

APPENDIX A: CALCULATING CARBON DIOXIDE EMISSIONS FROM FUEL CONSUMPTION

METHODOLOGY

Carbon dioxide emissions from fuel consumption are estimated according to the following simple formula:

$$Emission(mmtCE) = Fuel\ consumption\ (Btus) \times Carbon\ coefficient\ \left(\frac{mmtCE}{Btu}\right) \times \% \text{ Fuel Combusted}$$

As the formula suggests, three pieces of information are necessary to calculate CO₂ emissions:

- ◆ Fuel consumption (in BTUs)—This data is available from a variety of sources; US national inventories of CO₂, as reported by DOE and EPA, have been calculated using the Energy Information Administration’s State Energy Data Report.
- ◆ Carbon coefficients—Each fuel has a different carbon coefficient, which identifies the amount of carbon released when the fuel is burned. The carbon coefficient depends on the density, carbon content, and gross heat combustion of the fuel (these are reported in DOE/EIA, Emissions of Greenhouse Gases in the United States 1987-1994, Table A1).
- ◆ Fraction of Fuel Combusted—Some portion of fossil fuel consumption is not combusted. Some energy may be consumed for nonfuel use (for example, 50 percent of lubricants are assumed to be consumed for nonfuel use). For fuels that are combusted, the IPCC assumes that oxidation is 99 percent complete and that one percent of the carbon remains sequestered.

***CARBON EMISSION COEFFICIENTS OF PETROLEUM
AT FULL COMBUSTION, 1994***
(MILLION METRIC TONS OF CARBON PER QUADRILLION BTU)

Petroleum	Carbon Coefficients
Residual Fuel	21.49
Lubricants	20.24
Distillate Fuel	19.95
Special Naphtha	19.86
Motor Gasoline	19.43
Jet Fuel	19.34
Aviation Gas	18.87
LPG	17.02

Source: EIA 1994-*Energy Information Administration, Emissions of Greenhouse Gases in the United States*, Washington, DC, September 1995.

Since carbon coefficients differ for each fuel, emissions are calculated for each fuel and then summed to determine total sector emissions.

In addition, carbon dioxide is emitted from other sources associated with transportation but unrelated to travel. Mark Delucchi has estimated full fuel cycle emissions related to transportation.¹

¹ DeLuchi, M.A. *Emissions of Greenhouse Gases from the Use of Transportation Fuels and Electricity*. Argonne National Laboratory, November 1991.

DIFFERENCES IN DATA SOURCES

There is relatively little debate about carbon coefficients and fraction combusted for each fuel. However, the fuel consumption estimates, which are the source of carbon dioxide emissions estimates, do vary among different sources.

EIA’s fuel consumption estimates are used to compute inventories of carbon dioxide emissions for national and international reporting, and estimates using these data are reported in the *Climate Change Action Plan*, as well as the *US Climate Change Report* submitted under the United Nations Framework Convention on Climate Change.

Fuel consumption data for transportation is available from the following sources:

- ◆ US Department of Energy, Energy Information Administration, *Supplement to the Annual Energy Outlook*
- ◆ US Department of Energy, Energy Information Administration.
- ◆ US Department of Energy, Oak Ridge National Laboratory. *Transportation Energy Data Book*
- ◆ US Department of Transportation, *National Transportation Statistics*.

If different sources of energy consumption data are used, transportation sector carbon dioxide emissions estimates may vary considerably. For example, the following modal carbon dioxide emissions estimates were calculated using the same methodology, based on different fuel consumption data both reported by the US Department of Energy.

1993 Carbon Dioxide Emissions Estimates from Various Sources

Transportation Mode	DOE/EIA, Supplement to Annual Energy Outlook 1995		DOE Transportation Energy Databook: Edition 15	
	CO ₂ Emissions	% of Transportation Sector Emissions	CO ₂ Emissions	% of Transportation Sector Emissions
Highway ²	320.1	73.0	338.8	75.2
Rail	12.4	2.8	9.5	2.1
Aviation	44.9	10.2	38.3	8.5
Water-based	33.7	7.7	30.4	6.7
Military Use	16.7	3.8	16.7	3.7
Pipeline Fuel	9.0	2.1	15.5	3.4
Lubricants	1.6	0.4	1.6	0.3
TOTAL: ALL MODES	438.5³	100.0	450.7	100.0

Note: These estimates include bunker fuels.

² Total highway mode emissions do not equal the sum of components listed since the light-duty vehicles and freight trucks categories overlap.

³ This estimate of 1993 transportation sector emissions differs slightly from the estimate of 436.7 mmtCE reported by EIA. This difference is less than 0.5 percent and stems from slight differences in fuel consumption reported in the *Supplement to the Annual Energy Outlook 1995* (used to calculate estimates here) and the *State Energy Data Report 1993: Consumption Estimates* (used to calculate estimates in the EIA report).

The variation in emissions estimates is important since it suggests that accurately measuring progress toward targets contains a high degree of uncertainty. The variation stems from the approach used to estimate fuel consumption. EIA uses a modeling approach, whereas the DOE's Transportation Energy Databook estimates consumption from various sources, including FHWA's *Highway Statistics*, APTA's *Transit Fact Book*, and DOE sources.

UNCERTAINTY IN FORECASTING FUTURE EMISSIONS

Uncertainty regarding future levels of energy-related emissions arises from a number of sources:

- ◆ The relationships between economic activity, energy prices, and energy use are not completely understood (these assumptions are embodied in the Department of Energy's Annual Energy Outlook modeling process)
- ◆ Future conditions may diverge from assumptions made regarding economic growth rates, world oil prices, US energy resources, and the costs and performance of technologies used on the supply and demand sides of the energy market.

APPENDIX B: GLOBAL CLIMATE CHANGE INTERNET SITES

The discussion and debate surrounding global climate change theory evolves quickly, and often the most recent information is available on the World Wide Web. The following information was collected primarily from web sites operated by the US Environmental Protection Agency and other organizations.

American Council for an Energy Efficient Economy (ACEEE)

The American Council for an Energy-Efficient Economy (ACEEE) is a nonprofit organization dedicated to advancing energy efficiency as a means of promoting both economic prosperity and environmental protection. Their web site contains a list of their publications, some of which address transportation's contribution to global climate change.

<http://crest.org/aceee>

American Petroleum Institute

The American Petroleum Institute is the primary United States national trade association serving all components of the petroleum industry. This web site contains a number of issue papers on energy, the environment, and global climate change.

<http://www.api.org/>

California Air Resources Board

The California Air Resources Board mission is to promote and protect public health, welfare, and ecological resources through effective reduction of air pollutants while recognizing and considering the effects on the economy of the state. The site contains events calendar, related links, new releases, and software. Additionally, it contains reports on the zero emission vehicle program in California.

<http://www.arbis.arb.ca.gov/homepage.htm>

California Energy Commission

The California Energy Commission is the state's primary energy policy and planning agency, charged with ensuring a reliable and affordable energy supply. Their site contains a list of their publications, a few of which focus on global climate change.

<http://www.energy.ca.gov/energy>

Carbon Dioxide Information Analysis Center (CDIAC)

The Carbon Dioxide Information Analysis Center (CDIAC) provides information to help international researchers, policy makers, and educators evaluate complex environmental issues, including potential climate change, associated with elevated levels of atmospheric carbon dioxide and other radioactive trace gases.

