GLOBAL CLIMATE CHANGE AND CALIFORNIA

In Support of the *2005 Integrated Energy Policy Report*

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STAFF FINAL PAPER

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INTRODUCTION

California has the sixth largest economy, and is the tenth largest emitter of greenhouse gases (GHG), in the world.[1] The primary source of these greenhouse gases is the combustion of fossil fuels in motor vehicles, power plants, refineries, and industrial facilities.[2]

Leading scientists across the country recognize the "greenhouse effect" - the existence of a heat-trapping layer of gases surrounding the earth. The overall warming that occurs when concentrations of GHG increase in the atmosphere is referred to as "climate change". While consensus has yet to be reached on the timing and magnitude of the greenhouse effect, most scientists now agree that climate change is occurring, is caused by human activities, and could severely affect natural ecosystems and the world's economy.

GHG emissions in California are high and increasing, mainly due to population and economic growth. From 1990 to 2002 total GHG emissions rose nearly 12 percent and they are expected to increase by 24 percent from 1990 to 2020, if current trends continue. This steady increase in GHG emissions requires policy actions at the state and regional levels to reverse the trend.

While individual states cannot combat global warming alone, by acting together states can *significantly* reduce GHG emissions. State government leadership is necessary to reverse the trend in GHG emissions, and to achieve a sustainable, low-carbon future in California. The state's ranking as one of the world's largest GHG emitters underscores the need to take action, while simultaneously pursuing national and regional policies.

On June 1, 2005, California Governor Arnold Schwarzenneger set forth his Administration's goal to make California a leader in efforts to reduce global warming. The Governor signed an Executive Order which established statewide greenhouse gas emissions targets and directed the Secretary for the California Environmental Project Agency (Cal EPA) to lead an effort to achieve these targets, which would.[3]

- By 2010, reduce statewide GHG emissions to 2000 emission levels;
- By 2020, reduce statewide GHG emissions to 1990 emission levels;
- By 2050, reduce statewide GHG emissions to 80% below 1990 levels.[4]

Global climate change is also gaining national attention among policy makers, especially now that the Kyoto Protocol has gone into effect. This international treaty, signed by 140 countries, was negotiated in 1997 and became effective on February 16, 2005. After ratification by Russia, some 35 industrial nations have set limits on

their GHG emissions, pledging to reduce emission levels to five percent below 1990 levels by 2012.[5]

In its December 2004 Report to the Congress, the National Commission on Energy recommended that the United States establish a mandatory, economy-wide trading system to curb the nation's increasing GHG emissions, and that the United States should join efforts with other countries to reduce global GHG emissions.[6]

The Intergovernmental Panel on Climate Change (IPCC), an international scientific body which periodically assesses the state of the climate change science, found in 2000 that "there is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities."[7]

In May 2001, President George W. Bush asked the National Academy of Science (NAS) to assess the veracity of the IPCC findings. According to the NAS, the IPCC assessment "accurately reflects the current thinking of the scientific community on this issue." In addition, the NAS reported that "GHG are accumulating in Earth's atmosphere as a result of human activities, causing surface air temperatures and subsurface ocean temperatures to rise. Temperatures are, in fact, rising." [8]

A 2004 study by a team of leading California scientists, *Climate Change in California: Choosing Our Future*, predicts substantial increases in temperatures in both the summer and winter months as a result of climate change.[9] Using scenarios of lower and higher future emissions, and state-of-the-art climate models, the authors report significant changes in California's natural resources could result, including:

- Rising sea levels along the California coastline, especially in San Francisco and the San Joaquin Delta.

- Extreme-heat conditions, such as heat waves and very high temperatures, which will last longer and become more commonplace.

- An increase in heat-related human deaths, infectious diseases and a higher risk of respiratory problems caused by deteriorating air quality.

- Reduced snow pack and stream flow in the Sierra Nevada Mountains, affecting winter recreation and water supplies.

