama announced that the federal government would support California’s right to set vehicle standards for heat trapping emissions, and that the federal government would set national standards modeled after California. This new federal action will set the first national tailpipe heat-trapping emissions standard for vehicles at an average of about 250 grams per mile. Therefore, it is likely that future federal EPA regulations could have significant impacts for new vehicle sales in Texas.

Fuel Improvement

Vehicle fuel could also be improved as a way to reduce GHG emissions. Several states are funding alternative fuels research and development (such as the use of bio fuels and natural gas) to one day implement cleaner fuel alternatives in the future. California is pursuing a low carbon fuels standard, which would require that the mix of transportation fuels sold to automobiles or trucks include only a limited percentage of carbon-intensive fuels, could also be pursued as a way to reduce GHG emissions.

Transportation Systems Management

Many states have begun to pursue transportation system management techniques as strategies for reducing GHG emissions. For example, the Transportation Systems Optimization Project in Portland, OR helps reduce GHG emissions by cutting the amount of time cars spend idling and accelerating from traffic lights. Improved traffic flow and reduced fuel waste from stop-and-go driving leads to less CO_2 released into the atmosphere *(52)*. Another study by Matthew Barth and Kanok Boriboonsomsin found that CO_2 emissions can be reduced by up to almost 20 percent using three different strategies: 1) congestion mitigation strategies that reduce severe congestion, allowing traffic to flow at better speeds; 2) speed management techniques that reduce excessively high free-flow speeds to more moderate conditions; and 3) shock wave suppression techniques that eliminate the acceleration/deceleration events associated with stop-and-go traffic that exists during congested conditions *(53)*.

Incentives and Feebates

Vehicle incentive programs are also potential tools states are seeking to address climate change. Maine is piloting a program that encourages auto dealers to place brightly-colored "Cleaner Cars for Maine" static labels on the most "environmentally-friendly" current model vehicles on their lots. To qualify for the program a vehicle must be a California Certified LEV or better that gets 30 mpg or greater fuel efficiency. This will enable consumers to make an informed decision regarding the cars they purchase. Recently, California began offering rebates of up to $5,000 per light-duty vehicle for individuals and business owners who purchase or lease new eligible zero-emissions or plug-in hybrid electric vehicles. Certain zero-emissions commercial vehicles are eligible for rebates up to $20,000 *(54)*. Currently, the Emissions Reduction Incentive Grants (ERIG), which is a part of the TERP in Texas provides grants to eligible projects in nonattainment areas and affected counties. Expanding the program to include all Texas residents or providing more funding similar to California could help to further reduce GHG emissions.

In addition to offering incentives, some states are also imposing fees on high emissions vehicles to further encourage consumers to purchase low emissions vehicles. A “feebate” program works by imposing a fee on new, high-carbon emitting vehicles and then rebating the fee to buyers of new, low-emissions vehicles. California officials are currently proposing a bill that would allow CARB to design and establish a self-financing feebate program whereby funding for clean vehicle rebates would come from one-time surcharges on new gas-guzzling vehicles that emit high levels of global warming pollution *(55)*.

Enforcement and Education

Enforcement and education could also have positive effects toward reducing GHG emissions. Enforcing a state-wide 60 mph speed limit is one possible GHG reduction approach and is being

considered by officials in seven states. Promotion of public education and stricter enforcement of speed limits ultimately could seek to reduce the amount of GHG emitted into the air. According to a report by the General Accounting Office prepared in 2008, "lowering vehicle speed by 5 mph when traveling at 35 to 45 mph will boost fuel economy by as much as 10 percent" (*56*), while eco-driving could reduce GHG emissions up to 15 percent (*73*). Eco-driving refers to the efficient operation of a vehicle by avoiding rapid acceleration or deceleration, avoiding very high speeds, avoiding congestion, extra weight in the vehicle, and to inflate tires optimally and drive fuel-efficiently. States such as Arizona, Minnesota, New Hampshire, and New Mexico are considering such speed enforcement policies. Governments can also help to educate their states' public on ways to reduce GHG emissions. Recently, EPA has begun rating all new motor vehicles on a scale of 1 to 10 based on their GHG emissions (*57*). Education campaigns could also address the role of vehicle maintenance, tire pressure, and driver's behavior.

Adopting a Climate Action Plan

Adopting a state Climate Action Plan could be one way to comprehensively address state GHG reduction. To date, 33 states have developed state climate action plans, with several other states quickly seeking to adopt climate change programs for the future. Some of these plans have been formally adopted by the respective governor or state legislature, while others were prepared as reports without any official action being taken. These plans seek to put forth a comprehensive strategic plan on ways to reduce GHG emissions for the future. In addition, some state DOTs have also developed their own plans for implementing the transportation elements of state climate plans. Other state DOTs are taking a wide range of actions to reduce greenhouse gas emissions. California, Maryland, New York, Oregon, Vermont, and Michigan state DOT's all have developed strategic plans for implementing GHG emissions reduction goals. Currently, Texas has no comprehensive statewide climate action plan developed.

In 2009, a report to the National Cooperative Highway Research Program reviewed the transportation elements of most of the state climate action plans (*58*). This report found the transportation elements of these plans were often developed with limited state DOT input, are highly aspirational, vary considerably from state-to-state, and lack valid cost information and specifics as to their implementation. DOT staff in a significant number of states that developed climate action plans have expressed several concerns about the process used to develop these plans. In some cases, state DOTs and other major transportation interests were not invited (and in one state not allowed) to serve on the overall steering committees for climate action plans. Therefore, transportation officials in Texas would benefit greatly from lessons learned by other states if Texas were to pursue a climate action plan.

8. FUTURE IMPLICATIONS FOR TRANSPORTATION IN TEXAS

This chapter discusses implications that could result from climate change policies currently being considered by Congress. As discussed earlier, federal and state transportation-related GHG emissions are increasing rapidly and climatologists around the world are warning government leaders to act quickly. Furthermore, VMT and population in Texas are only projected to outpace national levels by as much as five percent, meaning Texas will likely be the prime target for new GHG regulations. In addition, recent moves by federal officials could change how state transportation agencies will be required to address climate change in the future. Federal "livability" strategic initiatives could result in new planning requirements that state and local transportation officials will need to consider. Listed below are significant legislative acts that could impact Texas transportation in the years to come.