<http://cdiac.esd.ornl.gov/cdiac/>

Center for Clean Air Policy

Founded in 1985 by a bipartisan group of state governors, the Center for Clean Air Policy seeks to promote and implement innovative solutions to major environmental and energy problems which balance both environmental and economic interests. The Center's work is guided by the belief that market-based approaches to environmental problems offer the greatest potential to reach common ground between these often conflicting interests. The site contains a number of reports on emissions trading concepts.

<http://www.ccap.org>

Center for Climatic Research, University of Delaware

Members of the Synoptic Climatology Lab group located at the University of Delaware perform research in a variety of applied climatological issues that affect humans and other organisms around the world. As synoptic climatologists they attempt to characterize an entire weather situation that exists in a given area at a given time, in hopes of being able to better understand the atmospheric environment and its effects on the organisms.

<http://www.udel.edu/SynClim/scl.html>

Center for Global Change (CGC) at the University of Maryland

The Center for Global Change, based at the University of Maryland, seeks innovative solutions to global environmental problems and studies their relationships to energy use, economic development and equity. The Center evaluates and recommends policies, technologies and institutional reforms to promote sustainable development and reduce the risks of environmental degradation, particularly those posed by climate change and ozone depletion.

<http://www.bsos.umd.edu/cgc>

Center for Integrated Study of the Human Dimensions of Global Change, Carnegie Mellon University

The Center is a group of more than 30 scientists worldwide who study how people affect the environment. Its goals include merging social and scientific knowledge to understand the patterns of human activity and environmental change and to communicate findings through educational materials, brochures and government briefings. The site contains a link to a brochure prepared by researchers at Carnegie Mellon University explaining the issue of global warming and climate change.

<http://hdgc.epp.cmu.edu/main.html>

Center for Renewable Energy and Sustainable Technology (CREST)

The Center for Renewable Energy and Sustainable Technology (CREST), located in downtown Washington, DC, is dedicated to the promotion of renewable energy, energy efficiency, the environment, and sustainable development. One of CREST's primary functions is to explore and demonstrate the use of advanced information and communication technologies in these fields.

<http://solstice.crest.org/>

CFCs: What they are and what they do

Chlorofluorocarbons (CFCs) and other halocarbons are greenhouse gases (GHGs) that may be causing severe damage to the Ozone Layer. This factsheet looks to provide the reader with accurate information on what CFCs are and how they may or may not be contributors to the breakdown of the Ozone Layer. The net effect of CFCs are unknown because even though they are a GHG they also destroy ozone, another GHG. Alternatives to CFCs are being developed.

<http://www.unep.ch/iucc/fs031.html>

CFCs and the Montreal Protocol

International legal efforts to protect the ozone layer also have important implications for climate change. The 1985 Vienna Convention for the Protection of the Ozone Layer and the 1987 Montreal Protocol on Substances That Deplete the Ozone Layer do not directly address the issue of climate change. However, they do seek to phase out chlorofluorocarbons (CFCs) and halons, an important group of greenhouse gases.

<http://www.unep.ch/iucc/fs224.html>

Climate Action Network (CAN) Newsletter

The Climate Action Network (CAN) consists of over 160 Non-Governmental Organizations (NGO) that produce, write, and electronically distribute a newsletter. The newsletter seeks to give its readers access to negotiations on climatic issues and what they mean. Past editions are available for download.

<http://www.igc.apc.org/climate/Eco.html>

Climate Change and Weather: What's the Connection?

This is a report outlining how unusual weather experienced in the US during the last few years has led to assertions that global warming was the cause for the extreme weather. The weather may not be necessarily attributable to climate change but just normal features of the climate. Defensible statements based on observations and what is known about the earth's weather and climate are provided. The site is run by The Center for Ocean-Land-Atmosphere Studies located in Calverton, Maryland.

<http://grads.iges.org/nmcc>

Climate Change Causes, Impacts, and Responses

The 90-plus fact sheets at this site are organized into three series: Causes, Impacts, and International Response.

<http://www.unep.ch/iucc/fs250.html>

Climate Institute

The Climate Institute seeks “to protect the balance between climate and life on earth.” The Institute has become one of the leading international NGO focused on climate change. Through worldwide conferences and programs the Climate Institute promotes awareness and responsible action that will hopefully lead to a balanced climate.

<http://www.his.com/~climate/>

Committee for the National Institute for the Environment

The Committee for the National Institute for the Environment is a national, non-profit organization working to improve the scientific basis for making decisions on environmental issues through creation of a new, non-regulatory environmental science and education agency (the National Institute for the Environment).

<http://www.cnie.org/>

Department of Energy (DOE)

The Department of Energy, in partnership with our customers, is entrusted to contribute to the welfare of the Nation by providing the technical information and scientific and educational foundation for technology and policy.

<http://www.ercn.doe.gov>

DOE’s Clean Cities Program (Alternative Fuels Data Center)

The Alternative Fuels Data Center (AFDC) is operated by the National Renewable Energy Laboratory (NREL) with funding and direction from the Office of Alternative Fuels within the Office of Transportation Technologies at the US Department of Energy (DOE). The AFDC collects operating information from vehicles (in programs sponsored by the Alternative Motor Fuels Act) running on alternative fuels, analyzes those data, and makes them available to the public.

<http://www.afdc.nrel.gov/>

The Econet Homepage

Econet serves organizations and individuals working for environmental preservation and sustainability. Econet builds coalitions and partnerships with individuals, activist organizations and non-profit organizations to develop their use of the electronic communications medium.

<http://www.igc.apc.org/econet>

Edison Electric Institute

The Edison Electric Institute is the association of shareholder-owned electric companies. EEI acts as a representative for its members on subjects of public interest and as a facilitator of information exchange among its members. EEI members generate more than three-quarters of the electricity in the US.

<http://www.eei.org/>

Energy and Environmental Analysis, Inc.

Energy and Environmental Analysis, Inc. (EEA) is a consulting firm founded in 1974 to perform economic, engineering, and policy analysis in the energy and environmental fields. The site lists publications on global climate change strategies, especially regarding the role of technology in reducing emissions. The site information on how to obtain copies of their publications.

<http://www.eea-inc.com/>

Environmental Alliance for Senior Involvement (EASI)

The Environmental Alliance for Senior Involvement (EASI) presents a springboard for senior citizens to be actively involved in focusing the direction in which their community, their nation, and their world will be headed in the future.

<http://www.easi.org/>

EPA's Green Lights and Energy Star Programs

The Environmental Protection Agency has individual web sites to explain two of its popular programs: Green Lights and Energy Star. The programs encourage energy-efficiency to reduce electricity, which in turns reduces harmful air pollutants, such as greenhouse gases.

<http://www.epa.gov/GCDOAR/EnergyStar.html>

<http://www.epa.gov/greenlights.html>

EPA's Global Warming Web Site

The Environmental Protection Agency has extensive information pertaining to global climate change at its Global Warming Web Site. The site contains a brief explanation of global climate change and a user survey. There are reports and other sources of information on the science and impacts of warming; policies and programs to address warming; ways of obtaining more information; latest developments in climate change; quick facts; and links to related sites.

<http://www.epa.gov/globalwarming/home.htm>

Electric Power Research Institute (EPRI)

The mission of the Electric Power Research Institute (EPRI) is to discover, develop, and deliver high value technological advances through networking and partnership with the electricity industry. The EPRI web site provides information on a variety of impacts commonly associated with global climate change.

