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The Greenhouse Effect and Global Climate Change: Doing Something About the Weather

Senate Office of Research

THE GREENHOUSE EFFECT AND GLOBAL CLIMATE CHANGE: DOING SOMETHING ABOUT THE WEATHER

Prepared by:

Senate Office of Research
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August 1989

425-S

CALIFORNIA LEGISLATURE

Senate

STATE CAPITOL
SACRAMENTO, CALIFORNIA
95814

August 31, 1989

Dear Colleagues:

Human activity is significantly increasing atmospheric levels of greenhouse gases, such as carbon dioxide, methane, chlorofluorocarbons, and nitrous oxide. According to many scientists, increases in these greenhouse gases will raise global temperatures by up to 8°F. within the next century. The resulting climate changes could cause catastrophic damages worldwide. Damages to California could include:

- Severe flooding, shortages of useable water, and increased water pollution.
- Ocean level increases of up to 5 feet, which could triple the size of the San Francisco Bay.
- Damage to wildlife and its habitats.
- Increased air pollution.
- Reduced forest growth and increased forest damage from fires, disease, and pests.
- Reduced agricultural output.

Although a global problem, California bears significant responsibility for the increasing greenhouse effect. With only about .6 percent of the world's population, we create about 1.5 percent of the world's carbon dioxide, the major greenhouse gas. As a responsible member of the world community, California must explore ways to reduce its contribution to the global climate change problem.

In response to our requests for information and assistance, the Senate Office of Research has written the accompanying report called "The Greenhouse Effect and Global Climate Change: Doing Something About the Weather." The report explains how human activities will change our climate, describes how climate changes

could damage the nation and California, and evaluates options for addressing the problem. The report also summarizes bills before the Legislature relating to the global climate change issue.

If you have any questions or comments on the report, please contact Buzz Breedlove of the Senate Office of Research at 445-1727. We welcome your comments.

Sincerely,

DAVID ROBERTI
President pro Tempore of the Senate

GARY HART
Senator, 18th District

ROBERT PRESLEY
Senator, 36th District

MILTON MARKS
Senator, 3rd District

HERSCHEL ROSENTHAL
Senator, 22nd District

DAN McCORQUODALE
Senator, 12th District

ART TORRES
Senator, 24th District

BB:abm

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EXECUTIVE SUMMARY

GLOBAL WARMING PROBLEM IS REAL

Based on our analysis of the global greenhouse effect issue, we believe that adequate scientific evidence exists to conclude that:

- Human activity is significantly increasing atmospheric levels of greenhouse gases, such as carbon dioxide (CO_2), methane (CH_4), chlorofluorocarbons (CFCs), and nitrous oxide (N_2O).

- Increasing greenhouse gas concentrations in the atmosphere will increase average global temperatures by up to 8°F. within the next century. Although virtually all scientists believe strongly that the Earth will warm, they are not sure whether significant warming has already occurred.

- The world, nation, and California face a high risk of significant and varied damages from increased global temperatures.

CALIFORNIA IS A SIGNIFICANT SOURCE OF GREENHOUSE GASES

The United States, with only about 5 percent of the world's population, is responsible for about one-fourth of CO_2 increases. California, with only about .6 percent of the world's population, is responsible for about 1.5 percent of CO_2 increases.

Our Emissions Will Likely Grow. California's contribution of CO_2 emissions likely will grow significantly in the future. The Energy Commission expects Californians to consume, for example, 55 percent more electricity in 2007 than they did in 1985. Caltrans estimates that California motorists will drive about 50 percent more miles in 2010 than they currently drive.

We Can Reduce Our Greenhouse Gas Emissions. Fortunately, the state can reduce its emissions of greenhouse gases. Many actions to reduce the state's emissions of greenhouse gases, in fact, can be justified on the basis of other and more easily identified benefits. Providing incentives to consumers to purchase more fuel efficient vehicles, for example, could be justified on the basis of improved air quality alone. Improving vehicle fuel economy also is one of the best ways to reduce CO_2 emissions, which account for about one-half of the increasing greenhouse effect.

Legislature Should Consider Economic Incentives to Reduce CO_2. The most straightforward method of reducing CO_2 emissions would be for the state to impose a volumetric tax on fossil fuels based on their carbon content. This not only would provide

incentives to reduce fossil fuel consumption, but would provide incentives to switch to fuels that produce more energy per amount of carbon in the fuel. Increasing the fuel economy of new cars sold in California by only 10 miles per gallon, for example, could reduce CO_2 emissions from cars by about 31 million tons per year by 2010, which is a reduction of about 26 percent. Using compressed natural gas in lieu of gasoline in cars would reduce CO_2 emissions from cars by about 19 percent.

CALIFORNIA COULD SUFFER SIGNIFICANT DAMAGE FROM GLOBAL WARMING

In October, 1988, the U.S. Environmental Protection Agency submitted a draft report to Congress called "The Potential Effects of Global Climate Change on the United States." In June 1989, the California Energy Commission released a draft report in response to Chapter 1506/88 (AB 4420) called "The Impacts of Global Warming on California." These two excellent reports concluded that California could incur significant damages from rising temperatures associated with the increasing greenhouse effect. The damage could include:

- Increased flooding, shortages of useable water, and increased water pollution.
- Ocean level increases of up to 5 feet, which could triple the size of the San Francisco Bay and damage coastal areas.
- Reduced wetlands and other habitats, which would endanger fish and other wildlife.
- Increased air pollution.
- Reduced growth rates for forests, and greater damage to forests from fires, disease, and pests.
- Increased electricity demand and reduced hydroelectric power.
- Reduced agricultural output.

CURRENT LEGISLATION ADDRESSES THE GROWING GREENHOUSE EFFECT

In response to compelling evidence that the growing greenhouse effect could increase global temperatures and cause local as well as worldwide damage, the Legislature is considering many measures that address the problem. Table 1 on the following page summarizes those bills that directly address the greenhouse issue.

Table 1

Bill*	Provisions Related to the Increasing Greenhouse Effect
SB 116 Rosenthal	Requires owners or operators of retail stores, cold storage warehouses, and other commercial and industrial buildings that use refrigeration systems to recycle CFCs.
SB 231 Roberti	Requires the ARB to identify options to reduce CFC emissions. Creates Environmental and Technical Assessment Advisory Committee to assist ARB. Requires ARB to assist users of CFCs to reduce emissions. Requires CFC users to provide ARB with inventory of CFC use.
SB 345 Torres	Requires the CEC to evaluate potential cost-effectiveness of increasing surface reflectivity to reduce energy use and global warming.
SB 361 Torres	Requires the ARB to study the potential costs and benefits of requiring large new and modified sources of carbon dioxide to offset CO2 increases with other reductions.
SB 427 Torres	Requires CEC to determine options for reducing carbon dioxide, examine cost-benefits of increased surface reflectivity, and study possible roles for the state in reducing foreign rainforest destruction. Requires CEC to evaluate potential for time-of-use utility rates in reducing greenhouse gas emissions. Requires ARB to inventory greenhouse gases. Includes global warming within scope of California Environmental Quality Act.
SB 1006 Leonard	Provides for a sales tax deduction on the cost of specified low-emission vehicles and alternative-fuel retrofits for the costs that are above comparable gasoline- and diesel-fueled vehicles.
SB 1123 Rosenthal	Sets goals for state purchase of low-emission vehicles, as defined by bill. Encourages utilities to offer off-peak rates for low-emission vehicles.
SB 1138 Marks	Bans products containing CFCs or halons, if the product is harmful to the environment.
SB 1192 Marks	Bans foam food service, food packaging products, and rigid polystyrene foam products made with certain CFCs.

* *Note: Versions of bills as of July 12, 1989.*

Bill	Provisions Related to the Increasing Greenhouse Effect
SB 1219 Rosenthal	Authorizes utilities to recover entire cost of burning fuel oil only if fuel cost plus incremental air pollution costs from fuel oil is less than cost of natural gas. Otherwise, can recover only price of natural gas. Requires ARB to determine incremental air pollution cost of fuel oil.
SB 1527 Hart	Requires the CEC to consider the environmental costs of fossil fuel use when evaluating the cost-effectiveness of energy conservation measures.
SB 1641 Marks	Creates the California Tree Planting and Urban Forestry Fund to be used for tree planting projects. Money for the fund would come from voluntary contributions through a new tax checkoff on state income tax forms, $5 million per year from the SAFCO, $4 million per year from the ELPF, and $1 million per year from Outer Continental Lands Act 8(g) revenue.
SB 1679 Hart	Requires the CEC to develop and implement an economic incentive program for new car buyers to purchase more fuel-efficient cars. Program would require DMV to offer rebate to buyers of new cars that exceed the average fuel economy level, to be funded by one-time fees to buyers of cars with fuel economy rating below the state average.
SJR 13 Keene	Requests that the President of the United States take the lead in making global environmental problems a top agenda item at the July 1989 Economic Summit.
SJR 31 Vuich	Asks Congress to permit farmers to grow crops to produce ethanol on land laying fallow under federal land set-aside programs.
AB 348 Sher	$300 million bond act for reforestation and urban forestry projects.
AB 471 Katz	Raises gas and diesel tax up to 18 cents per gallon by 1994. $10 million per year for ten years for environmental purposes, including tree planting.
AB 1332 Peace	Prohibits sale of vehicles using CFCs in air condition, beginning in 1993, with provisions for exemptions.

Bill	Provisions Related to the Increasing Greenhouse Effect
AB 1489 Bates	Creates tax credit for financial institutions that transfer foreign loans to conservation organizations – called debt for nature swaps.
AB 1718 Hayden	Requires auto repair stations to recycle CFCs when repairing auto air conditioners. Bans sale of small CFC containers used to recharge auto air conditioners and sale of cleaning agents and fire extinguishers with CFCs.
AB 1736 Friedman	Requires ARB to report on programs to reduce CFC emissions from auto air conditioners.
AB 2020 Cortese	Bans all food service, food packaging, and polystyrene foam products made from certain CFCs.
AB 2151 Willie Brown	Requires the CEC to consider the production of greenhouse gases from fossil fuel burning in its reports and deliberations. Requires the ARB to inventory greenhouse gases from electricity generation.
AB 2360 Sher	Requires the Office of Planning and Research to review the California Environmental Quality Act to determine if it should be amended to address potential impacts from global warming.
AB 2395 Sher	Requires that state funded projects be sited to avoid potential adverse impacts from global warming.
AB 2404 Connelly	Bans sale of CFC containers weighing less than 15 pounds that are used to recharge auto air conditioners.
ACR 47 Moore	Declares that a clean fuels approach to improving air quality shall preserve diversity of fuel sources.