Implications from future EPA/CAFE Regulations

Regardless of what happens on the legislative front, the Supreme Court has ruled that the Clean Air Act requires EPA to regulate GHG emissions. Sensing potential economic consequences that might result from future vehicle emissions regulation, Texas officials have challenged EPA's endangerment finding. However, many legal experts predict that Texas will be unsuccessful in its effort. Therefore, Texas transportation officials should be aware of the potential consequences this ruling may have on transportation planning and funding. As a result of the finding, EPA will be required to: 1) take action to prevent harm before it occurs; and 2) consider the limitations and difficulties inherent in information on public health and welfare.

In terms of transportation, this means that EPA will have the authority to regulate GHG emissions from new motor vehicles. However, the endangerment finding does not cover other transportation-related sources of GHG emissions, such as emissions from aircraft and other non-road mobile sources. EPA will have limited discretion over how these standards for new vehicles in these sectors will look like. This finding also could trigger compliance requirements for vehicle manufacturers and import restrictions as well. This could mean a reduction in overall transportation-related GHG emissions for Texas and could accelerate declining motor fuels tax revenues due to increasing fuel efficiency standards *(59)*.

Furthermore, EPA and USDOT are beginning to tighten fuel efficiency standards for passenger vehicles and have released stringent new fuel efficiency requirements for model year 2012 through 2016 vehicles. President Obama has recently directed the EPA and USDOT to work together to develop even more stringent regulations for model years 2017 and beyond, but this rule will likely face significant opposition in the months to come. Recent Congressional initiatives suggest that it may also be a while before comprehensive cap-and-trade legislation will be enacted in the United States. ,(See Chapter 9 for ways Texas transportation officials could pursue and implement Cap-and-Trade legislation).

Implications of the Federal Livability Initiative

As federal transportation policy begins to move toward livability, Texas transportation officials will need to quickly assess how it plans to address and adapt to these new federal initiatives. While in office, President Obama has pushed to develop federal policies to induce states and local communities to embrace "smart growth" land use strategies that would deter growth, crowd development, and discourage automobile use. In June 2009, HUD, U.S. DOT, and EPA joined

together to form the Partnership for Sustainable Communities. This partnership will be in charge of coordinating federal housing, transportation and environmental investments, protecting public health and the environment, promoting equitable development, and helping to address the challenges of climate change. Already, $293 million has been distributed through two competitive grant programs, the Urban Circulator Grant Program and the Bus and Bus Livability Grant Program. More funding for "livability" initiatives is likely to follow suit.

With an increasing share of transportation funding being aimed toward "livability" initiatives, Texas transportation officials would benefit from examining ways to reduce GHG emissions through promotion of "livability" initiatives. Coordination and adaptation will be key toward addressing these initiatives for the future. Recently, New York Transportation Journal author Paul Larroussee argued that while federal officials "should promote and allow flexibility with state and local officials in the use of its funds," local governments will "better position themselves" if they show more willingness to adopt and incorporate livability initiates in their planning proces. Larrousse further argued that once USDOT puts a comprehensive approach toward transportation and land use in place, states that quickly adapt to and incorporate these "livability" initiatives will benefit most *(60)*.

Implications of Future California GHG Reduction Policies

EPA agents have indicated that they intend to follow California's lead in implementing future policies on GHG emissions at the state level. As discussed in Chapter 5, California has demonstrated to be the leader in GHG reduction legislation and actions. For example, California's Low Emission Vehicle (LEVII) standards that set strict vehicle GHG emissions requirements could likely be adopted at the federal level. Leading EPA officials have also indicated that states may soon be required to develop state-wide GHG Inventories and Climate Action Plans based on the California model. The landmark California Global Warming Solution Act might also be used to set national GHG reduction targets as well. Ultimately, Texas transportation officials could likely expect that California initiatives and laws may soon be mandated at the federal level.

9. NEW DIRECTIONS IN CARBON CREDIT AND TRADING

In an effort to comprehensively address climate change, federal policymakers have sought to pursue a variety of initiatives to encourage greater GHG emissions reductions. In contrast to imposing a tax on carbon emissions, policymakers have recently suggested a carbon trading scheme whereby a market is created for reducing GHG emissions by giving a monetary value to the cost of polluting the air. In addition, a carbon tax could be levied on the carbon content of fuels. In a "cap-and-trade" approach (which tends to associate more with a carbon trading system mandated by a government), "caps" would be placed on total GHG emissions and "allowances" would traded on an open market. Yet despite efforts by Congress to pass comprehensive cap-and trade legislation this year, many political experts now believe that this will be at least a year away. Therefore, this chapter explains how a carbon trading system would function, how cap-and-trade system differs, how transportation might be incorporated, and regional carbon credit trading initiatives undertaken around the U.S.

Carbon Credits – Certification and Use

A carbon credit is a term used to assign a value to a reduction or offset of greenhouse gas and is usually equivalent to one ton of CO_2E. A carbon credit can be used by a business or individual to reduce their carbon footprint by investing in an activity that has reduced or sequestered GHG at another site. Carbon credits create a market for reducing GHG emissions by giving a monetary value to the cost of polluting the air, resulting in carbon trading. There are two main categories of carbon credits: certified and voluntary.

Voluntary emissions reductions are produced and purchased by entities that are not obligated to reduce GHG emissions. Essentially, in a voluntary market, individuals, companies, or governments purchase carbon offsets to mitigate their own GHG emissions from transportation, electricity use, and other sources. Certified carbon credit markets have much more restrictions on the way they are traded and are often more securitized. Certified emissions reductions (CER) are produced within a regulated jurisdiction in which emitters are obligated by law to purchase credits equivalent to their surplus GHG emissions. CERs can be purchased from the primary market (purchased from original party that makes the reduction) or secondary market (resold from a marketplace).