- Rising temperatures that can affect California agriculture, causing variations in crop quality and yield.

- Changes in the distribution of vegetation from projected increases in temperature and high fire risk.

These changes in California's climate and ecosystems are occurring at a time when the state's population is projected to grow from 34 million people to 59 million by the year 2040. Population growth and the demand for vital natural resources will compound the effects of climate change on water resources, human health and the environment.

Purpose of the Paper

This paper builds upon prior work carried out in numerous public forums, including the *2003 Integrated Energy Policy Report (Energy Report),* the *2004 Energy Report Update*, the California Climate Action Registry, the California Public Utilities Commission (CPUC) decisions related to climate change, and the California Energy Commission's (Energy Commission) Climate Change Advisory Committee. The paper also highlights coordinated efforts by state government agencies to address global climate change through the Joint Agency Climate Team in California, the West Coast Governors' Global Warming Initiative, and the Regional GHG Initiative in the Northeastern and Mid-Atlantic states.

This paper provides background and context to guide the formulation of policy options for reducing GHG emissions in California. Following a summary of state legislation on global climate change, the paper discusses the science of climate change, the impacts of climate change on California, emerging trends in GHG emissions, existing state policies and programs, options for addressing climate change, and recommended next steps.

Legislative Background

In 1988, the California Legislature first recognized the potential adverse effects of climate change when it enacted a state law [AB 4420 (Sher), Chapter 1506, Statutes of 1988] directing the Energy Commission to assess the impacts of climate change on energy supply and demand as well as the state's economy, environment, agriculture, and water supplies. The law also directed the Energy Commission to identify potential GHG reducing strategies. In response, the Energy Commission published *"Global Climate Change: Potential Impacts and Policy Recommendations"* in December, 1991.

Since then, numerous statutes have been enacted that have shaped California's climate change policies and programs. In 2004, the Legislature enacted budget control language which gave authority to the Secretary for Environmental Protection to coordinate greenhouse gas emission reductions and climate change activity in state government. (SB 1107, Chapter 230, Statutes of 2004)

Climate Change Impacts on California

Climate change has the potential to significantly affect California's natural resources and every sector of the economy. This section briefly summarizes the major scientific findings of recently completed reports and peer-reviewed, published scientific papers.[10]

Since 2001, significant progress has been made in the science of climate change. New scientific studies have concluded that:

- Global warming projections may have been understated and, therefore, potential impacts may be more severe than previously estimated.[11]
- Global warming and other human alterations of the earth's atmosphere may increase the possibility of large, abrupt, and unwelcome regional or global climatic events.[12]

Scientific projections from existing climate models suggest that California will grow warmer, but there is not yet consensus on the timing or degree of global warming. For example, some models suggest substantial increases in precipitation levels while others suggest less precipitation.[13] There is consensus, however, that the warming will result in early runoff and reduced snow levels at the end of the wet season.[14] Findings conclude that climate change produces:

Coastal impacts:

- Rising sea levels along the California coastline may require the construction of sea walls and other structures to protect coastal property.[15]
- Wind-induced movement of cool, deep water may be enhanced by climate change, reducing summer temperatures in coastal areas.[16]

Water impacts:

- Rising sea levels may severely impact the Sacramento-San Joaquin Bay Delta system that is used to transfer water from northern to southern California.[17]
- Reduced snow pack would reduce water availability during the dry spring and summer months.[18]
- Stream flow levels in the wintertime may substantially increase the risk of flooding.[19]

Temperature impacts:

- Extreme-heat conditions, such as heat waves and very high temperatures, may last longer and become more commonplace.[20]
- Increased temperatures will make it harder to meet ambient air quality standards for ozone.[21]
- Rising temperatures could affect California agriculture and may require new farming practices and shifts in the types of crops planted in the state. If

precipitation levels decrease, as suggested by some climate models, the impacts will be more severe.[22]

Changes in vegetation and fire risk:

- A changing climate will change vegetation patterns. Most ecosystems will be heavily impacted, and climate change may severely reduce their ability to cope with other stressors such as urbanization.[23]
- The risk of fire may increase under the projected climatic conditions in California under both a wet and dry climate scenario.