INTRODUCTION

> ***"Everyone talks about the weather, But nobody does anything about it."***
>
> Charles Dudley Warner
> Editorial, Hartford Courant
> August 24, 1897
>
> And many others,
> including Mark Twain

Everyone used to talk about the weather in the context of what they should wear to the beach, or when they should plant the corn; but the talk is changing. We read much today about the "Greenhouse Effect" and "Global Warming." We hear scientists debate whether beaches will be inundated by rising oceans and whether cornfields will be able to survive at all under increasing global temperatures.

Indeed, we are talking much more seriously about the weather these days. Contrary to common editorial comment, however, we <u>are</u> doing something about it. Unfortunately, we are making the weather potentially much <u>worse</u> by burning fossil fuels, using chlorofluorocarbons, producing air pollution, and destroying forests. Fortunately, we also can do something to <u>improve</u> the weather. That is what this issue brief is about.

This paper briefly examines the greenhouse effect, the issue of global climate change, and options for addressing this potentially catastrophic problem. In the paper, we:

- Explain what the global greenhouse effect is and how it affects global climate.
- Describe how human activities, including those of Californians, are increasing the global greenhouse effect.
- Discuss the possibility of increased global temperatures and related climatic changes that might result from increases in the Earth's greenhouse effect.
- Describe how global climate changes could damage the nation and California.
- Discuss and recommend options available to the Legislature to reduce the increasing greenhouse effect.
- Summarize state Legislation that at least in part addresses the global climate change issue.

SECTION 1

HUMAN ACTIVITIES ARE INCREASING THE GREENHOUSE EFFECT

Just as a gardener is able to grow tropical plants in colder climates by using a glass enclosure we call a greenhouse, the Earth can sustain life because of its greenhouse—the atmosphere.

GREENHOUSE GASES TRAP HEAT

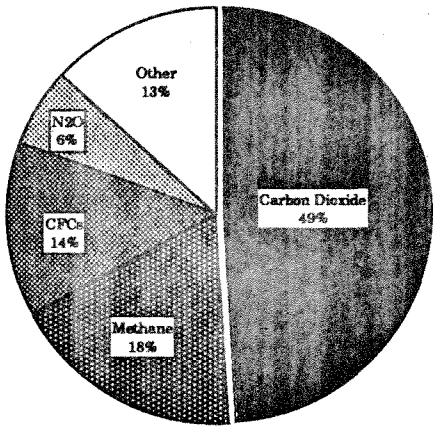
The Sun's rays heat the Earth. The Earth then emits some of this heat as infrared rays (like the heat from a bathroom heat lamp) into the atmosphere and towards space. Greenhouse gases absorb some of this energy, heating the atmosphere. The atmosphere envelops Earth with this heat and radiates some of it back to the surface of the Earth. This natural phenomenon, which is absent on many freezing planets and exaggerated on very hot ones, fosters life on Earth.

Absent an atmosphere, the average temperature of Earth would only be about 5°F., which is 55°F. less than the global average of 60°F. This is because the Earth would radiate much of the energy it receives from the Sun back into space. Fortunately, greenhouse gases fill the Earth's atmosphere. Unfortunately, human activities are increasing the amount of greenhouse gases in the atmosphere, which could raise the Earth's temperature by about 8°F. within the next century.

Figure 1 describes the role of greenhouse gases in increasing the Earth's greenhouse effect. Naturally occurring greenhouse gases, which humans augment, include water vapor, carbon dioxide, methane, nitrous oxide, and smog. Humans are the sole source of other prominent greenhouse gases, such as chlorofluorocarbons and halons. Dust, soot, and debris in the air also contribute to the greenhouse effect. Clouds and particles in the atmosphere also militate against the greenhouse effect by reflecting the sun's light back into space.

Figure 1

CONTRIBUTION OF MAN MADE GASES TO INCREASED GREENHOUSE EFFECT SINCE 1980



Source of Data: Renew America

WE ARE ADDING GREENHOUSE GASES TO THE ATMOSPHERE

Since the industrial revolution, human activities have significantly increased the kinds and amounts of greenhouse gases in the atmosphere. Table 2 briefly describes the major man made greenhouse gases. (Please see Appendix A for a discussion of each of these gases.) Carbon dioxide, for example, has increased in the atmosphere by about 25 percent since the industrial revolution. CFCs, which can last over 100 years in the atmosphere, are increasing at a rate of up to 11 percent per year.

DESTRUCTION OF VEGETATION INCREASES THE GREENHOUSE EFFECT

Humans are destroying about 40,000 square miles of forest per year, particularly in the tropics. This is equivalent to denuding tropical forests covering an area the size of Louisiana—each year. Destruction of forests account for about 30 percent of CO_2 increases during the 1980's. This increase in CO_2 production results from (1) increased burning and decay of destroyed vegetation, and (2) reduced capacity for photosynthesis, in which vegetation converts CO_2 to oxygen.

Brazil leads the world today in forest destruction. The country burned and otherwise destroyed, for example, about 12 million acres, or about 1 percent, of its tropical rainforests in 1988 alone. Brazil has destroyed a total of over 10 percent of its forests in recent years. The Brazilians convert the burned forest land into cattle ranches and farmlands. The U.S., by comparison, has destroyed about 30 percent of its forests since the 17th Century.

Table 2

Description of Significant Man Made Greenhouse Gases

Substance	Source	Share of Problem	Annual Rate of Growth	Atmospheric Lifetime
Carbon Dioxide (CO_2)	Fossil fuel burning, vegetation decay and burning, animal and plant respiration.	49%	0.5%	500 years
Methane (CH_4)	Coal and gas production, rice paddies and swamps, landfills, animal digestion, organic material decay.	18%	1%	7-10 years
Nitrous Oxide (N_20)	Ocean, fossil fuel burning, fertilizers, land disturbances.	6%	0.3%	150 years
Chlorofluorocarbons* (CFCs) and Halons	Refrigerants, aerosols, solvents, insulation, fire retardents.	14%	7%	Up to 110 years
Ozone (O_3**--smog) and other gases**	Ozone from fossil fuel combustion and evaporation, and solvents.	13%	1%-2%	Less than a few hours

* CFCs and halons also destroy ozone in the upper atmosphere (stratosphere), which protects the Earth from the damaging effects of ultraviolet light.

** Ozone in the upper atmosphere (stratosphere) is good, but ozone in the lower atmosphere (troposphere) is smog, which damages health, property and visibility.

SECTION 2

U.S. AND CALIFORNIA ARE MAJOR GREENHOUSE CONTRIBUTORS

Our continued production of greenhouse gases and destruction of tropical forests are causes for serious concern. Although the increasing greenhouse effect is a worldwide problem, we in the U.S. and California nevertheless bear a significant share of responsibility for causing the increased greenhouse effect, and presumably for mitigating it as well.

Data on the contribution to the greenhouse effect by country and region are sketchy. Nevertheless, evidence shows the U.S. to be a major contributor among all nations of man made greenhouse gases. The U.S. is contributing about 20 percent of the increase in the greenhouse effect, with only five percent of the world's population.

U.S. AND CALIFORNIA MAJOR CARBON DIOXIDE PRODUCERS

Table 3 below summarizes U.S. and California production of carbon dioxide (as measured by tons of carbon).

Table 3

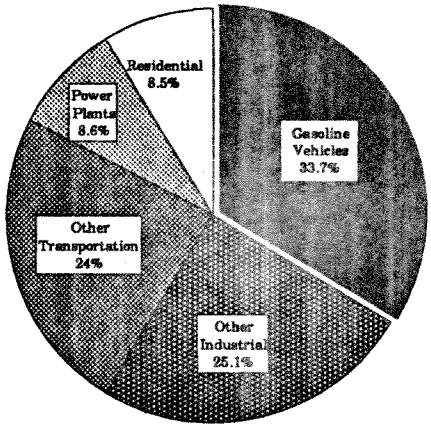
U.S. a Major Producer of Carbon Dioxide
(measured in tons of carbon emissions)

World:	5.5 billion metric tons per year.
U.S.:	1.3 billion metric tons per year 24 percent of world production.
California:	85 million metric tons per year 6.7 percent of U.S. production 1.5 percent of world production.

Transportation Biggest Source of California CO_2. Figures 2 and 3 show the sources of carbon dioxide in California and the U.S., by sector. Over 33 percent of total carbon dioxide emissions in the U.S. comes from electric power plants. By contrast, only 8.6 percent of carbon dioxide produced in California comes from power plants. About 58 percent of carbon dioxide produced in California comes from the transportation sector.