Carbon Credits – Markets and Pricing

Some examples of CER markets include the Emissions Trading Scheme in Europe and the Regional Greenhouse Gas Initiative (RGGI) in the northeastern U.S. The Chicago Climate Exchange (CCX) is North America's only voluntary, legally binding GHG reduction and trading system in North America and Brazil. See Figure 2 for common examples of compliance carbon credits and voluntary carbon credit unit standards used today.

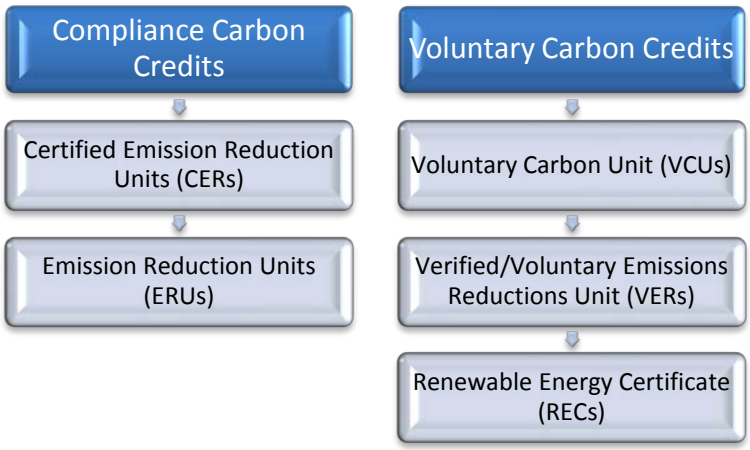


Figure 2. Types of Carbon Credits.

While carbon trading occurs in both the public and private sectors, cap-and-trade is a form of government-mandated carbon trading that is of particular importance to the transportation sector. See the following for a detailed explanation on how a cap-and-trade system might work and how transportation might be integrated into the process.

Cap and Trade Overview

In a cap-and-trade program, the government determines which facilities are covered by the program and sets an overall emission target, or "cap," for the covered entities. This cap is the sum of all allowed emissions from all included facilities. After the cap has been set and covered entities specified, tradable emissions allowances (synonymous with carbon credits) are distributed (either auctioned, or freely allocated, or some combination of these). Each allowance authorizes the release of a specified amount of GHG emissions, generally one ton of CO_2E. The total number of allowances is equivalent to the overall emissions cap (e.g., if a cap of one million tons of emissions is set, one million one-ton credits will be issued). Covered entities must submit allowances equivalent to the level of emissions for which they are responsible at the end of each of the program's compliance periods.

Allowance trading occurs because firms face different costs for reducing emissions. For some emitters, implementing new, low-emitting technologies may be relatively inexpensive. Those firms will either buy fewer allowances or sell their surplus allowances to firms that face higher emission control costs. Since a ton of CO_2 emitted from one source has the same warming effect as a ton emitted from any other, the location of a given emissions reduction does not matter. By giving firms a financial incentive to control emissions and the flexibility to determine how and when emissions will be reduced, the capped level of emissions is achieved in a manner that minimizes overall program costs *(66)*.

A Pew Research Center report on cap-and-trade entitled, *Climate Change 101: Cap and Trade,* provides an excellent example of how such a system might function *(61)*. For example, a state government could establish a cap-and-trade system by setting an overall emissions cap of 600 tons of CO_2E and then issuing 600 emissions allowances. If allowances were evenly distributed between two emitters, both emitters would have an incentive to trade because emissions reduction costs are higher for A than for B. Emitter B might cut emissions by 200 tons and sell

its excess allowances to Emitter A for less than it would have cost Emitter A to make the reductions itself (for example, $2,500 for 100 allowances). In this scenario, the desired level of emissions is reached at a lower total cost of $4,500 and a lower cost per ton of $15. The total cost is lower, as is the cost for each regulated facility. Figure 3 (obtained directly from the Pew report mentioned above) describes this "cap-and-trade" concept in greater detail.

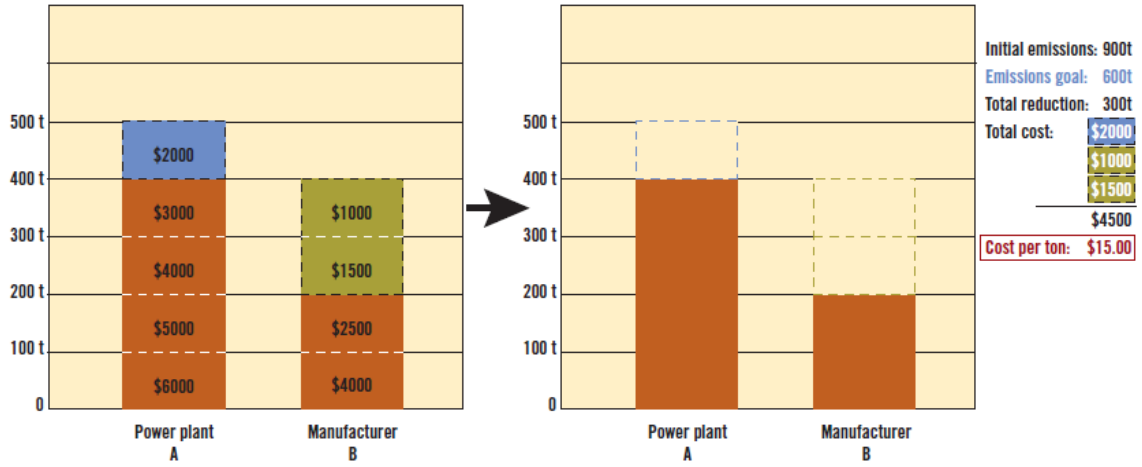


Figure 3. Cap-and-Trade Legislation Example.

Key decisions will have to be made in terms of which carbon trading program should be most appropriate to implement. These decisions include:

- Which entities would be required to hold allowances;
- The level of the emissions cap;
- Whether provisions would be included to ensure costs do not become too volatile;
- Whether the program should be linked with similar trading programs; and
- How allowances (or "credits") should be distributed.

After deciding which emissions would be covered under a cap-and-trade program, policymakers would need to decide who would be responsible for surrendering enough allowances to make each compliance goal (called the "point of regulation"), the types of cost containment mechanisms that will be utilized, and how the allowances will be distributed. Detailed discussion on each of these important decisions is provided in the following.