Energy demand and cost impacts:

- Energy demand may increase, but the degree of this increase depends on the actual level of warming. A mild warming scenario would increase net energy expenditures in the residential and commercial sectors by a small amount.
- Greater warming could increase state energy expenditures for cooling and heating by about $2 billion in 2020.[24] Californians currently spend about $30 billion for natural gas and electric heating and cooling each year. Cooling will require more energy for air conditioning, and heating will require less energy, but the net average effect is $2 billion in 2020, under a worse case scenario.
- Preliminary studies suggest that hydroelectric generation may increase under the increased precipitation scenarios, but generation will decrease from 10 to 30 percent if the dry scenarios materialize.[25] The degree of precipitation as a result of climate change is a key uncertainty which still needs to be addressed.

As stated above, these climate change impacts are occurring at a time when California's population is projected to grow from 34 million people in 2004 to 59 million in 2040. Population growth and the demand for vital natural resources will compound the effects of climate change on water resources, human health, and the environment.[26]

Greenhouse Gas Emissions Trends

California's GHG emissions are high, and increasing, due to population and economic growth. Based on 2002 data, California's emissions represent over seven percent of the total U.S. emissions and nearly two percent of the world's human-caused GHG emissions.

If this trend continues, total GHG emissions in California will grow 24 percent from 1990 to 2020. Current state policies have reduced emissions levels by more than half of what they would have otherwise been.[27] The state's use of renewable resources and energy efficiency programs has already significantly reduced GHG emissions in California and will continue to be effective in controlling the rate of GHG emissions growth.

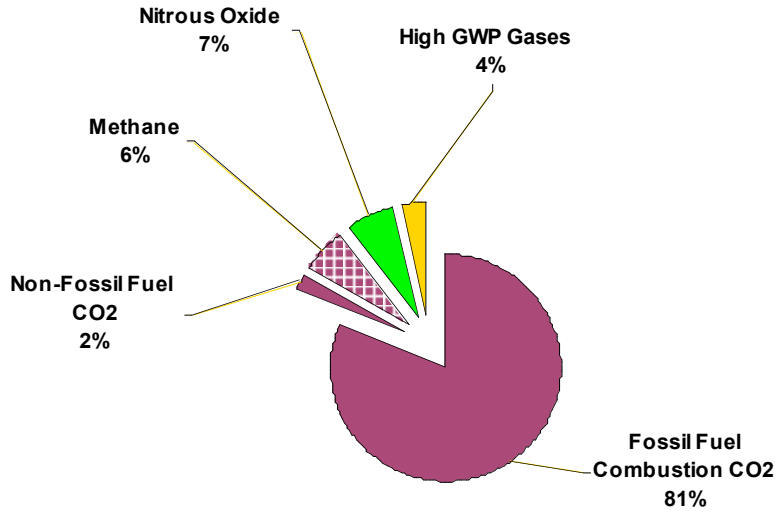
This section summarizes the results of staff's update to the statewide GHG emission inventory, using 2002 data. (An accompanying staff paper will document the

calculations behind the latest inventory update and include a more complete discussion of the data, methodology, and assumptions of this inventory update.)