<http://www.epri.com/>

<http://www.epri.com/mecca/Crops.html>

<http://www.epri.com/mecca/Cyclones.html>

<http://www.epri.com/mecca/Droughts.html>

<http://www.epri.com/mecca/Ecology.html>

<http://www.epri.com/mecca/Hazards.html>

<http://www.epri.com/Impacts.html>

Framework Convention on Climate Change: Full Text

Framework Convention on Climate Change (1992). This site contains the full text of the Climate Change Convention.

<http://www.unep.ch/unfccc/fca6e.html>

Framework Convention on Climate Change: Summary

The United Nations Framework Convention on Climate Change is the first binding international legal instrument that deals directly with climate change. The Convention was adopted on May 9, 1992 after 15 months of negotiations by the UN-sponsored Intergovernmental Negotiating Committee for a Framework Convention on Climate Change.

<http://www.unep.ch/iucc/fs250.html>

Global Change Data Center (GCDC)

The Global Change Data Center (GCDC) Home Page is part of the NASA/Goddard Space Flight Center's Earth Sciences Directorate, Greenbelt, MD, US. The mission of the Global Change Data Center is to develop and operate data systems, generate science products, and provide archival and distribution services for earth science data in support of the US Global Change Program and the NASA Mission to Planet Earth.

<http://ame.gsfc.nasa.gov/gcdc/gcdc.html>

Global Climate Change Information Programme

The Global Climate Change Information Programme (GCCIP) was established in October 1991 with the express purpose of providing the necessary information link between scientists (both natural and social), politicians, economists and the general public. GCCIP was formed as a part of the Atmospheric Research and Information Centre (ARIC) based at the Manchester Metropolitan University. The major aim of the Programme is to provide up-to-date information, in a number of user friendly options, on climate change to the general public, school pupils, students, teachers, lecturers, researchers, industry, and decision makers.

<http://www.doc.mmu.ac.uk/aric/gcciphm.html>

Global Change Master Directory (GCMD)

The Global Change Master Directory (GCMD) is a comprehensive source of information about Earth science, environmental, biosphere, climate, and global change data holdings available to the scientific community throughout the world.

<http://gcmd.gsfc.nasa.gov/>

Global Change Research Information Office (GCRIO)

The GCRIO site provides you with access to global change and environmental data and information from around the world.

<http://www.gcrio.org/>

Global Change Research Program (USGCRP)

This site provides extensive documents and data on global climate, as well as many useful links to other sources.

<http://www.usgrp.gov/>

Global Warming and Mortality

This site provides information on how global warming might potentially lead to higher mortality rates. Potential increase in mortality due to global warming require an understanding of how changes in the climate will affect different population groups and their sensitivities. This section leads to thematic guides on modeling potential increases in mortality to how and where climatic parameters are expected to vary due to global warming. The site is maintained by CIESIN a non-profit, non-governmental organization looking to help all better understand their changing world.

<http://www.ciesin.org/TG/HH/morthmpg.html>

Global Warming Update

The National Climatic Data Center (NCDC) is the world's largest archive of weather data. The center also produces climate publications and responds to data requests. The NCDC is part of the National Oceanic and Atmospheric Administration under the US Department of Commerce.

<http://www.ncdc.noaa.gov/>

Information Unit on the Framework Convention on Climate Change (IUCC)

This section of the Web is managed by the UNEP/WMO Information Unit on Climate Change (IUCC) and the secretariat for the United Nations Framework Convention on Climate Change (UNFCCC). It contains official documents from the Conference of the Parties (COP) as well as the archives of official documents from the Intergovernmental Negotiating Committee (INC), which negotiated the Convention.

<http://www.unep.ch/iucc.html>

Institute for the Study of Planet Earth

The Institute for the Study of Planet Earth (ISPE) located at The University of Arizona provides an interdisciplinary framework for addressing global environmental questions through active education and research. ISPE coordinates seminars and conferences in order to address society's most pressing concerns regarding the rates and patterns of environmental change.

<http://www.ispe.arizona.edu.ispe.html>

Integrated Assessment Models

The Model Visualization and Analysis service (MVA), developed by the Socioeconomic Data and Applications Center (SEDAC), provides background information on the use of integrated assessment to examine the relationship between human activities and global climate change, descriptions of integrated assessment models (IAMs), and access to model-generated output. Integrated assessment modeling tries to provide a systematic way of integrating knowledge across disciplines, styles, resolutions, and degrees of certainty.

<http://sedac.ciesin.org/sedac-2.3/iamcc.tg/TGsec3-1-3.html>

Intergovernmental Panel on Climate Change (IPCC)

The Intergovernmental Panel on Climate Change (IPCC) was established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) to assess the available scientific, technical, and socio-economic information in the field of climate change. The IPCC is organized into three working groups: Working Group I concentrates on the climate system, Working Group II on impacts and response options, and Working Group III on economic and social dimensions. The IPCC released its Second Assessment Report in 1995 and continues to produce technical papers and develop methodologies (e.g. national greenhouse gas inventories) for use by Parties to the Climate Change Convention.

<http://www.ipcc.ch/>

International Council for Local Environmental Initiatives (ICLEI)

The Cities For Climate Protection Campaign We are a campaign of the International Council for Local Environmental Initiatives (ICLEI), which encourages cities to reduce local emissions of carbon dioxide, other greenhouse gases which contribute to global warming (climate change), and related air pollutants.

<http://www.iclei.org/co2>

International Institute for Energy Conservation

This site is sponsored by CREST, the Center for Renewable Energy and Sustainable Technology located in Washington, DC and San Francisco, CA. Solstice is a CREST sponsored program providing internet accessible information on energy efficiency, renewable energy, and sustainable technology.

<http://solstice.crest.org/clients/iiec/iiec.html>

Interstate Renewable Energy Council (IREC)

IREC works to accelerate the sustainable utilization of renewable energy sources and technologies in and through state and local government activities.

<http://www.eren.doe.gov/irec>

Joint Implementation

The US Initiative on Joint Implementation (USIJI) was launched in October 1993 as part of President Clinton's Climate Change Action Plan. USIJI is the largest and most developed of several pilot programs being created worldwide to explore the potential of "joint implementation." Joint Implementation (JI) refers to arrangements between entities in two or more countries, leading to the implementation of projects that reduce, avoid, or sequester greenhouse gas (GHG) emissions.

<http://www.ji.org/>

George C. Marshall Institute

The Marshall Institute contains much information regarding the uncertainty of global warming theory and the models used to predict global climate change.

<http://www.marshall.org/>

National Association of State Energy Officials (NASEO)

The National Association of State Energy Officials exists to contribute to the success of the State and Territories as they pursue an economically, environmentally and socially sustainable energy future. The site contains NASEO's strategic plan to pursue their mission.

<http://www.naseo.org>

National Center for Policy Analysis (NCPA)

NCPA is a nonpartisan think tank addressing national policy concerns. The site contains some reports done by the organization on global climate change.

<http://www.public-policy.org/~ncpa/pi/enviro/envdex.html#q>

National Weather Service

The National Weather Services (NWS) is a part of the National Oceanic and Atmospheric Administration (NOAA). The NWS issues warnings and forecasts for severe weather conditions that may threaten the United States population. The site contains current weather information, climate and historical data and information of weather topics.