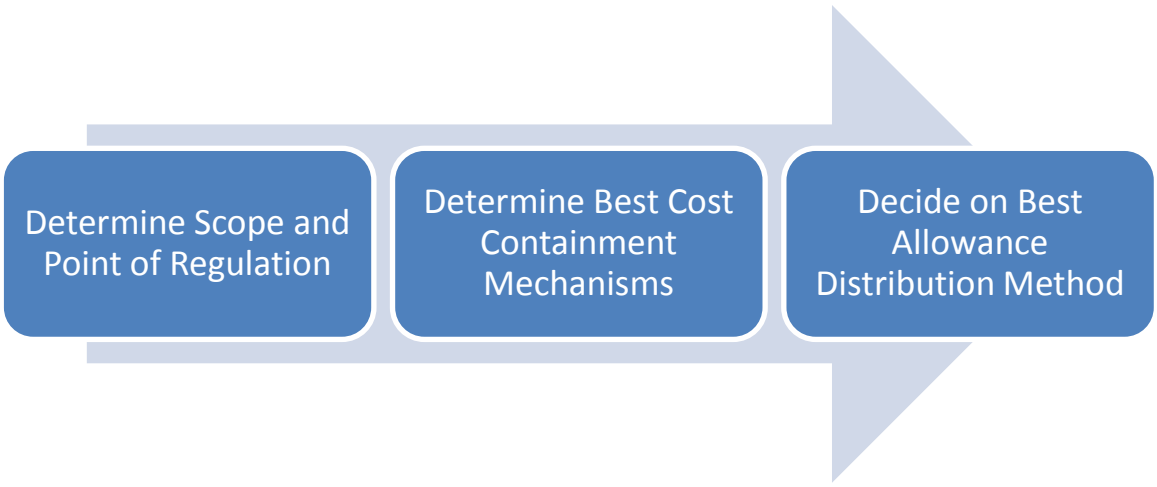


Figure 4. Effective Cap-and-Trade Decision-making Process.

Cap and Trade Market Design

Point of Regulation

There are three systems by which governments would be required to regulate GHG emissions. A downstream, source-based system, entities covered would be direct emitters of GHGs (which would include large emitters such as power plants or manufacturing facilities) *(62)*. In a product or load-based cap-and-trade system, covered entities are responsible for all the emissions associated with the production of electricity, natural gas, or other product they provide to customers. However, perhaps the most relevant point of regulation to transportation would be a pure upstream system. A pure upstream, economy-wide system for CO_2 would place a cap on the total amount of carbon contained in fossil fuels and other products used in the economy. It would require importers or suppliers of fossil fuels to submit allowances to cover the carbon in the products they sell. Incorporating transportation into this type of cap-and-trade system is discussed in greater detail in the following.

Cost Containment Mechanisms

There are many cost containment mechanisms that could help to manage the cost of compliance for covered entities in a cap-and-trade program, such as offsets, temporal flexibility, safety valves, and linkage. An offset mechanism allows covered entities to offset their own emissions by purchasing emission reduction credits generated through projects at facilities not covered by the cap. Offset projects may include landfill CH_4 capture and a forestation and should be measurable, real, additional, and have clear ownership *(63)*. Markets can also be designed to allow firms greater flexibility in compliance. Regulators could choose to let firms either "bank" or "borrow" their allowances. Banking allows firms to save any excess allowances for future use or sell their allowances to other firms. Firms could also "borrow" allowances with the expectation that they will "pay back" these allowances by reducing emissions in the future. A safety valve mechanism allows emitters greater flexibility in how they comply with a cap in case compliance costs are higher than expected. Finally, cap-and-trade programs could be designed to

link with other trading systems in other regions. This could result in a greatly expanded market and lead to more opportunities for low-cost emissions reductions.

Allowance Distribution

After the cap has been set and the overall design of the cap-and-trade system has been established, decisions about how to distribute allowances must be made. *(64)* There are two basic methods toward allowance distribution: free allocation and auction. Free allocation occurs when allowances are given away for free based on a firm's historical emissions. Allowances can also be auctioned. Auctioning generates revenue that a government can use to provide relief for compliance or higher energy costs. Either free allocation or auctioning can be used to advance program goals under a cap-and trade program. The key difference between auction revenue and allowances is that auction revenue could be used to adjust other taxes, and allowances are more easily limited to purposes more closely tied to the cap and trade program itself.

Incorporating Transportation into a Cap and Trade Program

Incorporating the transportation sector into a region-wide cap and trade system may be somewhat easy. The fuel supply chain has several "choke points," upstream from consumers and filling stations. At a chosen choke point, fuel handlers—either purchasers or sellers—would be required to track fuel volumes, and obtain emissions permits for the carbon that will be released when those fuels are burned. There are two types of points where this choke could be applied. A cap that applies to oil refiners and importers would cover virtually all CO_2 emissions from oil, not just transportation fuels. However, accounting for exempt product streams (e.g., lubricants, asphalt, exports), as well as apportioning auction revenue among states, may create technical and political complications. A cap at the "terminal rack" is a cap at the facility where fuel from a refinery or pipeline is delivered to trucks, trailers or rail cars. Currently, the IRS and many states collect gasoline and diesel taxes at the terminal rack, since virtually all highway fuels flow through the rack, and sales volumes are carefully measured by buyers and/or sellers. A "cap at the rack" system can piggyback on the state-level tax systems—systems that already accurately account for imports and exports, and that have careful auditing controls for fuel volumes. Fuel handlers will pass on most of the market value of emissions allowances as higher prices for consumers. Economic research has demonstrated that increases in fuel price create incentives for conservation.

These incentives work on many levels: sales of fuel-efficient vehicles get a boost; families with two vehicles use the more efficient one more frequently; some drivers cut back on discretionary trips, or chain some trips together; and lower-carbon fuels may become price-competitive with petroleum. Higher fuel prices help encourage more efficient land use patterns, as demand grows for housing that's near stores, services, and jobs. Similarly, higher prices can encourage investment in infrastructure to support lower-carbon travel alternatives, from streetcars to sidewalks. These adjustments may be gradual and subtle, but they will be real, and their effects will compound over time. Complementary policies—transit infrastructure, low-carbon fuel standards, CAFE standards, transportation demand management, and smart growth policies—will give consumers more options to deal with rising fuel costs *(64)*.