Historical GHG Emissions

In 2002, California produced 493 million metric tons of carbon dioxide (CO_2)-equivalent GHG emissions; about a twelve percent increase from 1990. Figure 1 shows that carbon dioxide emissions comprised 83 percent of the total GHG emissions in 2002; methane comprised six percent, nitrous oxide comprised seven percent and high global warming potential (GWP) gases the remainder.[28]

Figure 1—Composition of California's 2002 Greenhouse Gas Emissions (By Type of Gas)



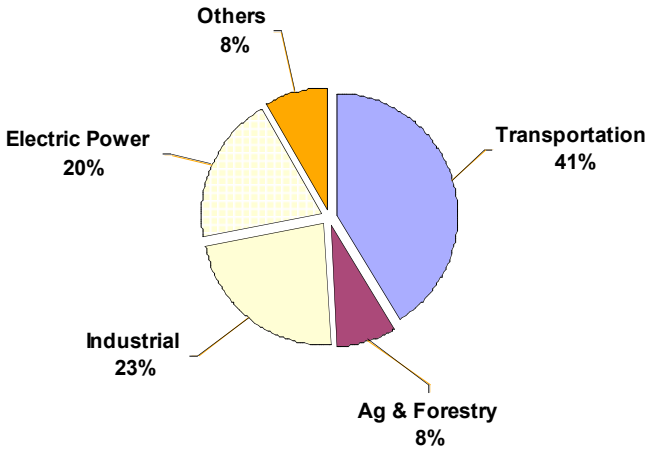
Source: California Energy Commission, June 2005.

As shown in Figure 2, combustion of fossil fuels in the transportation sector was the single largest source of California's GHG emissions in 2002, with the industrial sector as the second largest source, and electricity production, from both in-state and out-of-state sources, the third largest source. Agriculture, forestry, commercial, and residential activities were the source of the balance of California's GHG emissions.

Figure 3 shows historical California GHG emissions by sector, including both in-state and imported electricity.[29] Emissions from the transportation sector, including combustion of gasoline, jet, and other transportation fuels, increased 14 percent between 1990 and 2002.[30]

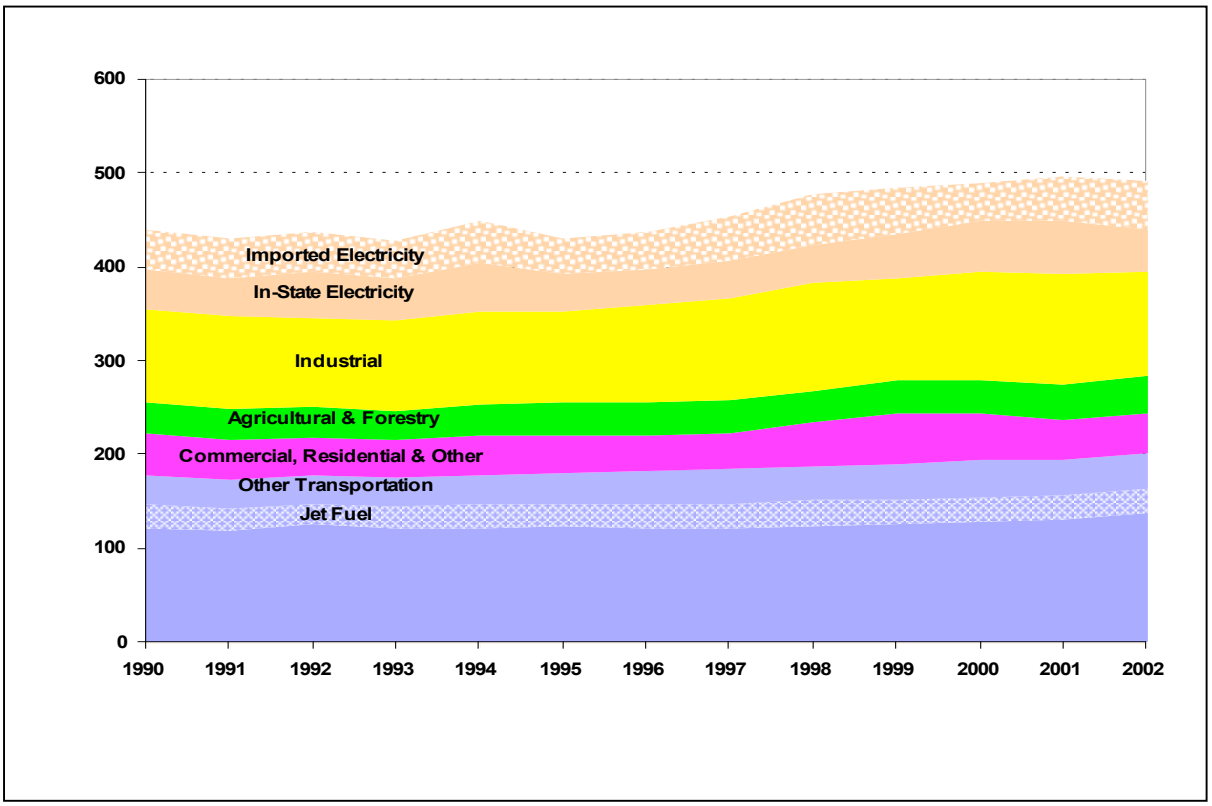
Commercial and residential GHG emissions decreased seven percent, agricultural and forestry emissions increased 18 percent, and emissions from industrial activities increased 16 percent. Lastly, emissions from electricity generation increased 14 percent and out-of-state emissions produced the majority of this increase, since imported power includes some coal imports.[31]