Figure 2

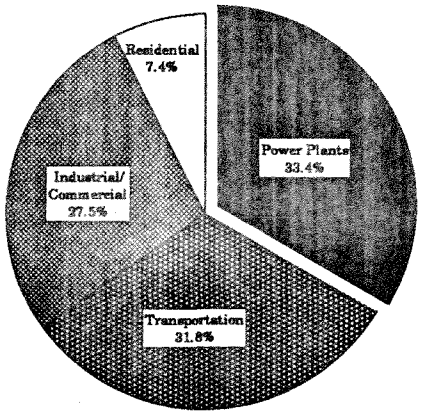
SOURCES OF CARBON EMISSIONS IN CALIFORNIA



Source of Data: Renew America

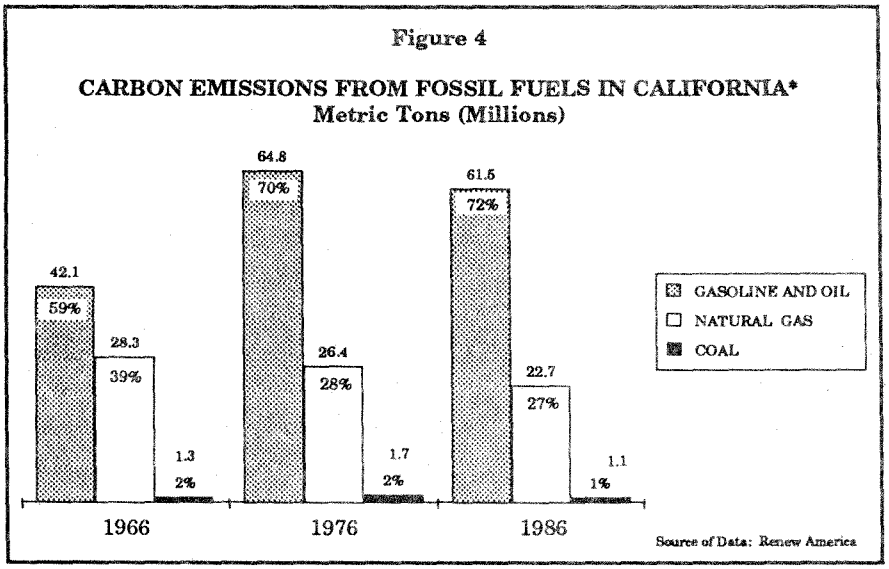
Figure 3

SOURCES OF CARBON EMISSIONS IN THE U.S.

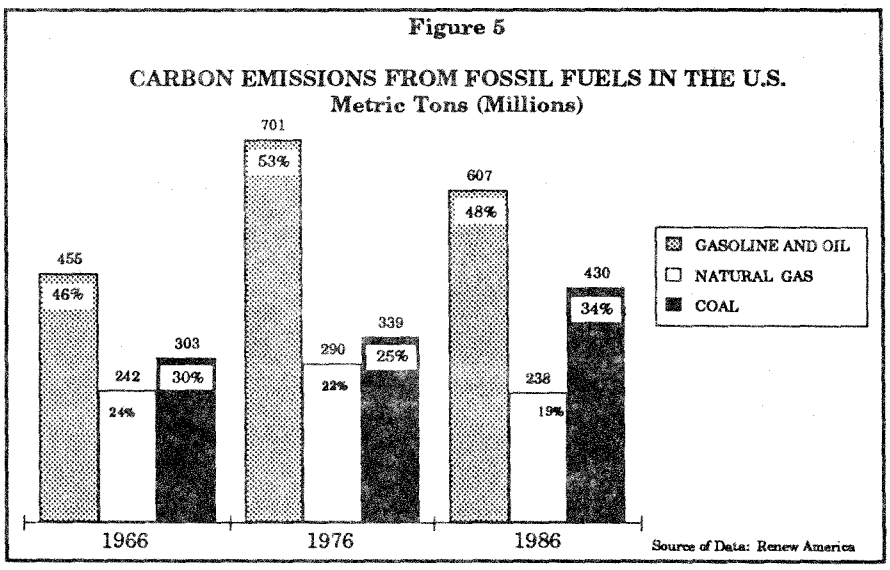


Source of Data: Renew America

California Power Plants Rely on Relatively Cleaner Natural Gas. Figures 4 and 5 show carbon dioxide emissions for California and the U.S., by fossil fuel type. California produces less carbon dioxide from power plants than the average for other states. Whereas, about 84 percent of U.S. electricity comes from coal-fired power plants, Californians get about 18 percent of our electricity from coal-fired power plants. We import virtually all electricity from coal from power plants in other states. (California does have one coal gasification plant and some coal powered cement plants.) By contrast, we get about 46 percent of our electricity from power plants that do not burn fossil fuels.



* Note: Does not include carbon emitted in other states in making products for California.



U.S. LARGEST SOURCE OF CHLOROFLUOROCARBONS

The U.S. and California are also leading producers of chlorofluorocarbon (CFC) and halon emissions. Although data are not available on the amount of CFCs emitted into the atmosphere by region, scientists estimate that the U.S. produces about 30 percent of CFCs and halons used in the world. California is a major user of CFCs in refrigeration, air conditioning, and the electronics industry (as a solvent).

CALIFORNIA HAS WORST OZONE POLLUTION

The U.S. Environmental Protection Agency has identified 62 metropolitan areas in the country that violate federal ozone standards (the damaging tropospheric smog, not the beneficial stratospheric ozone layer). Tropospheric ozone is a strong greenhouse gas. Eleven metropolitan areas in California violate the standard for ozone. Los Angeles, for example, exceeds the ozone standard by over 200 percent on about one-half the days each year. Although the state has reduced ozone levels in recent years by increasing controls on factories and motor vehicles, levels likely will increase again as the state's population and demand for fossil fuel increases.

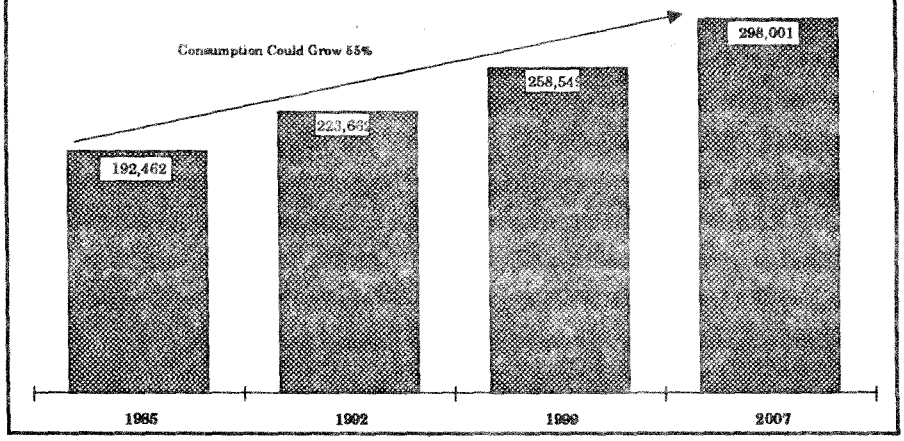
STATE'S GREENHOUSE GAS EMISSIONS WILL LIKELY INCREASE

Fossil Fuel Consumption to Rise. California and the nation have reduced carbon dioxide emissions in recent years by reducing electricity consumption through energy conservation efforts and by increasing the average fuel economy of our vehicles. A growing national and state population, and resulting increases in energy and travel demand, however, will increase CO_2 production.

As Figure 6 shows, the California Energy Commission estimates that electricity consumption in the state will increase by a total of 55 percent between 1985 and 2007. This is an increase of 2.1 percent per year. If we do not increase our energy conservation efforts to mitigate this increase, or if we do not significantly shift to non-fossil fuel generating technologies (such as hydroelectric, solar, wind, biomass plantations, and nuclear), our production of CO_2 will increase as well.

Figure 6

CALIFORNIA DEMAND FOR ELECTRICITY TO GROW
(Gigawatt Hours)

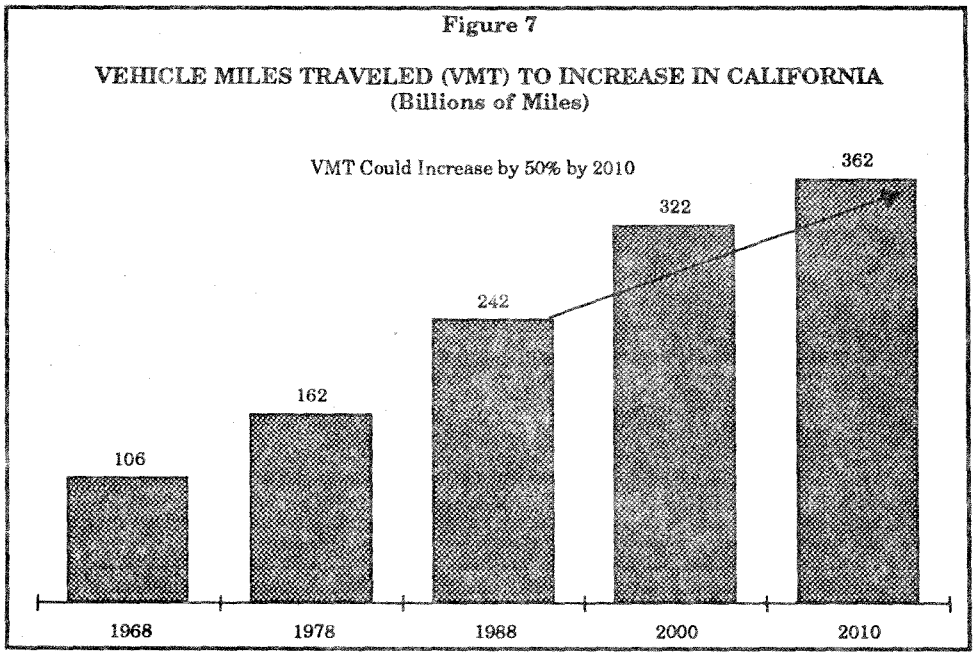


Source of Data: 1988 Electricity Report, California Energy Commission

As Figure 7 shows, the California Department of Transportation (Caltrans) estimates that motorists will drive a total of 50 percent more miles in the state in 2010 than they currently drive. Unless the fuel economy of automobiles increases significantly, or unless motorists switch to fuels that emit less CO_2 than gasoline (such as natural gas, ethanol, propane, and hydrogen), then the amount of CO_2 we emit from cars will increase.

Figure 7

VEHICLE MILES TRAVELED (VMT) TO INCREASE IN CALIFORNIA
(Billions of Miles)



Source of Data: Caltrans

Gains in Smog Reduction to Slow or Reverse. Many parts of California have reduced ozone levels since the 1970's by imposing federal, state, and local emission control requirements on industry and automobiles. In one part of the Los Angeles Air Basin (Azusa), for example, ozone levels exceeded federal standards on an average of 140 days per year between 1976 to 1978. From 1985 to 1987, this same area exceeded the standard an average of 118 days per year. The air should continue to improve through about 2000, as older and dirtier cars are replaced by cleaner cars. Increases in population, and related travel and industrial activity, however, will increase ozone levels again unless federal, state, and local governments strengthen air pollution control requirements.