<http://www.nws.noaa.gov/>

NICE3 Program: Building Energy Efficiency

The US Department of Energy (DOE) sponsors an innovative, cost-sharing program to promote energy efficiency, clean production, and economic competitiveness in industry. The grant program, known as NICE3, provides funding to state/industry partnerships for projects that develop and demonstrate advances in energy efficiency and clean production technologies.

<http://www.oit.doe.gov/access/nice3/>

Partnership for a New Generation of Vehicles (PNGV)

The PNGV website contains information on this initiative, including program goals and accomplishments, federal agency participants, background information, how to participate in PNGV, future technology needs, current status reports, and related events and articles on the PNGV news front. The PNGV website is maintained by the US Department of Commerce.

<http://www.ta.doc.gov/pngv/>

Resources for the Future (RFF)

RFF is an independent, nonprofit organization that does research and policy analysis of natural resource and environmental issues. The Energy and Natural Resources Division explores world oil markets and energy security; regulatory issues in natural gas and electricity; connections between energy and the environment; and improved management practices in agriculture, water, and forestry. The site contains a list of recent RFF Discussion Papers presented at their weekly seminars. Most of the papers are downloadable, and there are some recent reports on global climate change.

<http://www.rff.org/>

Science and Environmental Policy Project (SEPP)

A research organization founded by an atmospheric physicist, Dr. S. Fred Singer, a Professor of Environmental Sciences at U-VA at the time. The purpose of the SEPP is to ensure that sound science is the basis for environmental decision-making. There is a considerable amount of reading material at this site devoted to the uncertainty and skepticism regarding global climate change within the scientific community.

<http://www.his.com/~seep/glwarm/glwarm.htm>

Sierra Club Global Warming News

Global Warming News is an update set out by the Sierra Club Global Warming Team (Dan Becker, Ellen McBarnette, David Danzig, and Patty Glick) on what's new in Global Warming issues.

<http://www.sierraclub.org/news/global-warming/>

Trees For The Future

Trees for the Future is a non-profit member organization. The organization helps people plant useful, fast-growing trees to replace the ones they keep cutting down for fuel.

<http://wwwa.com/trees>

Union of Concerned Scientists (UCS)

This group of concerned scientist promote ideas and solutions to agriculture, arms control, energy, global resources, and transportation. Their Sound Science Initiative focuses on biodiversity, climate change, ozone depletion, and population growth. The site also contains a junk science quiz for those interested.

<http://www.ucsusa.org/>

The World Climate Report

World Climate Report is edited and written by a team headed by Environmental Scientist Dr. Patrick J. Michaels of the University of Virginia. The site contains reports and discussion on global climate change.

<http://www.wcrpt.com/>

World Meteorological Organization

The World Meteorological Organization (WMO) is a specialized agency of the United Nations located in Geneva, Switzerland. Their site provides a wealth of information on the various climate programs they institute throughout the world. The nations of the world coordinate through WMO in an effort to monitor, understand, predict, and protect the global environment in the interest of all humanity.

<http://www.wmo.ch/>

World Health Organization

The World Health Organization (WHO) seeks to promote the greater well being and health of earth's people. WHO is an agency of the United Nations administering programs around the globe to battle disease, famine and any other health hazard affecting the population. The WHO site contains publications and statistical information on the health of the world.

<http://www.who.ch/>

APPENDIX C: ANNOTATED BIBLIOGRAPHY

Due to the fact that much of the interesting discussions concerning the complexity or conflicting opinions of global climate change occur outside the realm of peer-review, both peer-reviewed documents and those which are not peer-reviewed are included in this annotated bibliography. Whenever it is fully known that a document was peer-reviewed, it is indicated at the end of the summary. Some of the literature that is not indicated as such may still have been peer-reviewed, but a confirmation of peer-review was perhaps unobtainable or uncertain.

INVENTORIES OF EMISSIONS AND CONCENTRATIONS

Energy Information Administration, Office of Integrated Analysis and Forecasting. *Emissions of Greenhouse Gases in the United States, 1995*. Pittsburgh, PA: US Government Printing Office, October 1996.

This report presents updated estimates of US anthropogenic emissions of greenhouse gases for the years 1987-1994 along with preliminary estimates of 1995 levels of emissions. EIA finds that updated energy data resulted in slightly higher estimates of emissions for the years before 1995 than had been found in the past. This report offers updated global warming potential, based on the further revised estimates of the IPCC. It incorporates reformulated gasoline into the 1995 emission coefficient for motor gasoline. Other new or updated information included in the document is as follows: revised historical estimates for methane emissions; revised methods for estimating methane emissions from the solid waste of domesticated animals and wastewater treatment; new carbon sequestration estimates; and new maps of the historical extent of forest land in the United States.

Energy Information Administration, Office of Integrated Analysis and Forecasting. *Emissions of Greenhouse Gases in the United States, 1987-1994*. Pittsburgh, PA: US Government Printing Office, October 1995.

This report presents estimates of US anthropogenic emissions of greenhouse gases for the years 1987-1993. Estimates of 1994 levels of halocarbons and carbon dioxide are also given. The study finds a somewhat higher effect of methane and nitrous oxide relative to that of carbon dioxide, which differs from past years. The report offers revised information on annual emissions of gasoline, liquefied petroleum gas, jet fuel and crude oil; revised flare gas estimation methods; revised historical estimates for methane emissions from coal mines and landfills; expanded coverage of nitrous oxide combustion emissions; new data on methane and nitrous oxide emissions from agricultural burning; and reviewed 1993 energy data.

Policy Dialogue Advisory Committee. *Majority Report to the President to Recommend Options for Reducing Greenhouse Gases from Personal Motor Vehicles*. December 1996.

This report represents the view of majority of the Policy Dialogue Advisory Committee. The Committee was charged by President Clinton to make recommendations for the implementation of three sets of policies to reduce greenhouse gas emissions to 1990 levels by 2005, 2015, and 2025, without subsequently increasing. Using figures from the *Annual Energy Outlook* for 1995, the Committee displayed the 1990 level of carbon emissions from the transportation sector, as well as the projected level of emissions in 2010. The Analytic Support Group (ASG) of the Interagency Steering Committee developed information used in this report to specify a feasible path for GHG emissions and a model to compare the amount of greenhouse gas reductions that would result from any specific policy.

Executive Office of the President. *The Climate Change Action Plan*. President William J. Clinton and Vice-President Albert Gore, Jr., October 1993.

The Climate Change Action Plan (CCAP) is the basis for the US response to the international *Framework Convention on Climate Change*. The CCAP outlines nearly 50 new or expanded initiatives in all sectors of the US economy—commercial, residential, industrial, and transportation—that are expected to return US greenhouse gas emissions to 1990 levels by the year 2000. The Plan broadly describes the major policy initiatives, implementation, projected greenhouse gas impacts, and costs.

Organization for Economic Cooperation and Development and the International Energy Agency. *Cars and Climate Change*. Washington: OECD Publications and Information Centre, 1993.

The book evaluates the contribution of automobile emissions to global warming, primarily focusing on Japan, the United States, and OECD Europe. The study gives thorough consideration to greenhouse gas emissions from highway vehicles, including emissions during construction of the vehicles and emissions during the generation of the final power source. Statistics on transportation-generated greenhouse gases are compared for several countries. The technological and economic feasibility of reducing transportation-generated greenhouse gases is considered in the context of both policy and market mechanisms for reducing emissions.