Figure 2—Sources of California's 2002 Greenhouse Gas Emissions (By End-Use Sector)



Source: California Energy Commission, June 2005.

Figure 3—California GHG Emissions Trends (Million Metric Tons of Carbon Dioxide Equivalent)



Source: California Energy Commission, June 2005.

Out-of-State GHG Emissions

Out-of-state electricity generation has shown higher carbon intensity than in-state generation in the past. In-state electricity produced 85 to 280 metric tons of carbon dioxide per gigawatt-hour, while imported electricity produced 660 to 1,350 metric tons. The carbon intensity variation is caused by the availability of hydropower and other factors.

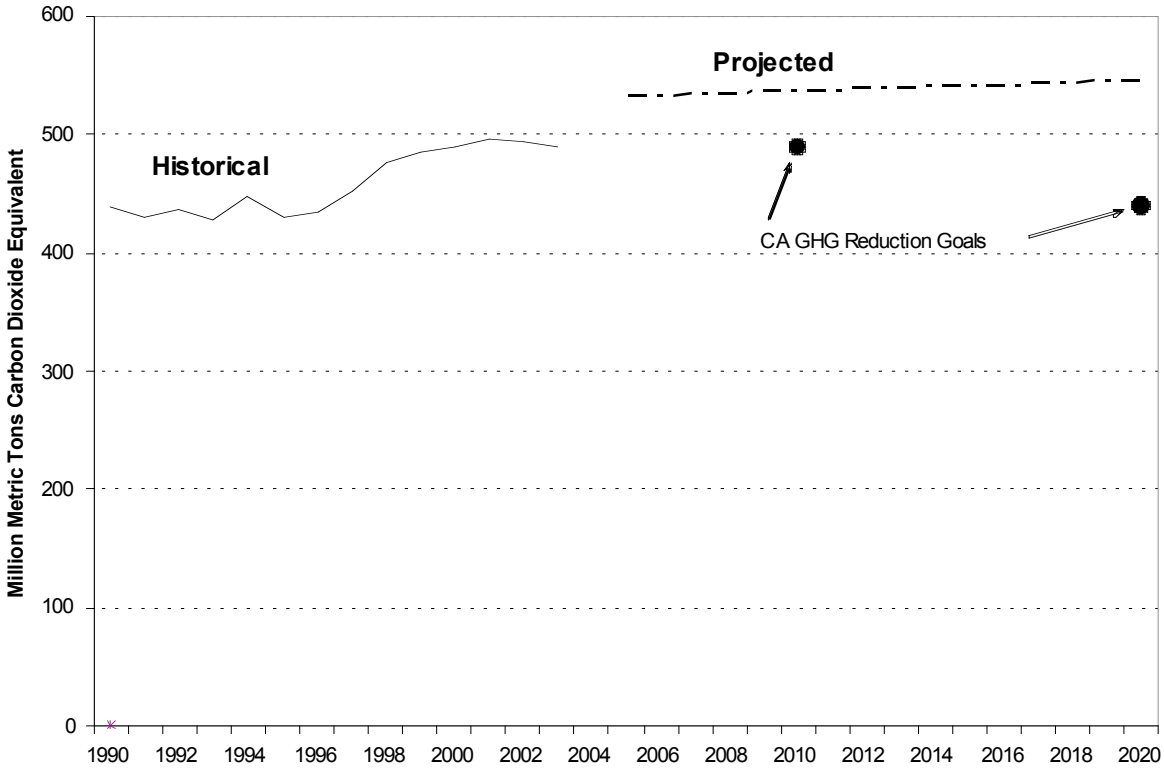
While the carbon intensity of both in-state and out-of-state electricity generation varied greatly, the amount of electricity California imported also varied from year to year. From 1990 to 2002, California imported 22 to 32 percent of the total electrical energy consumed in the state.