Regional Carbon Trading Initiatives

Western Climate Initiative

The WCI is a collaboration of independent jurisdictions who commit to work together to identify, evaluate, and implement policies to tackle climate change at a regional level. Arizona, California, Montana New Mexico, Oregon, Utah, and Washington are members, with Kansas, Colorado, Wyoming, Idaho, Nevada, and Alaska examining some initiatives. In contrast to most U.S. states, about half of all fossil fuel emissions in the WCI partner states come from the transportation sector. WCI members represent one-fifth of the total U.S. economy and most of Canada's and aim to cut the region's GHG emissions so that by 2020 emissions will be 15 percent lower than 2005 levels. Beginning in 2012, the WCI will begin placing these polluters under a cap-and-trade system. After target reductions have been met, each year the limit will be ratcheted lower.

Northeastern Regional Greenhouse Gas Initiative

The Northeastern RGGI was the first cap-and-trade program for GHGs in the U.S. It covers 10 Northeastern and Mid-Atlantic states (Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont). The program limits – or "caps" – CO_2 emissions from large fossil-fuel-fired electric generating units, with the goal of stabilizing emissions from 2009 through 2014 to a level roughly equivalent to recent historical emissions. The program then reduces the cap by 2.5 percent per year over the next four years so that in 2018 there is a 10 percent reduction from the baseline. RGGI took effect and began regulating CO_2 emissions on January 1, 2009.

Midwestern Accord

Members of the Midwestern Accord include Illinois, Iowa, Kansas, Michigan, Minnesota, and Washington. In November 2007, these states established the Midwestern Regional Greenhouse Gas Accord, under which members agreed to establish a long-term target of 60 to 80 percent below current emissions levels and develop a multi-sector cap-and-trade system to help meet the targets. In May 2009, an advisory group released their draft final design recommendations. These recommendations call for an economy-wide program that would reduce emissions 20 percent below 2005 levels by 2020, and 80 percent below 2005 levels by 2050, though the 2020 target may decrease to 18 percent if allowance prices increase too much. A model rule, which is the proposed set of GHG trading rules upon which participating jurisdictions base their own rules, is being developed. The Midwestern Accord cap-and-trade program is scheduled to launch in January 2012 *(70)*.

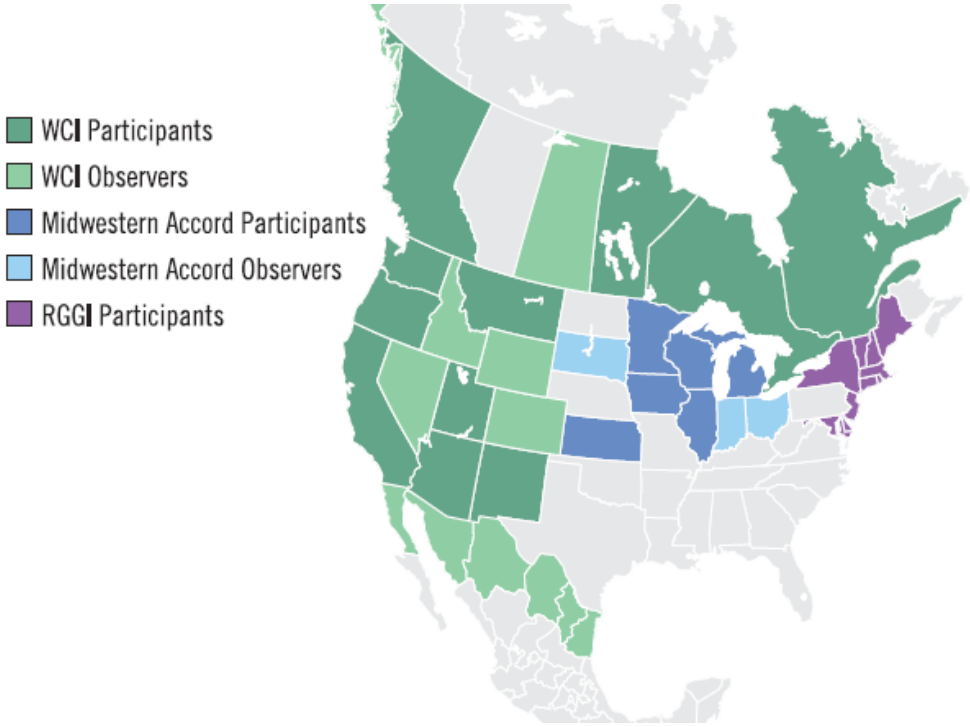


Figure 5. U.S. Regional Carbon Trading Programs.

APPENDIX A – INVENTORY METHODS AND MISCELLANEOUS DATA

EPA GHG Emissions Inventory Methodology

The GHG emissions inventory report prepared by the EPA every year adheres to a comprehensive set of methodologies for estimating sources and sinks of anthropogenic gases and a consistent mechanism that enables parties to the UNFCCC to compare the relative contribution of different emission sources and GHG to climate change *(65)*.

The estimates in the 2010 EPA report were calculated using methodologies consistent with those recommended in the Revised 1996 IPCC Guidelines for National Greenhouse Inventories *(66)*, the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories *(67)*, the IPCC Good Practice Guidance for Land Use, Land-Use Change, and Forestry *(68)* and the 2006 IPCC Guidelines for National Greenhouse Inventories reports *(69)*.

GHG emissions estimates are also recalculated each year the Inventory of U.S. Greenhouse Gas Emissions and Sinks report is published and attempts are made to improve methods in collecting data. In this effort, the U.S. follows the IPCC Good Practice Guidance, which states, "it is good practice to recalculate historic emissions when methods are changed or refined, when new source categories are included in the national inventory, or when errors in the estimates are identified and corrected *(70)*." In general, recalculations are made to U.S. GHG emissions estimates either to incorporate new methodologies or to update recent historical data *(71)*.