Amount of U.S. and California Forest Lands Have Decreased Slightly. The U.S. Department of Forestry estimates that the amount of forest land in the U.S. has decreased by roughly 1.6 percent since 1953. The amount of timberland in the U.S. (forest lands that are suitable for commercial harvesting) has decreased by about 5 percent during the same period. The department estimates that forest lands and timberlands in California have decreased by about 8 percent and 2 percent, respectively, since 1953.

In the next section, we discuss how the increase in greenhouse gases will increase global temperatures.

SECTION 3

THE INCREASING GREENHOUSE EFFECT COULD DRAMATICALLY CHANGE THE WEATHER

There is much scientific evidence that temperatures on Earth will get significantly hotter because of increases in greenhouse gases in our atmosphere. Scientists do not all agree on when or how the increasing greenhouse effect will change the worldwide and regional weather patterns, but most agree on one thing. Unless we reduce the amount of greenhouse gases we are putting into the atmosphere, we could be in trouble. In this section we summarize evidence that the Earth's temperature has begun or will begin to rise as a result of the increased greenhouse effect.

SOME EVIDENCE THAT THE EARTH IS ALREADY GETTING HOTTER

Data from the Goddard Institute for Space Studies and the U.S. Climatic Research Unit indicate that average temperatures on Earth have increased by over 1.5°F. since 1880. Many scientists, however, question the accuracy of this data. Reasons for these doubts include:

- There is a shortage of detailed world temperature data, particularly from earlier years.
- Scientists have changed temperature measuring techniques over the years.
- Temperatures taken from urban areas bias data (urban areas tend to be warmer because of buildings, asphalt, air conditioners, etc.). Scientists call this the urban heat island effect.
- Temperature readings from the oceans do not account for changes in ocean currents, shallow and deep ocean mixing, and geologic changes on the deep ocean floors. (Internal pressures within the Earth and friction from moving ocean floors send heat into the ocean depths.)

After adjusting for these problems, however, some scientists conclude that the Earth has warmed by about 1°F. over the last century. The 1980's also has been the hottest decade during the past 100 years. Although the heat and severe weather conditions of the 1980's do not prove that global warming has begun, one noted scientist is almost positive that it has.

Dr. James E. Hansen of the National Aeronautics and Space Administration asserts that the global warming we have experienced in the 1980's is not a result simply of natural variation. Dr. Hansen has testified before Congress that he is 99 percent certain the temperature increases have been caused by increases in the amount of greenhouse gases in the atmosphere. (Interestingly, Congress harshly criticized the Office of Management and Budgets recently for trying to weaken Dr. Hansen's assertions before it presented them to Congress.)

STRONG EVIDENCE FOR SEVERE CLIMATE CHANGES IN FUTURE

Geologic data from the past 600 million years shows a very high correlation between atmospheric CO_2 levels and global temperatures. Although scientists are not positive which causes which, most agree that increasing levels of CO_2 and other greenhouse gases will increase global temperatures. (Please see Appendix A for a description of greenhouse gases.)

Based on well established theories of how greenhouse gases trap heat near earth and projections of growing concentrations of greenhouse gases in the atmosphere, scientists estimate that the Earth's average temperature could increase by up to 8°F. during the next century.

WE MAY HAVE COMMITTED OURSELVES TO UNAVOIDABLE CLIMATE CHANGE

Many scientists believe that our past and current emissions of greenhouse gases will cause at least some unavoidable global climate changes. This is because the greenhouse gases that we are emitting have significantly long lifetimes in the atmosphere, as Table 2 on page 9 shows.

The Administrator of the U.S. Environmental Protection Agency, William K. Reilly, asserts "under our most optimistic control [of greenhouse gases] scenario, we could reduce global warming in the year 2025 by only one-fourth." The chief environmental policymaker for President Bush's Administration is saying, in effect, that global temperatures will increase by a minimum of 3°F. to 6°F. in the next 35 years, even if we take drastic measures to reduce greenhouse gas emissions. In addition, the Administrator said that to reduce greenhouse emissions by even this much would require massive economic and industrial restructuring, but that developing nations must play a prominent role in doing what can be done to reduce the increasing greenhouse effect.

SIGNIFICANT GLOBAL CLIMATE CHANGES MIGHT OCCUR VERY RAPIDLY

The Earth's climate might be able to change surprisingly, and perhaps dangerously, fast. Scientists have recently uncovered data from Greenland ice caps, for example, that indicate the average temperatures in North America increased by about 13°F. within less than 50 years at the end of the most recent ice age (10,700 years ago).

Such rapid climatological change could occur, scientist believe, because of Earth's many feedback mechanisms. As the Earth heats, for example, organic matter decomposes more quickly releasing methane, fires abound releasing CO_2, and shrinking glaciers reflect less solar energy back into space. The Earth also has a complex set of climatological balancing mechanisms, which can offset at least some of the feedback mechanisms. Greater CO_2 levels, for example, can promote increased plant growth, which could stabilize CO_2 levels.

The feedback and balancing mechanisms compound the problem of predicting the weather. They also make it possible for major and unexpected shifts in global weather. Increasing the levels of greenhouse gases might cause such shifts.

The potential for major global climatological changes over short periods of time underscores the importance of reducing our contribution to the increasing greenhouse effect. For if by increasing the greenhouse effect, we change the climate quickly, we might face catastrophe before we can do anything to prevent it. We might not even have time to prepare for catastrophes if and when they occur.

SECTION 4

THE RISK OF CATASTROPHE IS GREAT

The increasing greenhouse effect portends more than hotter temperatures and Midwestern droughts—much more. Scientists cannot predict with certainty the effect rising global temperatures will have on world and particularly regional climate patterns. In fact, modeling the Earth's climate, which is done on the largest computers made, is one of the most complex and difficult challenges facing scientists. Nevertheless, scientists are aggressively studying the potential effects of global warming.

EPA STUDY PREDICTS MAJOR NATIONAL CHANGES

In October, 1988, the U.S. Environmental Protection Agency (EPA) submitted a draft report to Congress called "The Potential Effects of Global Climate Change on the United States." The two-volume report estimates the effect of global warming on the U.S. and its regions. The report projects that global climate change caused by the increasing greenhouse effect could adversely affect water resources, coastlines, agriculture, forests, biological diversity, air quality, human health, electricity demand and public works. The EPA predicts, for example, that:

- The sea level will rise 3 feet by 2100, inundating between 5,000 to 10,000 square miles of dry land in the U.S.
- Crop yields could decrease, due to droughts, flooding and higher temperatures.
- Plant and animal ecosystems could be severely stressed, endangering many species.
- Ozone (smog) and acid deposition levels will increase significantly.
- Energy capacity needs could increase by up to 20 percent by 2010, while availability of hydroelectric power declines.

The EPA study also predicted that global warming would have significant adverse consequences for California.

CALIFORNIA ENERGY COMMISSION PREDICTS SEVERE PROBLEMS IN STATE

Chapter 1506/88 (AB 4420, Sher) directs the California Energy Commission (CEC) to report to the Legislature by June 1, 1990, on how global warming trends might affect the state's energy supply and demand, economy, environment, agriculture, and water supplies. The statute also directs the CEC to recommend measures for avoiding and reducing the potential adverse effects of global warming.

The CEC released a draft interim report in June 1989, titled "The Impacts of Global Warming on California." The report is one of the best expositions and analyses on the greenhouse effect and global warming that has been produced. It is easy to read, yet evaluates the many complex issues related to global warming in a balanced manner. Paul Thayer, consultant for the Assembly Natural Resources Committee (of which Assemblyman Sher is the Chair), also published an excellent discussion of the greenhouse effect issue, titled "Global Warming: A Blueprint for State Response." Among its findings, the CEC draft report finds that:

Global Greenhouse Warming Is Very Probable

- There is a high probability that California temperatures will rise by 3°F. to 8°F. by the middle of the next century.

- An increase of from 1°F. to 4°F. might be unavoidable.

- It might be 10 to 15 years before we have proof that recent weather changes are the result of increased greenhouse gases, but in that time we might commit to greater unavoidable weather changes.

- The immediacy and magnitude of increased global warming (and associated problems) will increase with emissions of man made greenhouse gases.

Global Warming Would Have Severe Effects on State

The CEC's draft report predicts that a temperature increase of about 5°F. could result in:

- ***Water Resources***: Significant risk of increased flooding, shortages of useable water, and increased water pollution.

- ***Electricity***: Moderate risk of increased electricity demand and hydroelectric decreases.

- ***Agriculture***: Significant risk to agriculture from lower water supplies and increased weather variability. Possibly helped by longer growing season and increased CO_2 levels (used in photosynthesis process of plant growth).

- ***Forestry***: Significant Risk of lower growth rates, and more fires, insects, and disease.

- ***Up to 5 Foot Rise in Ocean***: Significant risk of ocean rise causing flooding and damage. Without additional protection, for example, size of San Francisco Bay could triple.

- ***Natural Habitat***: Significant risk of reduced wetland and other habitats, which would endanger fish and other wildlife populations.

- ***Air Quality and Health***: Possible risk of worse air pollution and associated health problems. Higher heat might also cause increased health problems.

- ***Economy***: Moderate risk of global warming having varied adverse effects on states economy.

The CEC's draft report also summarizes the commission's plans for analyzing possible measures to reduce global greenhouse warming and resulting damage. In the next section, we discuss selected options for addressing the global greenhouse problem. We also describe measures before the Legislature that address the problem.

SECTION 5

OPTIONS FOR REDUCING THE GLOBAL GREENHOUSE EFFECT

Based on our analysis of global greenhouse theories and data, we believe that there is a **high** probability that global temperatures will rise significantly as human activity increases greenhouse gas emissions. Furthermore, the risks associated with rising global temperatures are great, for the world, the nation, and California. Although truly a global issue, California is part of the problem, and can be part of an effort to mitigate it.