Projected GHG Emissions

Figure 4 displays total historical and projected GHG emissions trends. California's GHG emissions were stable for 1990 to 1995, largely due to a stagnant economy, but increased steadily after 1995. While economic conditions have certainly had an impact on the emissions growth rate, other factors, including California's progressive energy efficiency programs, have lowered the rate. Short-term variations in future year-to-year values are likely, but are not shown.

These emissions are projected to continue to increase through 2020 unless additional policies to mitigate GHG emissions are adopted and new actions are taken to slow the rate of increase. Strategies have been proposed by the Governor as part of his greenhouse gas emissions leadership initiative, as shown in Figure 4. This figure shows the projected effect on current trends of achieving the Governor's climate change goals of achieving 2000 GHG emissions levels in 2010, 1990 GHG emissions levels in 2020, and 80 percent below 1990 levels in 2050.[32]

Figure 4—California's Historical and Projected Greenhouse Gas Emissions (Million Metric Tons of Carbon Dioxide Equivalent)



Source: California Energy Commission, June 2005.

Existing State Policies and Programs

The State of California has been, and continues to be, a national leader in addressing climate change through various state policies. California leads the nation in renewable energy development and energy efficiency programs, which have important climate change benefits.

GHG emissions in California are projected to increase steadily in the future, but the rate of growth has been lowered due to the benefits of recently enacted state policies. California's experience in the electricity sector demonstrates that economic growth does not necessarily mean growth in electricity consumption. In fact, California's economic output per unit of electricity consumed increased over 40 percent over the past 25 years, while the in rest of the country output increased by only 8 percent.[33]

California's Greenhouse Gas Reduction Targets

On June 1, 2005, the Governor established ambitious yet achievable greenhouse gas reductions for California, which would:

- By 2010, reduce statewide GHG emissions to 2000 emission levels;
- By 2020, reduce statewide GHG emissions to 1990 emission levels;
- By 2050, reduce statewide GHG emissions to 80% below 1990 levels.[34]

Implementing strategies to reach these targets will be the responsibility of a Climate Action Team, an interagency team established by the Governor. The Team is led by Cal EPA and is composed of high level representatives from key state agencies. This Team will report to the Governor and the Legislature in January 2006, and biannually thereafter.[35]

Strategies are already underway in California which, when fully implemented, will significantly reduce greenhouse gas emissions in the state. These same strategies were evaluated by the California Climate Action Team to determine California's GHG reduction targets.[36]

Integrated Energy Policy Report

Current policies include state motor vehicle GHG emissions standards, utility resource procurement, energy efficiency, and the accelerated Renewable Portfolio Standard. Without these state policies in place, the state's GHG emissions would rise by another 40 percent above 1990 levels by 2020.[37]

The *2003 Integrated Energy Report,* the state's biennial energy policy report*,* recommended specific state actions to address climate change, asking state agencies to:

- Require the reporting of GHG emissions as a condition of state licensing of new electricity generating facilities.