The Osbourne Group, in association with DesRosiers Automotive Consultants Inc. and Pilorusso Research & Consulting Inc. *Reducing Greenhouse Gas Emissions From the Ontario Automotive Sector*. May 26, 1995.

The report explores measures to reduce greenhouse gas emissions from the automotive sector in Ontario over the next ten years. It provides a statistical description of the passenger car and light truck fleet with projections of its growth in size and use; estimates emissions factors for greenhouse gases under different reduction options; assesses the technological feasibility and implementability of various reduction options; and offers insight into the barriers to implementation that are unique to Ontario.

Submissions of the United States of America Under the United Nations Framework Convention on Climate Change. *Climate Action Report*. Washington, DC: US Government Printing Office, 1994?

The document describes the current program as required under the Framework Convention on Climate Change in the *Climate Change Action Plan*. It is intended to identify current policies dealing with climate change and aid in the conception of ideas for future actions. The report gives a brief overview of recent scientific estimates on the state of the climate and the need for CCAP. The rest of the report provides a look at the US program, including information on national circumstances, an inventory of greenhouse gas emissions, mitigation programs, adaptation programs, research and education programs, international activities, and the future direction of US planning for climate change.

United States Congress, Office of Technology Assessment. *Changing by Degrees: Steps to Reduce Greenhouse Gases*. Washington, DC: US Government Printing Office, 1991.

OTA addresses whether the United States could effectively reduce carbon dioxide emissions in the near term, a question posed by six congressional committees. The OTA project staff examines the feasibility of emissions reductions in the next 25 years in six key sectors of the US economy, including transportation; and whenever possible the report quantifies the potential for emissions reductions in each sector. In doing so, OTA considers energy efficiency gains, product substitution, conservation, and technological options to reduce the level of greenhouse gas emissions. Policy options are proposed and organized into three scenarios: no reduction, moderate reduction, and extreme reduction. [peer-reviewed]

United States Congress, Office of Technology Assessment. *Saving Energy in US Transportation*. Washington, DC: US Government Printing Office, July 1994.

This report was the final part of an OTA assessment on *US Energy Efficiency: Past Trends and Future Opportunities*. The report analyzes energy use in US transportation. It analyzes the widely varied opinions about the ability of proposed measures to reduce energy consumption of the transportation sector, which currently uses over 60 percent of all the oil consumed in the US. OTA addresses the various opinions of consumption reduction measures and applies them to the current status of the system. Additionally, OTA evaluates current transportation-related problems, forecasts future energy use in transportation, and describes a variety of alternatives for saving energy. [peer-reviewed]

US Department of Energy. *The Climate Change Action Plan: Technical Supplement*. March 1994.

The CCAP Technical Supplement documents the assumptions and parameters used in developing the analysis for the CCAP. This Annex provides more detail about the analytical underpinning and assumptions of the CCAP and the events necessary to transpire for the projected emissions reductions to occur. It describes the administration baseline assumptions and calculations of the emissions impacts of each action. In addition, the Annex provides an overview of the IDEAS model used to determine the integrated energy impacts of the Plan and provides contacts for the various actions.

POTENTIAL IMPACTS OF GLOBAL CLIMATE CHANGE

Barnola, J.M., et. al., “Vostok Ice Core Provides 160,000-year Record of Atmospheric CO₂”, *Journal of Geophysical Research* 92: 14722-14780 (1987).

This article summarizes results from ice cores, which provide fairly reliable historical records of gas concentrations. The article was peer-reviewed and has been widely cited. [peer-reviewed]

Baliunas, Sallie. *Uncertainties in Climate Modeling: Solar Variability and Other Factors*. Testimony presented on September 17, 1996 to the Senate Committee on Energy and Natural Resources.

Baliunas, Senior Scientist at the George C. Marshall Institute, explores the scientific factors in support of the claim that global warming due to human activities will be significant or problematic. Baliunas argues the need to test computer simulated models of climate change against the record of climate change in the last 100 years. Baliunas concludes that there is no evidence that dangerous levels of warming have been or will result from human activities.

Black, William, “Global Warming: Impacts on the Transportation Infrastructure”, in *TR News*, Vol. 150, pp. 2-8 (Sept. - Oct. 1990).

This article overviews the potential impacts of global warming on transportation infrastructure. Some impacts could be positive, such as a decrease in the need for snow removal and longer shipping seasons in northern ports. However, the majority of impacts would require resources to adapt infrastructure. For example, transportation would need to adapt to changes in the flow of goods and people caused by regional economic changes in existing patterns of production and consumption. Roads and railroads in low-lying coastal areas would need to be relocated in the event of significant sea level rise. Drops in lakes and rivers in some regions could disrupt shipping.

George C. Marshall Institute, *Are Human Activities Causing Global Warming?* (April 1996).

This report expresses significant skepticism that human activities are affecting global warming. As climate models improve, the report says, the predictions get closer to a small gradual warming indistinguishable from the natural warming we have been experiencing for the last several hundred years. Instead, the report concludes that natural climate change is the most probable link to moderate temperature increases.

Greene, David L., and Santini, Danilo J., eds. *Transportation and Global Climate Change*. Washington, DC and Berkeley, CA: American Council for an Energy-Efficient Economy, 1993.

The book responds to the 1991 Asilomar Conference on Transportation and Global Climate Change, attended by leading transportation experts from around the world. The conference addressed the transportation sector's contribution to greenhouse gas emissions and role in global warming. A long-term strategy to deal with growing global demand, energy efficiency, and the use of alternative energy sources was discussed at the conference and is continued in this book. The text contrasts the problems of the US transportation system to the rest of the world. A range of mitigation options, such as technological advances, government policies, and use of renewable energy, are examined in a thorough manner.

IBI Group. *Transportation and Climate Change Collaborative: Urban Planning, Public Transit and Related Initiatives for More Sustainable Urban Transportation*. March, 1995.

This report presents a discussion of urban transportation conditions and future challenges in Canada, with an extensive description of some of the attempts being made to achieve more sustainable urban travel. It provides an analysis of the potential of these attempts for reducing greenhouse gas emissions. Barriers to implementation are also discussed, and two strategies for achieving sustainable urban transportation in Canada in both the short and long run are recommended.

Innes, Robert, and Kane, Sally, “Agricultural Impacts of Global Warming: Discussion”, in *American Journal of Agricultural Economics*, Vol. 77, pp. 747-750 (Aug. 1995)

This article provides an overview of ongoing discussions about the impacts of global warming upon agriculture. One significant area of uncertainty is the extent of potential warming, because of the uncertainty of global climate models. However, a shift in global agricultural patterns seems likely. The authors conclude that free trade among nations and regions can help to mitigate the adverse impacts to human populations of such a shift in agriculture.

Intergovernmental Panel on Climate Change, *Second Scientific Assessment of Climate Change, Summary and Report*, World Meteorological Organization / UN Environment Program (Cambridge, MA: Cambridge University Press, 1995).