The state has many options for reducing its contribution to the increasing greenhouse effect. These options include:

- Economic incentives to reduce CO_2.
- Shifting to cleaner fuels.
- Reducing emissions of CFCs.
- Reducing smog.
- Reducing emissions of methane and nitrous oxide.
- Increasing vegetation growth.
- Reflecting more solar energy back to space.
- Preparing for climate changes.
- Encouraging national and international action to reduce the increasing greenhouse effect.
- Increasing research into the greenhouse effect.

In our discussion of these options below, we highlight bills that are before the Legislature relating to the global greenhouse effect.

REDUCING USE OF FOSSIL FUELS IS PRIMARY CHALLENGE

CO_2 emissions account for about one-half of man made increases to the greenhouse effect. Fossil fuel burning is the major source of CO_2 emissions. To reduce CO_2 emissions, therefore, we must burn less fossil fuel. We cannot reduce CO_2 emissions by placing emission control devices on smoke stacks and tailpipes. In fact, the goal of air pollution control is to convert smog producing gases into more stable and less dangerous substances, primarily CO_2. We can also reduce CO_2 by switching toward fossil fuels that produce more useable energy per molecule of CO_2 produced.

ECONOMIC INCENTIVES TO REDUCE CO_2 EMISSIONS BETTER THAN COMMAND AND CONTROL

State programs to reduce CO_2 emissions—or any other type of emissions—can be of two general types. The state can either (1) command that individual sources or categories of emitters meet specified emission limits and then police the sources to ensure compliance with the limits (the "Command and Control" approach), or (2) provide economic incentives to emitters of CO_2 to reduce their use of fossil fuels. The most straightforward economic incentive for control of CO_2 would be a volumetric tax on fossil fuels, based on the carbon content of each fuel.

The command and control approach to reducing air pollution is common to all federal, state, and local air pollution control programs. Under this approach, statutes and regulations give the air pollution control agencies the authority and responsibility to develop and enact air pollution control measures for polluters. Agencies must spend tremendous resources developing and defending pollution control plans and emission control technologies. That is, the burden of improving the air starts and rests primarily with air pollution control planners. Polluters do not have any incentives, beyond complying with air pollution control standards, to reduce their emissions of air pollutants.

Without getting into the merits of command and control strategies versus economic incentives for controlling air pollution emissions (e.g. NOx, HC, CO), economic incentives to reduce CO_2 emissions are clearly superior to a command and control strategy. Economic incentives to control CO_2 emissions are superior because:

- **Rate of CO_2 Emissions Is Easily Measured.** CO_2 is an unavoidable product of fossil fuel combustion (actually, all carbon-based fuels, such as wood). The amount of carbon within a fuel determines its CO_2-producing potential per unit of fuel. Emission rates of air pollution, on the other hand, depend on many factors, such as the type of fuel, temperature of combustion, and type of pollution control employed. The air pollution effects of emissions also depend on the reactivity of the emissions while in the atmosphere. Providing an easily measurable basis upon which to assess fees, therefore, is much easier for CO_2 than for air pollution emissions.

- **CO_2 Control Does Not Require Modeling.** The costs to society of air pollution emissions can vary by when, where, and under what weather conditions the pollutants are emitted. Air pollution control agencies rely on sophisticated modeling to determine optimum control strategies. How CO_2 emissions affect the global greenhouse depends very little, if at all, on such factors. We can treat all CO_2 emissions alike, therefore, when we seek to control them.

- **Reducing CO_2 Means Reducing Fuel Use, Not Adding Control Technology.** Reducing CO_2 is straightforward, if not easy. We must burn less and cleaner fossil fuels. Fees or taxes on fossil fuels can reflect the cost to society of associated greenhouse gas emissions. Just as producers maximize profits by efficiently using labor and capital (which have prices), they would also seek to efficiently avoid creating CO_2, if we gave this greenhouse gas a price (fee or tax). CO_2 fees would raise the cost of goods and services that create more CO_2 compared to goods and services that create less CO_2. CO_2 fees, therefore, would shift production and demand toward less CO_2 intensive products.

- **Fees Require Only One Regulatory Action.** Under command and control, air pollution control agencies typically must become experts in each type of pollution-producing process. They then must develop regulations for each source or category of sources. The state, if it chose to control CO_2 emissions, could establish a single fee formula for the CO_2 content of fuel. To increase CO_2 control, the state would simply raise the fee. If policy makers determined that the fee exceeded the society's will or need for CO_2 control, they could lower the fee. Under an economic incentive approach to controlling CO_2, the state would be responsible only for setting and collecting the emission fee. Producers of CO_2 would be responsible for creating less CO_2.

- **CO_2 Fees Would Augment Pollution Control Efforts.** Burning fossil fuels produces the constituents of smog in addition to CO_2. A CO_2 fee would also provide incentives to reduce air pollution emissions. Up to certain levels, in fact, CO_2 fees could be justified solely on the basis of air pollution control benefits.

- **Fees Could Be Revenue Neutral.** The state could rebate fee revenues in excess of those it needed (or could use with existing appropriations limits) back through the income tax system, as long as the rebates were not based on fuel use.

For these reasons, we strongly recommend that the Legislature pursue economic incentive approaches to CO_2 control in lieu of command and control regulations. Although a CO_2 fee on all fossil fuels would be the most efficient and straightforward approach to reducing CO_2, the Legislature can implement economic incentives in other ways as well.

Increasing the Gasoline and Diesel Tax

Motor vehicles account for about 34 percent of CO_2 emissions in the state. Increasing the tax on gasoline and diesel, therefore, would provide incentives to reduce the major source of CO_2 in the state. Increased gasoline and diesel taxes, created for whatever purpose, would reduce CO_2 emissions by:

- Reducing miles driven, and
- Increasing demand for more fuel-efficient vehicles.

Increased gasoline and diesel taxes could also reduce CO_2 emissions by providing additional funds for transit and better traffic flow (improved roads and highways).

A Tax of at Least 37 Cents per Gallon Defensible. Based on air pollution emission control data provided by staff of the South Coast Air Quality Management District and on the air pollution emission rates of new cars, we estimate that the state could justify a gasoline tax of at least $.37 per gallon as an air pollution emission fee. (Please see Appendix B for the methodology we used to calculate this emission fee level.) In other words, a gasoline tax of $.37 per gallon would result in payments by drivers for their pollution that are comparable to what society currently pays to control air pollution emissions.

A Surrogate Measure for CO_2 Costs is Possible. We do not have a comparable measure for the cost to society of CO_2 emissions, because policy makers have not yet adopted CO_2 reduction regulations. We could derive one, however, if and when policy makers mandate measures to reduce CO_2 levels. We estimate, for example, that if policy makers required CO_2 reductions through forestation at a cost of $8 per ton, the state could justify a CO_2 tax on gasoline of $.08 per gallon (the equivalent of $8 per ton of CO_2). (Please see Appendix B for the methodology we used to compute these values.)

In sum, the state could justify a tax on gasoline and diesel that was at least $.37 per gallon on the basis of the cost to society of air pollution caused by burning these fuels. In addition, a tax on CO_2 emissions from gasoline and diesel of $.08 per gallon would be as efficient as planting trees to reduce CO_2.

Although not specifically intended to reduce air polllution or CO_2 emissions, AB 471 (Katz) would raise the gasoline and diesel tax from $.09 per gallon to $.18 per gallon.

- **AB 471 (Katz) – Increased Gasoline and Diesel Taxes.** This bill increases the taxes on gasoline and diesel from 9 cents per gallon to 14 cents per gallon on August 1, 1990. It increases the taxes 1 cent per gallon on each January 1 through 1994 (when the tax would become 18 cents per gallon). In addition to providing additional funds for road and highway and transit projects, the measure allocates $10 million per year for ten years for mitigating and enhancing the environment harmed by motor vehicle transportation. The Legislature has passed and the Governor has signed AB 471. The voters must approve a State Constitutional Amendment to adjust the state appropriations limit before the bill becomes effective.

Economic Incentives for Greater Vehicle Fuel Economy

The amount of CO_2 produced by a car is directly proportional to the amount of gasoline (and diesel) they burn per mile of travel. A car that burns twice the fuel per mile traveled as another car, that is, creates twice the CO_2 emissions in going from one place to another. We could significantly reduce the amount of CO_2 we use, simply by increasing the average fuel economy of the motor vehicles we drive. We can improve fuel economy easier than we can reduce our miles driven, because reducing our miles driven will require significant changes in life and work styles.

If the average fuel economy of cars in California increased by only 10 miles per gallon, the avoided carbon dioxide emissions in 2010 from burning less gasoline would be equivalent to planting over 13 million acres of trees. As a bonus, California consumers would save over 300 million gallons of gasoline per year, which would be worth over $340 million per year at todays prices.

Senate Bill 1679 (Hart) would create a self-financing program of incentives to encourage motorists to buy more fuel efficient motor vehicles.

- **SB 1679 (Hart) – Vehicle Fuel Economy Incentives.** This bill directs the California Energy Commission to develop and implement a program to encourage consumers to buy more fuel efficient motor vehicles, and thereby reduce CO_2 emissions. Under the program, the Department of Motor Vehicles would give a rebate to purchasers of new cars that have better-than-average fuel economy. The department would pay for the rebates by charging a one-time fee to purchasers of vehicles that have worse-than-average fuel economy. According to Senator Hart's staff, they will amend SB 1679 to apply the incentive program to air pollution emissions as well as to CO_2. Contractors for the Environmental Protection Agency (EPA) are working with the Senator and the Senate Office of Research to develop the legislation. The EPA hopes to use the legislation as a national model.

Incorporating Cost of CO_2 Into Energy Planning and Regulations

Typically, state energy planners and regulators use only qualitative measures when they consider the cost to society of air pollution from energy production and use. They rarely, if ever, incorporate the potential cost to society of greenhouse gas emissions into energy plans and regulations.