Limitations to GHG Emissions Estimates

While the U.S. emissions inventory provides for a solid foundation for the development of a more detailed and comprehensive national inventory in the future, there are uncertainties associated with emissions estimates. Lack of data or an incomplete understanding of how emissions are generated increases the uncertainty associated with GHG emissions estimates that are reported (*71*).

Texas GHG Inventory Data Methodologies and Limitations

State inventory data for GHG emissions from 1990-2007 were collected from reports by the Energy Information Administration (EIA), the Texas Climate Initiative and TCEQ. VMT data were collected using data compiled by TTI researchers using the TRENDS model. While the EPA and the EIA work together to identify and collect GHG Emissions data, each agency reports slightly different results due to differences in inventory methodologies. This might result in differences in calculations from both agencies but not by a significant amount (+/– 3 $MMTCO_2$ at most). These figures presented in Figure 3 were taken from the 1990-2007 EIA Report and should be taken as relative estimates only. Finally, because the EPA and the EIA analyze only CO_2 GHG emissions at the state level, inventory data on other GHG emissions are available only from a 2002 report from the TCEQ.

APPENDIX B – U.S. TRANSPORTATION-RELATED GHG EMISSIONS

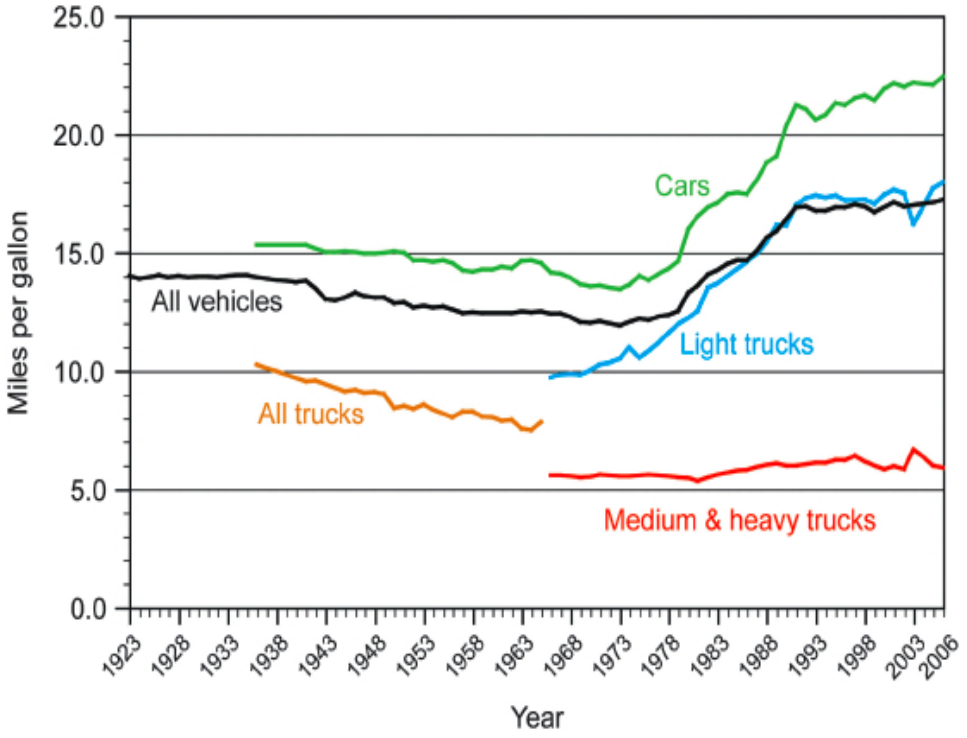
Figure 6. Transportation-Related GHG Emissions (Tg CO2 Equivalent).

Gas/Vehicle Type	1990	1990%	2000	2000%	2005	2005%	2008	2008%
Passenger Cars	**657.3**	**42%**	**695.2**	**36%**	**709.3**	**35%**	**632.1**	**33%**
Carbon Dioxide (CO2)	629.2	96%	644.1	93%	662	93%	597.5	95%
Methane (CH4)	2.6	0%	1.6	0%	1.1	0%	0.8	0%
Nitrous Oxide (N20)	25.4	4%	25.2	4%	17.8	3%	11.7	2%
Hydroflourocarbons (HFC's)	+	+	24.3	3%	28.4	4%	22.1	3%
Light Duty Trucks	**336.5**	**22%**	**512**	**26%**	**551**	**27%**	**552.4**	**29%**
Carbon Dioxide (CO2)	321	95%	466.9	91%	505.6	92%	513.7	93%
Methane (CH4)	1.4	0%	1.1	0%	0.7	0%	0.6	0%
Nitrous Oxide (N20)	14.1	4%	22.4	4%	13.7	2%	9.5	2%
Hydroflourocarbons (HFC's)	+	+	21.7	4%	31	6%	28.6	5%
Medium/Heavy Duty Trucks	**231.1**	**15%**	**354.5**	**18%**	**408.3**	**20%**	**401.2**	**21%**
Carbon Dioxide (CO2)	230.1	100%	345.8	98%	396	97%	388.6	97%
Methane (CH4)	0.2	0%	0.1	0%	0.1	0%	0.1	0%
Nitrous Oxide (N20)	0.8	0%	1.2	0%	1.1	0%	1.1	0%
Hydroflourocarbons (HFC's)	+	+	7.4	2%	11.1	3%	11.6	3%
Buses	**8.4**	**1%**	**11.2**	**1%**	**12**	**1%**	**12.1**	**1%**
Carbon Dioxide (CO2)	8.4	100%	11.1	99%	11.8	1%	11.7	97%
Methane (CH4)	+	+	+	+	+	+	+	+
Nitrous Oxide (N20)	+	+	+	+	+	+	+	+
Hydroflourocarbons (HFC's)	+	+	0.1	1%	0.2	+	0.4	+
Motorcycles	**1.8**	**0%**	**1.9**	**0%**	**1.7**	**0%**	**2.2**	**0%**
Commercial Aircraft	**136.8**	**9%**	**170.9**	**9%**	**162.8**	**8%**	**123.4**	**7%**
Other Aircraft	**44.4**	**3%**	**33.5**	**2%**	**35.1**	**2%**	**33.7**	**2%**
Ships and Boats	**45.1**	**3%**	**61.3**	**3%**	**45.2**	**2%**	**38.7**	**2%**
Rail	**39**	**3%**	**48**	**2%**	**53**	**3%**	**50.6**	**3%**
Pipelines	**36**	**2%**	**35.2**	**2%**	**32.3**	**2%**	**34.9**	**2%**
Lubricants	**11.8**	**1%**	**12.1**	**1%**	**10.2**	**1%**	**9.5**	**1%**
Total GHG Emissions from Transportation (Tg CO2 Equivalent):	**1548**	**100%**	**1935.8**	**100%**	**2021**	**100%**	**1891**	**100%**

* Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2008.