This recent IPCC report explores potential impacts of climate change on hydrological systems, sea level, agricultural productivity, human health, and other factors. Relatively few references are made to transportation, other than to note that the sensitivity of the transportation sector is relatively low compared to agricultural or natural ecosystems, and the capacity for adaptation through management and normal capital replacement is expected to be high. The report’s findings were formally accepted by the Second Conference of Parties to the Framework Convention on Climate Change. As such, the IPCC report represents an “official” international scientific consensus. The IPCC report is explicit about those conclusions it reaches with certainty, and those about which it is confident but unable to state with certainty given available scientific evidence. See also the description under “Developments in Global Climate Change Policy. [peer-reviewed]

Mendelsohn, Robert, and Rosenberg, Norman, “Framework for Integrated Assessments of Global Warming Impacts”, *Climatic Change*, Vol. 28, pp. 15-44 (1994).

This article provides a framework for integrated assessment of the impacts of climate change on natural resources, and for assessing the potential for specific policies for mitigating adverse impacts. The paper also includes a ‘primer’ on the current understanding of the science underlying climate change.

Moore, T.G., “Health and Amenity Effects of Global Warming” *Working Papers in Economics*, E-96-1 (The Hoover Institution: 1996)

This paper examines statistics on mortality and climate variables for 89 metropolitan counties in the United States. It finds a statistically significant inverse relationship between temperature and mortality—warmer weather is correlated with fewer deaths. If the United States were to warm by 2.5°C, the paper predicts mortality would be reduced by 41,000 per year.

Poiani, Karen, and W. Carter Johnson, “Global Warming and Prairie Wetlands,” *Bioscience*. Vol. 41, No. 9, Oct. 1991, pp. 611-618.

This article reviews the effect of potential global warming on inland prairie wetland ecosystems. These wetlands are the single most important breeding area for waterfowl. While not directly related to potential transportation impacts, the article presents a short summary of likely impacts on ecosystems and water resources.

Singer, S. Fred. *Shaky Science Behind the Greenhouse Effect*, SFS 8/23/90.

This article was taken from the Science and Environmental Policy Project home page on the internet: <http://www.his.com/~sepp/glwarm/ghw-ipcc.htm>. Dr. Singer argues that the IPCC conclusions are drawn hastily from inadequate models that are based on our limited understanding of the physical processes of the atmosphere. He recommends discretion in formulating policies under the pressure of uncertainty when they will affect economic growth and the welfare of billions of people.

Titus, J., and Narayanan, V., “The Risk of Sea Level Rise: A Delphic Monte Carlo Analysis in Which Twenty Researchers Specify Subjective Probability Distributions for Model Coefficients Within Their Respective Areas of Expertise”, *Climactic Change*. Vol. 33, pp. 151-212, 1996.

This paper estimates a probability distribution for sea level rise, using existing models and subjective assessments of reviewers. The models and assumptions used in the paper suggest that greenhouse gases have contributed 0.5mm per year to sea level over the last century. Its projections suggest that there is a 65 percent chance that sea level will rise 1mm per year in the next thirty years, more rapidly than it has been rising in the past century. Assuming that nonclimatic factors do not change, the paper estimates a 50 percent chance that global sea level will rise 45 cm, and a 1-percent chance of a 112 cm rise by the year 2100.

Titus, J., et. al., “Greenhouse Effect and Sea Level Rise: The Cost of Holding Back the Sea”, *Coastal Management*. Vol. 19, p. 172 , 1991.

This article assesses the impacts of sea level rise from global warming on the United States. A one-meter rise in sea level would inundate 14,000 square miles of drylands and wetlands, if no protective measures were taken. Cost impacts of sea level rise include (1) the cost of protecting ocean resort communities by maintaining protective barrier islands and beaches, (2) cost of protecting developed areas along sheltered waters through the use of levees and bulkheads, and (3) the loss of coastal wetlands and undeveloped lowlands. The estimated total cost for a one-meter rise would be between \$270 and \$475 billion, ignoring future development. [peer-[reviewed]

Titus, J., “Strategies for Adapting to the Greenhouse Effect,” *APA Journal*. Summer 1990, pp. 311-323.

This article discusses opportunities for preparing for consequences of predicted levels of global warming, focusing on options “that are rational even if one is skeptical about global warming”. The article discusses questions to ask when setting policy priorities for addressing global warming. Among options discussed are the rerouting of the Mississippi River to save coastal Louisiana, changing coastal land use conventions to enable ecosystems to migrate inland as sea level rises, and phasing out federal water subsidies in the west.

Titus, James G. and Greene Michael. US Environmental Protection Agency. *An Overview of the Nationwide Impacts of Rising Sea Level*, Peer Review Draft.

The draft document considers the effects of sea level rise in terms of disruptions to both physical and economic processes. The authors examine four studies to analyze the nationwide impact of a rise in sea level of 50-200 centimeters by the year 2100. They find that a large amount of land could be lost to the sea from a one meter rise if shores are not protected. They argue that the coastal areas and wetlands could be protected in a cost-effective manner using what they term as a “conditional” policy approach, which they explain in detail. [peer-reviewed]

Toman, Michael, et. al, “Climate Change and Its Consequences”, *Resources*. Issue 124, Summer 1996, pp. 10-13.

The article succinctly summarizes the IPCC’s *Second Scientific Assessment*, and places its conclusions in a broader scientific context. The authors argue that the current state of scientific certainty about global climate change argues strongly for aggressive policies to reduce greenhouse gases.

US Congress Office of Technology Assessment, *Preparing for an Uncertain Climate, Vol. I,II* (Washington, D.C.: US Government Printing Office, 1993).

This study provides an in-depth discussion of policies which might enhance the ability of human and natural systems to adapt to changes in global climate. The report assesses how natural systems may be affected by climate change and evaluates available tools to ease adaptation to a warmer climate. Volume I addresses coastal areas, water resources, and agriculture; volume II includes wetlands, preserved lands, and forests. [peer-reviewed]

US Environmental Protection Agency, *The Probability of Sea Level Rise*. (EPA 230-R-95-008), October 1995.

EPA’s report provides estimates of the impact of greenhouse gas emissions on coastline sea level elevations. The report projects that along the US Atlantic and Gulf of Mexico Coasts, sea level is most likely to rise 26 centimeters by the year 2050 and 55 centimeters by the year 2100. The report discusses elements of its predictive model, which includes the cooling effects of sulfate emissions, stratospheric ozone depletion, possible declines in ocean circulation, and the chlorofluorocarbon phase-out under the Montreal Protocol. [peer-reviewed]

US Environmental Protection Agency. *The Potential Effects of Global Climate Change on the United States: Appendix A—Water Resources*. (EPA-230-05-89-051, June 1989).

This report contains a series of case studies on the potential effects of climate change on water resources in several areas of North America. Featured areas include the Sacramento-San Joaquin River Basin in California; San Francisco Bay; California generally; water resources in Atlanta, Georgia; Laurentian Great Lakes; Lake Michigan; Lake Erie; Tennessee Valley Authority reservoirs; and the Upper Chattahoochee River in Tennessee. [peer-reviewed].

World Health Organization Task Group, “Potential Health Effects of Climate Change” (Geneva: World Health Organization, 1990).

This report explores the potential health effects of climate change, including its impact on vector-borne diseases. The report observes that several vector-borne diseases might be influenced by climate change, including malaria, lymphatic filariasis, dengue and yellow fever. Initial impacts would likely be at the margins of the diseases’ current distributions, with distributions expanding as warmer temperatures expand polewards. WHO also predicted that climate change might also affect the altitude at which vector-borne diseases are found. On the positive side, climate change may cause the elimination of some disease vectors and pathogens as the result of very hot dry conditions.