As we discussed earlier, the state can quantify the cost to society of air pollution from energy production and use. Furthermore, the state could qualitatively, and perhaps quantitatively, incorporate the cost of greenhouse gases into energy plans and regulations. State energy planners and regulators, for example, could incorporate air pollution and greenhouse gas costs into plans and regulations when they:

At the Energy Commission

- Determine the most cost-effective means of meeting electricity needs in the state (the Biennial Electricity Report),

- Evaluate the cost-effectiveness of energy conservation technologies and standards,
- Compare the cost-effectiveness of alternative fuels, and
- Consider applications to site new power plants and transmission lines.

At the Public Utilities Commission

- Approve electricity and natural gas rates,
- Evaluate the need for additional power plant and transmission capacity,
- Establish contract procedures for third-party electricity producers, and
- Develop alternative rate structures, including time-of-use electricity pricing.

The following bills incorporate either directly or indirectly the cost of CO_2 into energy planning and regulation.

- **SB 361 (Torres) – Carbon Dioxide Offsets.** This bill requires the Air Resources Board to study the potential feasibility and costs of requiring large new and modified industrial sources of CO_2 to offset any additional CO_2 emissions they create by reducing CO_2 emissions from other sources or by preserving tropical rainforests.
- **SB 427 (Torres) – Time-of-Use Pricing and CO_2.** Among its provisions, this bill requires the PUC to evaluate the potential for energy conservation and reduced greenhouse gas emissions from increased use of time-of-use electricity pricing.
- **SB 1219 (Rosenthal) - Environmental Cost of Fuel Oil.** This bill requires the Air Resources Board to determine the extra cost of air pollution to society from fuel oil rather than natural gas in electricity production (the air quality cost differential of fuel oil). The bill authorizes utilities to recover the entire cost of fuel oil burned to produce electricity only if the fuel oil cost plus the air quality cost differential for fuel oil total less than the cost of natural gas (on a kilowatt basis). If the total is more than for natural gas, the utility may recover only the price of natural gas for its fuel costs.
- **SB 1527 (Hart) – Environmental Costs of Fuel Use.** This bill requires the CEC to include the environmental cost of fuel use into its analyses of the cost-effectiveness of energy conservation standards.
- **AB 2151 (Willie Brown)** –Considering Greenhouse Gases in CEC Deliberations. This bill requires the CEC to consider within its Biennial Electricity Report and other administrative decisions the production of greenhouse gases from fossil fuel burning. The bill also requires the CEC and the Air Resources Board to inventory sources of greenhouse gases in the state.
- **AB 2395 (Sher) – Considering Greenhouse Gas Problems in Energy Issues.** Among its provisions, this bill requires the CEC to consider greenhouse gas problems when reviewing energy supply and demand issues.

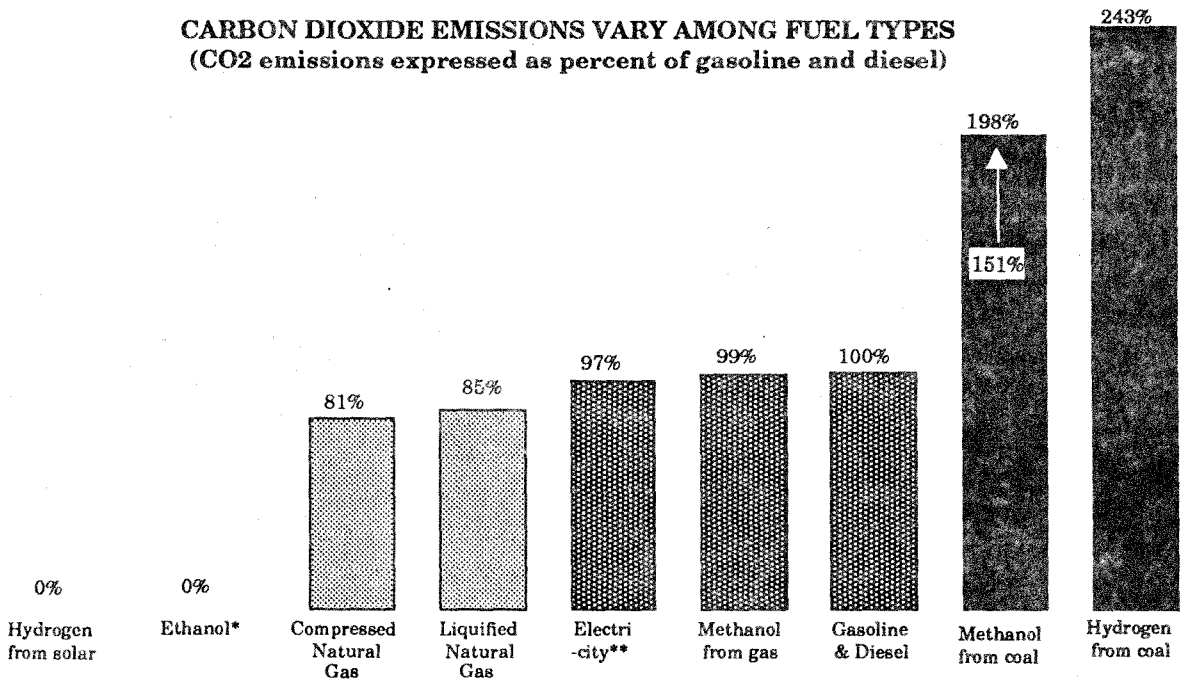
ALTERNATIVE FUELS CAN REDUCE CO_2 EMISSIONS AND IMPROVE AIR QUALITY

Motor vehicles in the state rely almost exclusively on gasoline and diesel fuels for power. Vehicles could use other "alternative" fuels, however, that have the potential to reduce air pollution and CO_2 emissions. Currently, prices of the various vehicle and industrial fuels do not include any price component to reflect their different contributions to air pollution and greenhouse gases. Consequently, fuel users do not have appropriate incentives to use potentially cleaner fuels as a means to reduce air pollution and greenhouse gas emissions.

As Figure 8 shows, CO_2 emissions per unit of energy vary significantly by fuel type. Among all fuels, hydrogen produced from solar energy (and solar itself) and complete cycle ethanol produce zero net CO_2 emissions. Ethanol produces zero CO_2 only if it is produced from dedicated crop or tree farms and if ethanol is used in every step of the production process. Coal and fuels derived from coal are the dirtiest. The EPA, ARB, CEC, local air pollution control districts, and others are evaluating the relative cost-effectiveness of replacing gasoline and diesel with alternative fuels to reduce air pollution. Preliminary analyses indicate that some fuels offer significant air pollution reduction potential. This research might also determine how alternative fuels contribute to the greenhouse effect.

Figure 8

CARBON DIOXIDE EMISSIONS VARY AMONG FUEL TYPES
(CO2 emissions expressed as percent of gasoline and diesel)



* Ethanol produced from crop or tree farms and using ethanol fuel to harvest and process (complete ethanol cycle).
** Electricity produced from fuels in same proportion as a current generating capacity.
Note: Propane emissions between compressed natural gas and gasoline.
Data Source: Mark A. DeLuchi, et. al., "Transportation Fuels and the Greenhouse Effect"

To the extent that researchers can identify the impact of alternative fuels on air pollution and the greenhouse effect, the Legislature should consider economic incentive programs to foster the cleaner fuels. The Legislature should structure any such incentive programs to reflect the value society places on cleaner air and reduced CO_2 emissions. The state can approximate these societal values by measuring the cost-effectiveness of existing air pollution control regulations (and any future CO_2 efforts).

The following bills relate to the use of alternative fuels.

- **SB 1006 (Leonard) – Sales Tax Deduction for Low-Emission Vehicles.** This bill provides for a sales tax deduction for the incremental cost of specified low-emission vehicles and alternative fuel retrofits. The incremental cost eligible for the deduction is defined as any additional cost associated with a low-emission vehicle or conversion kit compared to a comparable gasoline or diesel vehicle.

- **SB 1123 (Rosenthal) – Encouraging Use of Low-Emission Vehicles.** This bill sets goals for the state to purchase low-emission vehicles. The bill says a low-emission vehicle is any vehicle that either:

  - Is as clean as a comparable vehicle operating on methanol, or

  - Emits hydrocarbons at a rate that is 50 percent of the applicable hydrocarbon standard.

  - For heavy-duty vehicles, emits either particulates or oxides of nitrogen at a rate that is one-half the applicable standard.

  The bill encourages the state to use low-emission vehicles, including natural gas and electric vehicles, as long as they cost less than twice as much to purchase and less than 1.5 times as much to operate as comparable gasoline and diesel cars. The bill also encourages the gas and electric companies to offer special off-peak rates for low emission vehicles.

- **SJR 31 (Vuich) – Fuel Crops on Set-Aside Lands.** This bill asks Congress to permit farmers to grow crops to produce ethanol on lands lying fallow under federal land set-aside programs.

- **ACR 47 (Moore) – Diversity of Fuel Sources.** This resolution declares that a clean fuels approach to improving air quality shall preserve diversity of fuel sources.

REDUCING CHLOROFLUOROCARBON AND HALON EMISSIONS

Chlorofluorocarbons (CFCs) and halons destroy ozone in the upper atmosphere. This good ozone protects us from dangerous ultraviolet rays. CFCs and halons are also extremely powerful greenhouse gases. The United States and 23 other nations signed the Montreal Protocol on Substances that Deplete the Ozone Layer in September 1987. This Montreal Protocol established a timetable for reducing CFC emissions. In September 1988, the Environmental Protection Agency called for an immediate and complete phase out of the most damaging CFCs. The Legislature is considering numerous bills to reduce CFC and halon emissions.

The following bills relate to CFC and halon products.

- **SB 116 (Rosenthal) – Recycling CFCs Used in Refrigeration.** This bill requires owners or operators of retail stores, cold storage warehouses, and commercial and industrial buildings that use CFCs in refrigeration systems to reuse or recycle the CFCs when servicing the systems and to inventory their CFC use.

- **SB 231 (Roberti) – Identifying CFC Reduction Options.** This bill requires the ARB to biennially identify options to reduce CFC and halon emissions and report to the Legislature its findings and recommendations for regulatory actions. The bill creates the Environmental and Technical Assessment Advisory Committee to advise the board on its evaluations. The bill also requires the ARB to assist CFC users in reducing CFC use. CFC users would be required to provide the ARB with CFC inventories.