APPENDIX C – HISTORICAL AVERAGE FUEL ECONOMY

Figure 7. Historical Average Fuel Economy (1923-2006).



Source: "Fuel efficiency of Vehicles on U.S. roads: 1923–2006," by Michael Sivak and Omer Tsimhoni, published in the most recent issue of *Energy Policy*.

APPENDIX D – TEXAS POPULATION ESTIMATES

Four population projection scenarios are presented by the Texas State Demographer. The 1.0 Scenario assumes that population migration rates are equal to those experienced in Texas from 1990 to 2000. The 0.5 Scenario assumes population migration rates one-half the rates experienced from 1990 to 2000. The 04 Scenario assumes migration rates estimated for the period 2000 to 2004. The 07 Scenario assumes migration rates estimated for the period 2000 to 2007. Under these alternative assumptions, the 1.0 Scenario produces the largest population, the 0.5 Scenario produces the smallest future population and the 04 Scenario produces a population that is roughly a mid-range between the 1.0 and 0.5 Scenarios. Alternative projections of future Texas population were secured from the Texas State Data Center website at the following web address: http://txsdc.utsa.edu/. The following presents the details of the results of the alternative population forecasts.

Alternative Migration Scenarios				
YEAR	0.5	2000-2004	2000-2007	1.0
2008	23,614,468	24,178,180	24,383,647	24,902,639
2009	23,971,476	24,637,254	24,873,773	25,473,256
2010	24,330,612	25,105,646	25,373,947	26,058,565
2011	24,692,184	25,583,249	25,883,999	26,659,084
2012	25,056,035	26,070,099	26,403,743	27,275,196
2013	25,421,611	26,565,655	26,932,619	27,906,499
2014	25,788,872	27,069,526	27,470,110	28,553,097
2015	26,156,715	27,581,188	28,015,550	29,213,801
2016	26,525,347	28,100,315	28,568,732	29,889,143
2017	26,894,510	28,626,868	29,129,530	30,578,924
2018	27,264,177	29,160,863	29,697,950	31,283,092
2019	27,634,735	29,702,803	30,274,269	32,002,432
2020	28,005,788	30,252,539	30,858,449	32,736,693
2021	28,379,252	30,812,396	31,452,815	33,488,562
2022	28,755,425	31,382,834	32,057,766	34,258,696
2023	29,133,913	31,963,803	32,673,327	35,047,393
2024	29,514,739	32,555,481	33,299,749	35,855,249
2025	29,897,443	33,158,042	33,936,986	36,682,163
2026	30,281,749	33,771,203	34,584,918	37,528,722
2027	30,667,562	34,395,189	35,243,768	38,395,221
2028	31,054,431	35,029,972	35,913,396	39,281,924
2029	31,442,217	35,675,768	36,593,880	40,189,363
2030	31,830,589	36,332,880	37,285,486	41,117,624
2031	32,220,722	37,002,633	37,989,546	42,068,727
2032	32,611,793	37,684,240	38,705,621	43,042,653
2033	33,003,541	38,377,918	39,433,732	44,039,653
2034	33,396,336	39,084,191	40,174,225	45,060,720
2035	33,789,668	39,802,939	40,927,000	46,105,933

APPENDIX E –TEXAS FUTURE VEHICLE FUEL ECONOMY

The following table is projected fuel economy for vehicles in Texas. Fuel economy data were calculated by the Texas Transportation Institute (TTI) and Cambridge Systematics.

	Low MPG Scenario		High MPG Scenario		Average MPG Scenario	
Year	Personal Vehicles	Commercial Vehicles	Personal Vehicles	Commercial Vehicles	Personal Vehicles	Commercial Vehicles
2006	18.3657	6.0057	18.3657	6.0057	18.3657	6.0057
2007	19.0761	6.0183	19.0857	6.0192	19.0809	6.0188
2008	19.8017	6.0322	19.8412	6.0357	19.8215	6.0340
2009	20.5429	6.0476	20.6534	6.0570	20.5981	6.0523
2010	21.3000	6.0647	21.5627	6.0864	21.4313	6.0755
2011	22.0687	6.0882	22.5354	6.1338	22.3021	6.1110
2012	22.4190	6.1089	23.1374	6.1749	22.7782	6.1419
2013	22.7793	6.1311	23.7531	6.2203	23.2662	6.1757
2014	23.1505	6.1548	24.4243	6.2706	23.7874	6.2127
2015	23.5334	6.1802	25.1604	6.3264	24.3469	6.2533
2016	23.9288	6.2075	25.9733	6.3885	24.9510	6.2980
2017	24.3378	6.2368	26.8773	6.4579	25.6076	6.3474
2018	24.7616	6.2684	27.8910	6.5356	26.3263	6.4020
2019	25.2014	6.3026	29.0376	6.6230	27.1195	6.4628
2020	25.6587	6.3395	30.3475	6.7216	28.0031	6.5306
2021	26.1351	6.3796	31.8604	6.8334	28.9977	6.6065
2022	26.6324	6.4230	33.6301	6.9605	30.1313	6.6918
2023	27.1529	6.4704	35.7302	7.1059	31.4415	6.7882
2024	27.6988	6.5220	38.2651	7.2732	32.9819	6.8976
2025	28.2728	6.5784	41.3873	7.4667	34.8300	7.0225
2026	28.8782	6.6401	44.9660	7.6704	36.9221	7.1553
2027	29.5184	6.7079	49.1075	7.8851	39.3129	7.2965
2028	30.1977	6.7825	53.9533	8.1117	42.0755	7.4471
2029	30.9207	6.8648	59.6970	8.3513	45.3088	7.6080
2030	31.6932	6.9559	66.6102	8.6049	49.1517	7.7804
2031	32.5129	7.0548	71.2729	8.8669	51.8929	7.9608
2032	33.3782	7.1608	75.5492	9.1370	54.4637	8.1489
2033	34.2879	7.2734	79.3267	9.4153	56.8073	8.3443
2034	35.2408	7.3921	82.4998	9.7020	58.8703	8.5471
2035	36.2366	7.5164	84.9748	9.9975	60.6057	8.7570
2036	37.2746	7.6460	86.6742	10.3021	61.9744	8.9740
2037	38.3547	7.7806	87.9744	10.6159	63.1646	9.1982
2038	39.4771	7.9199	88.8541	10.9392	64.1656	9.4296
2039	40.6417	8.0638	89.6982	11.2724	65.1700	9.6681
2040	41.8490	8.2122	90.5459	11.6157	66.1974	9.9140