STRATEGIES TO REDUCE GREENHOUSE GAS EMISSIONS FROM TRANSPORTATION SOURCES

Cambridge Systematics. *The Effects of Land Use and Travel Demand Management Strategies on Commuting Behavior*. Prepared for US Department of Transportation and US Environmental Protection Agency. November 1994.

This report presents analytical results of a project undertaken to investigate the effects of land use and demand management on traffic congestion and VMT. Activities were designed to test various land use and urban design variables to determine their influence on travel behavior. Some general conclusions include: financial incentives are important as part of a TDM strategy; specific land use/urban design characteristics influence mode choice; a positive interaction exists between land use and financial incentives; and tradeoffs exist between ridesharing, transit, walking, and bicycling.

Cambridge Systematics. *Transportation Control Measure Information Documents*. Prepared for US Environmental Protection Agency. March 1992.

These documents provide information on the formulation and emission reduction potential of transportation control measures related to criteria pollutants and their precursors.

Congressional Research Service, *Global Climate Change (Issue Brief updated September 6, 1996)*.

CRS' report reviews the political context of global warming policies, describing various international negotiations and agreements. The report also summarizes sources and trends of information on greenhouse gases. CRS reports are typically widely read by Congress, but are not peer-reviewed.

Deakin, Elizabeth and Greig, Harvey. *Transportation Pricing Strategies for California: An Assessment of Congestion, Emissions, Energy, and Equity Impacts*. Prepared for the California Air Resources Board, June 1995.

This report analyzes the impacts five market-based transportation control measures on air quality, congestion, energy and equity. Those five measures are congestion pricing, parking charges, fuel tax increases, VMT fees, and emissions fees. Each measure is discussed generally in the form of a literature review. The measures are applied to four major California cities, including Los Angeles, Sacramento, San Diego, and San Francisco.

DeCicco, John M., American Council for an Energy-Efficient Economy. *The Greenish Machine: On the Road to Reduced CO₂ Emissions via Higher Fuel Economy and Alternative Fuels (Revised Draft)*. September 24, 1992.

This report is a revised version of a paper presented to the Urban CO₂ Reduction Project Workshop in Miami, Florida during March of 1992. The report explores ways to quickly reduce the carbon dioxide emissions and petroleum dependence of personal transportation in the US. Vehicle technologies are explored, rather than demand-side management techniques, with a focus on the short-term effects of various strategies. Alternative fuels are considered, particularly methanol and natural gas used in an internal combustion engine and grid electricity used in battery-powered vehicles. Several alternative cars are presented and analyzed for cost and performance. The findings suggest that the pursuit of both efficiency and alternative fuel technologies is desirable, because of the close relation between the development of both approaches. This report provides a good review of recent studies, and is one of few that addresses in detail the various technological strategies for reducing greenhouse gas emissions.

DRI/McGraw-Hill, *An Analysis of Public Policy Measures to Reduce Carbon Dioxide Emissions from the US Transportation Sector*, for Office of Policy, Planning, and Evaluation, US Environmental Protection Agency, January 1991.

This study defines the tax strategies that would stabilize or reduce the amount of CO₂ produced by the combustion of gasoline in cars and small trucks. The underlying result of the study is that changes retail gasoline taxes, which affect the usage and efficiency of motor vehicles, is the policy of choice since it virtually taxes pollution directly. Other policy instruments investigated in the study include gas-guzzler taxes and gas-guzzler/gas-sipper rebates. However, these strategies do not affect driving habits (i.e., travel demand) and thus are less able than gasoline taxes to influence the level of CO₂ emissions. Finally, an oil import fee is analyzed as an alternative to gasoline taxes, but although effective such a policy places an unnecessary burden on the economy.

The study finds that federal taxes on gasoline must rise dramatically to achieve a 20 percent reduction in CO₂ emissions, but only moderately to restrain emissions growth. Specifically, if a 20 percent reduction in CO₂ emissions from the transportation sector was achieved by an increase in the gas tax (of roughly 25 cents each year for the next 20 years), over 85 percent of the reduction in gas consumption would result from lower VMT and the adoption of more fuel-efficient technologies.

DRI/McGraw-Hill in association with Charles River Associates, *Highway Transportation and Greenhouse Gas Emissions*. April, 1994.

DRI/McGraw Hill reviewed and assessed current findings concerning highway transportation's contribution to greenhouse gases in a study for the Federal Highway Administration. After synthesizing relevant information, they considered the costs and effectiveness of emissions reduction options. A literature search was performed and a list of future project ideas was compiled. An annotated bibliography is included, which contains literature written up until 1994 on transportation data, policy options, comparative analyses, and alternative transportation fuels.

Policy Dialogue Advisory Committee. *Majority Report to the President to Recommend Options for Reducing Greenhouse Gases from Personal Motor Vehicles.* December 1996.

The report represents the view of the majority of the Policy Dialogue Advisory Committee. The Committee was charged by President Clinton to make recommendations for the implementation of three sets of policies to reduce greenhouse gas emissions to 1990 levels by 2005, 2015, and 2025, without subsequently increasing.

The Committee examined three main factors that determine greenhouse gas emissions from personal vehicle use: fuel economy, VMT, and alternative fuels. They also provided an analytical framework for assessing the merits and weaknesses of certain policies. The members of the Committee did not reach a consensus, but the report offers valuable insights regarding the array of options that exist for emissions reduction. The report recommends a balanced set of policies intended to reduce vehicle emissions by: increasing the efficiency of the vehicle fleet; reduce emissions by introducing cleaner burning fuels; and reduce the amount of driving through attractive transit alternatives and prices that more accurately signal the true cost of driving.

Policy Dialogue Advisory Committee. *Development of Measures to Significantly Reduce Greenhouse Gas Emissions From Personal Motor Vehicles.* Interim Report to the President. March 1995.

This report is a summary of the Advisory Committee's first six months of progress, including a discussion of the assumptions to be used in future estimates of baseline scenarios for greenhouse gas emissions in the next century. It also reviews factors affecting fuel economy, alternative fuel technologies, and vehicle miles traveled. Finally, an outline of 65 potential policy options for further consideration and method for evaluating such options is presented.

Executive Office of the President. *The Climate Change Action Plan.* President William J. Clinton and Vice-President Albert Gore, Jr., October 1993.

The Climate Change Action Plan (CCAP) is the basis for the US response to the international *Framework Convention on Climate Change*. The CCAP outlines nearly 50 new or expanded initiatives in all sectors of the US economy—commercial, residential, industrial, and transportation—that are expected to return US greenhouse gas emissions to 1990 levels by the year 2000. The Plan broadly describes the major policy initiatives, implementation, projected greenhouse gas impacts, and costs.

Framework Convention on Climate Change (FCCC)

This international treaty was negotiated in 1992, and signed by the United States and 153 other nations. The FCCC calls for a voluntary reduction of greenhouse gases to 1990 levels by the year 2000. The treaty encapsulates the international goal of preventing global climate change caused by human greenhouse gas emissions.

Intergovernmental Panel on Climate Change, *First Scientific Assessment of Climate Change, Summary and Report*, World Meteorological Organization/UN Environment Program (Cambridge, MA: Cambridge University Press, 1990).