- **SB 1138 (Marks) – CFC Prohibition.** This bill bans products containing CFCs or halons, if the product is harmful to the environment.

- **SB 1192 (Marks) – Foam Prohibition.** This bill bans foam food service and packaging products made with specified CFCs. It also bans rigid polystyrene foam products made with specified CFCs, if specified substitutes are available.

- **AB 1332 (Peace) – Ban of CFCs in Motor Vehicle Air Conditioning.** This bill prohibits the sale, beginning in 1993, of motor vehicles using CFCs in automobile air conditioning systems. The ARB may waive the prohibition if it finds that alternatives to CFCs are not available.

- **AB 1718 (Hayden) – CFC Recycling and Ban.** This bill requires auto repair facilities to recycle CFCs when repairing auto air conditioners. The bill also bans the sale of specified small containers of CFCs used to recharge auto air conditioners. It also bans the sale of fire extinguishers and specified cleaning equipment using CFCs.

- **AB 1736 (Friedman) – Reducing CFC Emissions From Vehicles.** This bill requires the ARB to report to the Legislature on programs to reduce CFC emissions from motor vehicle air conditioners.

- **AB 2020 (Cortese) – Ban of CFCs In Foams.** This bill bans all food service, food packaging, and polystyrene foam products made from specified CFCs and halons.

- **AB 2040 (Connelly) – Ban on Small CFC Containers.** This bill bans the sale of containers of CFCs weighing less than 15 pounds used to recharge auto air conditioners.

REDUCING SMOG REDUCES GREENHOUSE EFFECT, AND VICE VERSA

Tropospheric ozone (smog) is a powerful greenhouse gas. Global warming that would result from increased greenhouse gases will, in turn, increase smog formation. (This is one of many feedback mechanisms within global climatology.)

Incorporating Reduced Greenhouse Benefits into Evaluations of Pollution Control Measures. Traditionally, policy analysts and decision makers measure the effectiveness of proposed pollution control measures on the basis of reduced air pollution emissions. The Legislature should explicitly direct air pollution control agencies to include reductions of greenhouse gases into their cost-benefit analyses of air pollution control options.

Air Quality Benefits Justify Many CO_2 Reduction Measures. Many options for reducing greenhouse gases, including CO_2, can be justified on the basis of air pollution control benefits. It makes sense, for example, to provide incentives to consumers to buy more fuel efficient cars on the basis of air quality benefits alone. Reducing CO_2 emissions and global warming is a significant added benefit.

RESEARCH NEEDED INTO METHANE AND NITROUS OXIDE SOURCES

Scientists do not have good data on the various sources of methane (CH_4) and nitrous oxide (N_2O) emissions, which are two significant greenhouse gases. Scientists are not sure of, for example, the relative contribution of cows, rice paddies, termites, swamps, and fossil fuels to atmospheric methane concentrations. Opportunities for public policies to reduce these gases will depend in large part on how and where the emissions are formed. Studies by the Environmental Protection Agency and scientists should provide more information on these two gases.

PLANTING TREES CAN REDUCE CO_2 AND REDUCE ENERGY DEMAND

Trees and other vegetation use the carbon from CO_2 to grow. In this process of photosynthesis, trees reduce CO_2 levels in the atmosphere. The trees release their carbon when they burn or decay. Planting trees, therefore, is one strategy for reducing the greenhouse effect. Trees planted in urban areas also reduce local temperatures and reduce the demand for electricity to operate air conditioners. A scientist at the Lawrence Berkeley Laboratory estimates that the maximum annual high temperature in Los Angeles has increased by 7°F. as a result of reduced vegetation and associated irrigation.

According to the chief of the American Forestry Association, there is room to plant about 100 million additional trees around U.S. homes and cities. He estimates that planting 100 million trees in the cities would offset over 18 million tons per year of CO_2 emissions. This would offset, for example, the CO_2 emissions from about 2.7 million cars. He also estimates that the trees would save about $4 million per year in energy costs.

Urban trees reduce temperatures where people live. We do not have any basis for comparing the esthetic and ecological values of urban and rural trees. In addition, the costs of planting and maintaining urban trees probably is significantly greater than for rural trees. If it chooses to implement tree planting programs to reduce CO_2, therefore, the state should compare the costs and benefits (both direct and indirect) of planting urban and rural trees.

The following bills relate to forest protection, preservation, and enhancement.

- **SB 1641 (Marks) – Tax Checkoff Plus $10 Million Per Year for Tree Planting.** This bill creates a tax checkoff on state income tax forms, to allow taxpayers to voluntarily donate to the California Tree Planting and Urban Forestry Fund, created by the bill. The bill also transfers $10 million per year to the fund from the Special Account for Capital Outlay ($5 million), the Environmental License Plate Fund ($4 million), and the Outer Continental Shelf Land Act Section 8(g) Revenue Fund ($1 million). The bill authorizes the California Conservation Corps and local conservation corps programs to plant trees, primarily in urban areas, with funds from the California Tree Planting and Urban Forestry Fund.

- **AB 348 (Sher) – Bond Act for Reforestation and Urban Forestry.** This bill, if enacted and approved by the voters, would authorize the sale of $300 million in general obligation bonds. Proceeds from bond sales would be deposited in the Reforestation and Urban Forestry Fund of 1990, created by the bill. The Department of Forestry and Fire Protection would use the money for forest resource improvements and reforestation. The money would be allocated as follows:

  - $120 million for grants and loans to small industrial landowners,
  - $40 million for grants to government agencies,
  - $40 million for grants to public land trusts, and
  - $100 million to government and nonprofit agencies for urban forestry projects.

- **AB 471 (Katz) – Tree Planting With Fuel Tax Revenue.** Among its provisions, this bill provides $10 million for ten years for enhancing the environment associated with transportation projects. The bill expressly permits tree planting with the funds, which would be generated from increased gasoline and diesel taxes (from current $.09 per gallon to $.18 per gallon by 1994).

- **AB 1489 (Bates) – Tax Credits for Rainforest Investments.** This bill establishes a tax credit for financial institutions to transfer foreign loans to organizations that conserve rainforests in those countries. This is commonly referred to as debt for nature swaps.

REFLECTING MORE SOLAR ENERGY BACK TO SPACE

According to scientists at the Lawrence Berkeley Laboratory, making the skyward surfaces of buildings, parking lots, roads, and so on, more reflective is one of the most cost-effective options for reducing urban temperatures and resultant electricity demand. The scientists also believe that increasing the reflectivity of skyward surfaces (called albedo) would cost-effectively reduce air pollution and CO_2 as a result of reduced energy consumption.

The following bills relate to increasing surface reflectivity.

- **SB 345 (Torres) – Study of Albedo.** This bill requires the CEC to study the potential benefit of increasing the reflectivity of surfaces as a means to reduce energy demand and greenhouse gases.

- **SB 427 (Torres) – Feasbility Study of Albedo.** Among its provisions, this bill requires the CEC to study the potential benefit of increasing the reflectivity of surfaces as a means to reduce energy demand and greenhouse gases.

INCORPORATING GREENHOUSE ISSUES INTO THE PLANNING PROCESS

The California Environmental Quality Act (CEQA) establishes procedures for evaluating and mitigating the potential adverse environmental effects of new developments. The act does not make reference, however, to environmental problems that might occur outside the state, such as contributions to the global greenhouse effect. The act also does not require developers to consider potential problems a project might face as a result of global warming, such as increased risk of floods.

The following bills incorporate greenhouse issues into the planning process.

- **SB 427 (Torres) – Global Component to CEQA.** Among its provisions, this bill would require developers to evaluate the potential out-of-state and global environmental consequences of projects in Environmental Impact Reports.
- **AB 2360 (Sher) – Determining if CEQA REsponds Adequately to Global Warming Issue.** This bill requires the Office of Planning and Research to review the California Environmental Quality Act to determine if it should be amended to address the potential impacts from global warming.
- **AB 2395 (Sher) – Preparing State Projects for Global Warming.** Among its provisions, this bill would require that state funded projects be sited to avoid potential adverse impacts from global warming.

ENCOURAGING NATIONAL AND INTERNATIONAL EFFORTS TO REDUCE INCREASING GREENHOUSE EFFECT

Although a significant contributor to the increasing greenhouse effect, California cannot solve the problem alone. There are encouraging signs, however, that this global problem is receiving global attention. The Montreal Protocols for CFC reductions, for example, demonstrate the potential for international cooperation in addressing the many global greenhouse and ozone depletion issues.

Given that the U.S. produces about one-fourth of the carbon dioxide emissions in the world (California produces about 1.5 percent of world CO_2 emissions), the state probably should not be too aggressive in criticizing other nations for adding to the greenhouse effect. The U.S. and California might be able to help other countries, however, with technical and economic assistance.

According to many agricultural scientists, for example, Brazil might be injuring its own economy and fragile ecosystems by replacing rainforests with agriculture that is not suited for the soils and weather of the forests. Our forestry and agricultural scientists and economists might assist the Brazilians in establishing more sound incentives for forest preservation. Furthermore, if we want Brazil to maintain the rainforests in order to offset CO_2 emissions from our fossil-fuel-based economy, then it might be prudent to support Brazilian forest preservation and reclamation with fees generated from increased fossil-fuel taxes.

In sum, we believe it is imprudent to condemn less developed countries for contributing to the increasing greenhouse effect, when we might more productively assist them in addressing the problem in a spirit of cooperation.

The following bills encourage international action on greenhouse issues.

- **SB 427 (Torres) – Technical Assistance for Rainforest Management.** Among its provisions, this bill requires the CEC to report to the Legislature on the causes of tropical rainforest destruction and whether the state can do anything to reduce the rate of rainforest destruction worldwide, including providing technical assistance to countries with rainforests.

- **SJR 13 (Keene) – Priority for Global Environment at Economic Summit.** This resolution requests that the President of the United States take the lead in making global environmental problems a top agenda item for the July 1989 Economic Summit.