APPENDIX F – STATE CLIMATE CHANGE INITIATIVES AND PROGRAMS

Category	Measure	State
Reducing VMT	Transit, Ridesharing, and Commuter Choice Programs	Alaska, Arizona, Arkansas, Florida, Iowa, Maryland, Michigan, Minnesota, New Hampshire, New Jersey, New Mexico, New York, Oregon, Pennsylvania, Rhode Island, South Carolina, Utah, Virginia, Vermont, Washington, Wisconsin
	Promote Efficient Development Patterns (Smart Growth)	Alaska, Arizona, Arkansas, Florida, Iowa, Illinois, Maine, Maryland, Michigan, Minnesota, Montana, New Hampshire, New Mexico, New York, Oregon, Pennsylvania, South Carolina, Utah, Virginia, Vermont, Washington
	VMT and GHG Reduction Goals in Planning	Alaska, Colorado, Connecticut, Iowa, New Hampshire, New Jersey, New Mexico, Oregon, Pennsylvania, Utah, Virginia, Washington, Wisconsin
	Pay-As-You-Drive Insurance	Arizona, Maine, Maryland, Minnesota, New Mexico, Pennsylvania, Virginia, Vermont
	School and University Transportation Bundle	Arkansas
	Increasing Freight Movement Efficiencies	Connecticut, Florida, Iowa, Michigan, Minnesota, Montana, New Hampshire, New Mexico, Oregon, Pennsylvania
	Support Passenger Rail Service In Iowa	Iowa, Michigan, New Hampshire, Nevada, New York, South Carolina, Washington
	Bike and Pedestrian Infrastructure	Maryland, Minnesota, New Hampshire, New York, Rhode Island, South Carolina, Virginia, Vermont, Washington

Vehicle Improvement	Heavy-Duty Vehicle Idling Regulations and/or Alternatives	Alaska, Arizona, California, Maine, Michigan, Montana, New Hampshire, New Mexico, Nevada, Oregon, Pennsylvania, Utah, Virginia, Washington, Wisconsin
	Heavy-Duty Vehicle SmartWay	Alaska, California, Montana, New Hampshire, Washington
	Heavy-Duty Vehicle Phase Out	Alaska, Arizona, Virginia
	Heavy-Duty Vehicle Public Fleets	Alaska, Maine
	Promotion of Alternative-Fuel Vehicles	Alaska, Arizona, Arkansas, Iowa, Maryland, Michigan, New Hampshire, New Mexico, Nevada, New York, Utah, Vermont, Wisconsin
	Low Rolling Resistance Tires	Arizona, Florida, Montana, New Mexico, New York, Oregon, Pennsylvania
	Vehicle Climate Change Standards (Low emission vehicle (LEV))	California, Connecticut, Iowa, Maine, Minnesota, Montana, New Hampshire, New Jersey, New Mexico, Nevada, New York, Oregon, South Carolina, Washington, Wisconsin
	Off-Road Engines and Vehicles GHG Emissions Reductions	Montana, Wisconsin
Fuel Improvement	Alternative Fuels Research and Development	Alaska, Arizona, Arkansas, California, Florida, Maine, Minnesota, New Hampshire, New York, Oregon, Pennsylvania, Utah, Vermont
	Clean Diesel and Black Carbon	Connecticut, Maine, New Hampshire, Oregon, South Carolina
	Low Carbon Fuels Standard	Iowa, Illinois, Maine, Michigan, Montana, New Hampshire, New York, South Carolina, Utah, Washington, Wisconsin
	Low Friction Engine Oil	New York
Infrastructure	Transportation System Management	Alaska, Arkansas, California, Connecticut, Florida, Maryland, Michigan, Minnesota, Montana, New Hampshire, Oregon, South Carolina, Utah, Virginia, Washington
	Alternative-Fuel Infrastructure	South Carolina, Virginia, Vermont
	Develop and Provide Parking Incentives and Management	Washington

Incentives or Feebates	State Clean Car Program	Arizona, California, Colorado, New Mexico, Nevada, New York, Oregon, Pennsylvania, Rhode Island, Utah
	Clean Car Incentive	Arkansas, Connecticut, Florida, Iowa, Illinois, Montana, New Hampshire, New Mexico, Nevada, New York, Oregon, South Carolina, Virginia, Vermont, Wisconsin
	Feebates	Arizona, Connecticut, Maine, New Hampshire, New York, Pennsylvania, Rhode Island
	State Lead-by-Example	Arizona, Arkansas, Maine, Montana,
Enforcement/ Education	60mph Speed Limit	Arizona, Minnesota, New Hampshire, New Mexico, Pennsylvania, Utah, Wisconsin
	Public Education	Arkansas, Connecticut, Michigan, Minnesota, Montana, New Hampshire, New York, Oregon, Pennsylvania, Utah, Virginia
	Stricter Enforcement of Speed Limits	South Carolina
Urban/Suburban Forestry Program		Rhode Island
Open Space Protection Program		Rhode Island
Marine Vessel Efficiency Improvements		Alaska, Michigan
Aviation Emission Reductions		Alaska, Montana

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