This report is the IPCC's initial peer-reviewed summary of scientific knowledge about global climate change. As a widely peer-reviewed document, it represents a reliable snapshot of global climate science in 1990. The report stated with certainty that a natural greenhouse effect already keeps the Earth warmer than it would otherwise be, and that emissions from human activities are substantially increasing atmospheric concentrations of greenhouse gases. The report also concluded that atmospheric concentrations probably adjust only slowly to changes in emissions. The IPCC stressed that all its predictions were subject to many uncertainties with regard to the timing, magnitude, and regional patterns of climate change. [peer-reviewed]

Intergovernmental Panel on Climate Change, *Second Scientific Assessment of Climate Change, Summary and Report*, World Meteorological Organization/UN Environment Program (Cambridge, MA: Cambridge University Press, 1995).

This report is the IPCC's 1995 peer-reviewed summary of scientific knowledge about global climate change. The report asserted clearer linkages between human activity and global warming, saying that a human cause for climate change now observed is "likely", not just possible—a much stronger conclusion than in its *First Scientific Assessment*. The report includes extensive discussions of greenhouse gas inventories, potential impacts of global warming, and areas of scientific uncertainty. The report's findings were formally accepted by the Second Conference of Parties to the Framework Convention on Climate Change. As such, the IPCC report represents an "official" international scientific consensus. [peer-reviewed]

MacKenzie, James J., Roger C. Dower, and Donald D. T. Chen. *The Going Rate: What It Really Costs to Drive*. World Resources Institute, Washington, DC; 1992.

This document is a detailed review of the costs of automobile use. Costs are categorized as direct personal costs such as auto insurance and gasoline, and hidden social costs, such as health and safety-related expenses. The discussion provides significant historical information on factors such as energy use, air pollutant emissions levels, vehicle miles of travel, and transportation costs over the last several decades.

Pilorusso Research & Consulting, Inc. *The Role of Transportation Technologies in Reducing Greenhouse Gas Emissions*. May 25, 1995.

This document was prepared for the Ontario Roundtable on Environment and Economy and offers a thorough look at the major technologies option for reducing greenhouse gas emissions. Technologies to improve fuel efficiencies are considered, including policy initiatives in the United States. Other sections are dedicated to alternative fuels for combustion engines; electric and hybrid vehicles; advanced transit; intelligent transportation systems (ITS); high speed rail; and bicycles. For each of the above options, the feasibility of and barriers to implementation of such measures are considered, as well as both the environmental and economic benefits of such policy options. The findings suggest that technology must be taken in context. That is, technological fixes are attractive, especially to the voting public who would prefer not to modify behavior. However, while technologies have a significant role to play in reducing emissions, they are unlikely to sufficiently achieve emissions reduction targets on their own. This is a useful, detailed presentation of technological options for reducing greenhouse gas emissions.

United States Congress, Office of Technology Assessment. *Saving Energy in US Transportation*. Washington, DC. July 1994.

This report assesses the US transportation system, its energy use, and its energy use patterns as compared to those of European nations. It then provides a review of a series of transportation policy options designed to reduce energy use, and addresses the interplay among these policies and other transportation problems such as air pollution and congestion.

United States Department of Energy, Office of Policy and International Affairs. *Policies and Measures for Reducing Energy Related Greenhouse Gas Emissions: Lessons from Recent Literature*. July 1996.

This DOE document provides a review of the recent literature on various policy options intended to reduce greenhouse gas emissions. As such, it reviews various sectors of the economy, including manufacturing, transportation, and electricity generation and their respective contribution to greenhouse gas emissions. The document then addresses economy-wide options to reduce emissions.

US Department of Energy, *Report to the Congress of the United States: Limiting Net Greenhouse Gas Emissions in the United States*, September 1991.

This two-volume study evaluates policy options for reducing US emissions of carbon dioxide and other greenhouse gases. Volume I, Energy Technologies, identifies and describes the principal performance and cost characteristics for energy and environmental technologies that were expected to play a role during the study period—to 2030. Volume II, Energy Response, includes a national-level policy analysis to determine the effectiveness and costs of various federal policy instruments in reducing projected US emissions.

The study finds that the most cost-effective combination of strategies for meeting the congressional emissions objectives encompassed a wide array of actions, including NES Actions such as emissions reductions of chlorofluorocarbons and hydrogenated chlorofluorocarbons, the planning of large areas of new forests, and a broad energy-related emissions reduction program. Transportation fuel efficiency improvements and alternative fuels comprise the spectrum of policies addressing the transportation sector. The study finds that increases in the fuel economy of conventionally-powered light duty vehicles causes only a small decrease in emissions relative to those achieved by the NES Actions.

US Department of State. *Draft Protocol*. January 17, 1997.

This draft protocol lays out specific responsibilities for countries to help reduce the threat of global warming, focusing on actions to be taken after the year 2000. The US plan would establish a multi-year “budget” for greenhouse gas emissions, with a specific cap on the amount of greenhouse gas emissions and industrialized country could release during that time. Caps would be a percentage of greenhouse gas emissions each nation released in 1990. If a nation fell under budget, it could transfer its savings to the next period, or sell off its excess emissions allowances. Alternatively, countries emitting over their budget could use part of the next budget period’s allocation, but would have to include extra emission cuts in their paybacks—a form of “interest”. The US proposal would set up an international trading regime for greenhouse gases. The US proposal also would require all developing countries to take “no-regrets” actions to control their greenhouse gas emissions, and report annually.

The proposal does not specify what the cap might be, or what specific actions must be taken. However, it is expected to act as a basis for discussions among the countries signing the Framework Convention on Climate Change (FCCC) at several meetings held during 1997. The draft protocol is accompanied by a press release and fact sheet describing the proposal.

US Environmental Protection Agency, *Policy Options for Stabilizing Global Climate: Report to Congress* (EPA Report No. 21P-2003.1, December 1990).

This report examines a range of possible responses to global climate change, and estimates their potential for reducing or limiting emissions of greenhouse gases on a global scale. The report describes the types of gases involved, their physical sources, and the level of emissions by source as well as geographic location. The transportation sector is discussed, both in terms of its contribution to greenhouse gas emissions and potential strategies to reduce those emissions. [peer-reviewed]

A number of sources provide information on VMT-reduction strategies without specifically focusing on greenhouse gas emissions. Much of the literature on transportation control measures (TCMs) focuses on local or regional programs rather than national implementation of strategies. A few sources include:

US Environmental Protection Agency. *Methodologies for Estimating Emissions and Travel Activity Effects of TCMs*. Prepared by Systems Applications International. July 1994.

This report provides methodologies for estimating the travel activity effects from individual TCMs. It discusses interactions among TCMs, mode choice dependence on multiple attributes, and an approach to evaluating TCM packages.

US Environmental Protection Agency. *Transportation Control Measure: State Implementation Plan Guidance* (450/2-89-020). September 1990.

This guidance document provides descriptions and examples of the most frequently implemented TCMs; institutional guidance such as assessing feasibility, agency responsibilities, and funding; and techniques for monitoring and enforcing TCMs as a strategy to attain National Ambient Air Quality Standards (NAAQS).

US Environmental Protection Agency. *Guidance on the Use of Market Mechanisms to Reduce Transportation Emissions*. (Final Draft, May 1996.)

This guidance document provides state and local transportation and air quality officials with assistance in analyzing the emissions reductions potential of market-based approaches for state and local air quality planning purposes.