RESPONDING TO RESEARCH NEEDS

Society has much to learn about the increasing greenhouse effect and how it will effect global and local climate. International, national, and state research efforts have consequently expanded significantly in recent years. More research is needed, for example, to:

- Refine computer models to better predict global climate changes from increasing greenhouse gases,

- Improve models to determine local climate effects of global climate changes,

- Estimate effects of local climate changes on California and other areas,

- Determine sources of greenhouse gas emissions,

- Examine options for reducing greenhouse gas emissions,

- Measure potential costs and benefits of reducing greenhouse gases.

- Accomodate changes due to global warming, such as rising tides and increased flooding.

This list of research needs certainly is not complete. The magnitude of what scientists do not know, however, should not deter the state from taking actions to reduce greenhouse gas emissions. Scientists do know, after all, that the risks of global warming and resulting catastrophes are great. Accordingly, we recommend that the state aggressively pursue measures to reduce greenhouse gas emissions, particularly the many that are justified on the basis of well known air quality benefits.

CONCLUSION

Most scientists agree that man made greenhouse gas emissions are increasing rapidly; the Earth will therefore become significantly warmer; and society might face catastrophes as a result of rising temperatures and resulting climate changes. The risks of significant global and local problems from increased global warming are too great to ignore. The state can adopt policies to cost-effectively reduce greenhouse gas emissions. In fact, air quality improvements alone can justify many actions to reduce greenhouse gas emissions. Reducing our use of fossil fuels, for example, is justified on the basis of improved air quality, plus it is the best method for reducing CO2 emissions. In sum, as a significant contributor to the increasing greenhouse effect, the state has good reasons and opportunities to reduce its emissions of greenhouse gases. **Indeed, it is time we started to do something about the weather.**

Appendix A

SUMMARY DESCRIPTIONS OF MAJOR MAN MADE GREENHOUSE GASES

CO_2 HAS INCREASED BY 25% SINCE INDUSTRIAL REVOLUTION

Plant and animal respiration, natural decay and burning of vegetation, and fossil fuel burning produce carbon dioxide. Vegetation recycles CO_2 back into oxygen through the photosynthesis process of plant growth. Rising CO_2 levels have contributed about 49 percent to the greenhouse effect increase during the 1980's.

Carbon dioxide levels in the atmosphere have increased by about 25 percent over pre-industrial levels and are growing at about 1/2 percent per year. Fossil fuel burning accounts for about 70 percent of this increase. Forest destruction accounts for the other 30 percent.

METHANE (CH_4) IS INCREASING BY ABOUT 1% PER YEAR

Methane is produced from coal and gas production, fermentation of organic matter in rice paddies and swamps, animal digestive actions, decaying and burning vegetation, landfills, and other natural sources. Methane absorbs about 16 times more heat than an equivalent amount of carbon dioxide. It has contributed about 18 percent to the greenhouse effect increases of this decade.

Samples of methane trapped in polar ice show that atmospheric methane levels have increased during the past several centuries. Methane levels now are increasing by about 1 percent per year. Although scientists do not know exactly how methane levels are increasing, some believe that increased rice farming, livestock grazing, and natural gas transportation and use account for a majority of atmospheric methane increases.

NITROUS OXIDE (N_2O)

The oceans, fossil fuel and biomass burning, fertilizers, and land disturbances produce nitrous oxide (N_2O). Increases in N_2O have contributed about 6 percent to greenhouse effect increases in this decade. N_2O levels are increasing by about 0.2-0.3 percent per year.

CHLOROFLUOROCARBONS (CFCs) AND HALONS ARE A CRITICAL PROBLEM

Fully halogenated chlorofluorocarbons (CFCs) and halons, which are man-made gases only, can absorb up to 10,000 times more heat per molecule than CO_2. The world currently produces over one million tons per year of these chemicals,[1] which we use as refrigerants, aerosols, sprays, insulating materials, fire retardants, and solvents. CFCs and halons have contributed about 14 percent to greenhouse effect increases in this decade. Human activity is increasing CFC and halon concentrations in the atmosphere by up to 7 percent per year, and they can last in the atmosphere for over 100 years.

CFCs and halons also are destroying the good ozone in the upper atmosphere. We discuss this problem below.

HUMANS CREATE BAD OZONE (O_3) AND DESTROY GOOD OZONE

Ozone in the lower atmosphere (tropospheric ozone) is bad, whereas ozone in the upper atmosphere (stratospheric ozone) is good. Both forms of ozone relate to the greenhouse effect.

Ozone, as Smog, Is Harmful and a Greenhouse Gas. Nitrogen oxides (NO_x) and reactive organic gases (ROGs), in the presence of sunlight, produce ozone in the lower atmosphere. Reactive organic gases come mainly from incomplete combustion of fossil fuels, evaporation of fuels and solvents, and other human activities. Oxides of nitrogen result when nitrogen in the air combines with oxygen during the burning of fossil fuels.

In addition to increasing the greenhouse effect, tropospheric ozone damages human, animal, and plant health and destroys paints, rubber, and other products. California has the worst ozone pollution problem in the country. Los Angeles, for example, exceeds the federal clean air standard for ozone by up to 200 percent on roughly one-half of the days each year.

Upper-Level Ozone Protects Us From Ultraviolet Rays. Ozone occurs naturally in the Earth's upper atmosphere—the stratosphere. Plant and animal life need this ozone as protection from ultraviolet light rays. Ultraviolet light in high doses causes damage to human skin, eyes, crops, sea life, building products, and other things. CFCs are depleting the protective layer of stratospheric ozone and are the subject of worldwide concern on this basis alone. These same CFCs are extremely potent greenhouse gases as well.

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Appendix B

METHODOLOGY FOR CALCULATING COST TO SOCIETY OF AIR POLLUTION AND CO_2 EMISSIONS

(Referenced on page 25)

THE COST TO SOCIETY OF AIR POLLUTION EMISSIONS CAN BE DERIVED

Although scientists have shown that air pollution emissions damage human health, physical structures, visibility, and the environment generally, they do not know the exact monetary cost to society of the emissions. Nevertheless, it is possible to derive the cost to society of air pollution emissions, based on what society has been willing to pay to control the emissions through laws and regulations.

Staff of the South Coast Air Quality Management District indicate that the current cost of pollution control in the district is about $20,000 per ton for oxides of nitrogen (NOx), $17,500 per ton for hydrocarbons (HC), and $2,000 per ton for carbon monoxide (CO). We can assume, therefore, that the cost to society in the district of NOx, HC, and CO emissions is at least $20,000 per ton, $17,500 per ton, and $2,000 per ton, respectively. Presumably, if NOx, HC, and CO emissions did not create medical, visual, environmental, and other damages that were this great, then society would not have chosen to incur such costs to prevent the pollutants from entering the atmosphere. As the district strives to meet federal and state air quality goals, the cost of control per ton of reduction will increase significantly. Consequently, the current control costs cited by the SCAQMD staff are very conservative estimates of the cost to society of air pollution emissions.

CALCULATING THE AIR POLLUTION COSTS FROM GASOLINE VEHICLES

The average <u>new</u> car sold in the state produces .019 pounds of NOx per gallon of fuel burned, .0098 pounds of HC per gallon, and .095 pounds of CO per gallon. The emission rates of cars increase signficantly as cars age. Based on (1) the surrogate cost to society of air pollution emissions derived above, and (2) the emission rates of new cars, we calculate the cost to society of new gasoline cars (per gallon of gasoline burned) as follows:

<u>NOx</u>: ($20,000/ton) x (.019 pounds/gallon) x (1 ton/2,000 pounds)
= $.19 per gallon

HC: ($17,500/ton) x (.0098 pounds/gallon) x (1 ton/2,000 pounds)
= $.09 per gallon

CO: ($2,000/ton) x (.095 pounds/gallon) x (1 ton/2,000 pounds)
= $.09 per gallon

Total Cost NOx, HC, and CO = $.19 + $.09 + $.09 = $.37 per gallon

In sum, the cost of air pollution emissions to society from gasoline powered cars in the SCAQMD is at least $.37 per gallon of gasoline burned by new cars. The cost is much greater for older cars that emit more pollutants per gallon of gasoline.

CALCULATING THE COST TO SOCIETY OF CO_2 FROM GASOLINE VEHICLES

On page 25 of the text, we state that if policy makers required CO2 reductions through forestation at a cost of $8 per ton of CO_2 reduced, then the state could justify a CO_2 tax on gasoline of $.08 per gallon of gasoline burned. We derived this estimate with the following calculations.

Assumptions:

- Value of non-urban land upon which trees planted
  = $1,000/acre
  (Source: Staff person, State Lands Commission.)

- Cost to plant one acre of trees in non-urban area
  = $200/acre[1]
  (Source: Staff person, U.S. Forest Service.)

- CO_2 absorption rate of trees
  = 2.4 tons/acre/year for 60 years
  (Source: Greg Marland and R.O. Curtiss, U.S. Forest Service.)

- CO_2 produced per gallon of gasoline
  = 19.4 pounds per gallon[2]
  (Source: Chemist for Chevron.)

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1. $200/acre is a rough average for timber lands currently in production. It probably would be more costly to produce timber on additional lands.

2. 5.3 pounds of carbon in each gallon of gasoline combines with 14.1 pounds of oxygen when gasoline is burned to produce 19.4 pounds of CO_2 per gallon of gasoline burned.

Calculation

($1,200/acre) / [(2.4 tons/year/acre) x (60 years)] x
(1 ton/2,000 pounds) x (19.4 pounds/gallon)
= $.08 per gallon

In sum, assessing a fee of $.08 per gallon of gasoline to reduce CO2 emissions would be as efficient as planting trees in non-urban areas as a means to reduce CO_2. The cost to society of CO_2 per gallon of gasoline consumed ($.08) would be higher, if the cost of growing trees is greater than we assumed, or if trees are less effective in converting CO_2 than we assumed. Conversely, the cost would be less than $.08 per gallon if growing trees is less costly than we assumed, or if trees convert more CO_2 than we assumed.