- Account for the cost of GHG emission reductions in utility resource procurement decisions.

- Use sustainable energy and environmental designs in all state buildings.

- Require all state agencies to incorporate climate change mitigation and adaptation strategies in planning and policy documents.[38]

The State of California is implementing these recommendations.

State Motor Vehicle Emissions Standards

In 2002, landmark legislation [AB 1493 (Pavley), Chapter 200, Statutes of 2002] directed the California Air Resources Board (ARB) to establish motor vehicle standards to limit GHG emissions from passenger cars and light trucks, declaring that "global warming is a matter of increasing concern for public health and the environment in the state."

In September 2004, ARB unanimously approved standards to limit GHG emissions from new passenger cars and light trucks, starting with the 2009 model year. The regulations will not take effect until 2006 to allow a one year period for legislative review. Pending legislative review, the standards will be take effect with the 2009 vehicle model year (allowing time for auto companies to retool to produce the new vehicles) and will be phased in during the 2009 through 2016 model years.

Based on a comprehensive assessment of emerging and existing technologies and fuels, the standards are expected to reduce GHG emissions from passenger cars and light trucks by 18 percent in 2020 and by 27 percent in 2030. In addition, the standards will cut ozone-forming pollution by about 6 tons per day in 2020 and 10 tons per day in 2030.

According to CARB, the expected cost for the added technology to meet the standards will average $325 per vehicle in 2012, and about $1,050 per vehicle in 2016 (2004$). These increased costs, however, will be more than offset by operating cost savings over the life of the vehicle.

California is the first state in the nation to regulate motor vehicle GHG emissions. The states of New York, Massachusetts, and Connecticut have publicly committed to adopting the California GHG regulations. Several other states, including New Jersey, Maine, Vermont, Rhode Island, Washington and Oregon, are exploring the

possibility. As expected, the automobile manufacturers filed suit in federal and state court seeking to overturn California's regulations in December 2004.

Utility Resource Procurement

In May 2003, the CPUC, the Energy Commission, and the California Power Authority jointly adopted an *Energy Action Plan (Plan)*. This *Plan* recognized the need for "continuing progress in meeting the state's environmental goals and standards, including minimizing the energy sector's impact on climate change." The *Plan* also articulates the need to "encourage companies that invest in energy conservation and resource efficiency to register with the state's voluntary Climate Action Registry."[39]

Furthermore, the *Plan* established as state policy the preferred "loading order" for utility resource procurement which identified energy efficiency and renewable energy as the state's top priority resources. This "loading order" policy is a key part of California's strategy to combat global climate change.[40]

In December 2004, the CPUC recognized the importance of reducing GHG emissions in its decision on utility resource procurement that directed the state's investor-owned utilities to account for climate change risk in their long-term resource procurement plans.[41] By internalizing climate change risk into the evaluation of bids for fossil-fueled generation, the utility procurement process will allow for increased renewable energy and demand-side management options, which will reduce carbon dioxide emissions.[42]

Under this decision, the utilities are required to use a "greenhouse adder," using an initial value of $8 per ton to reflect the amount of CO_2 that would be emitted by an electricity generating unit under the terms of a contract. This adder represents an estimate of the likely future cost of purchasing CO_2 offsets to comply with future mitigation regulations. The adder also corresponds to the financial risk associated with likely future regulation of GHG emissions. This adder encourages utilities to invest more in lower-emitting resources, such as efficiency and renewable sources, and less in high-emitting resources such as conventional coal.

Other CPUC rulings require the utilities to estimate the GHG emissions reductions associated with energy efficiency programs and broaden participation in the California Climate Action Registry.[43] The CPUC is currently investigating the creation of a "carbon cap" on utility resource portfolios, and a procurement incentive framework to encourage the utilities to select environmentally-preferable resources.

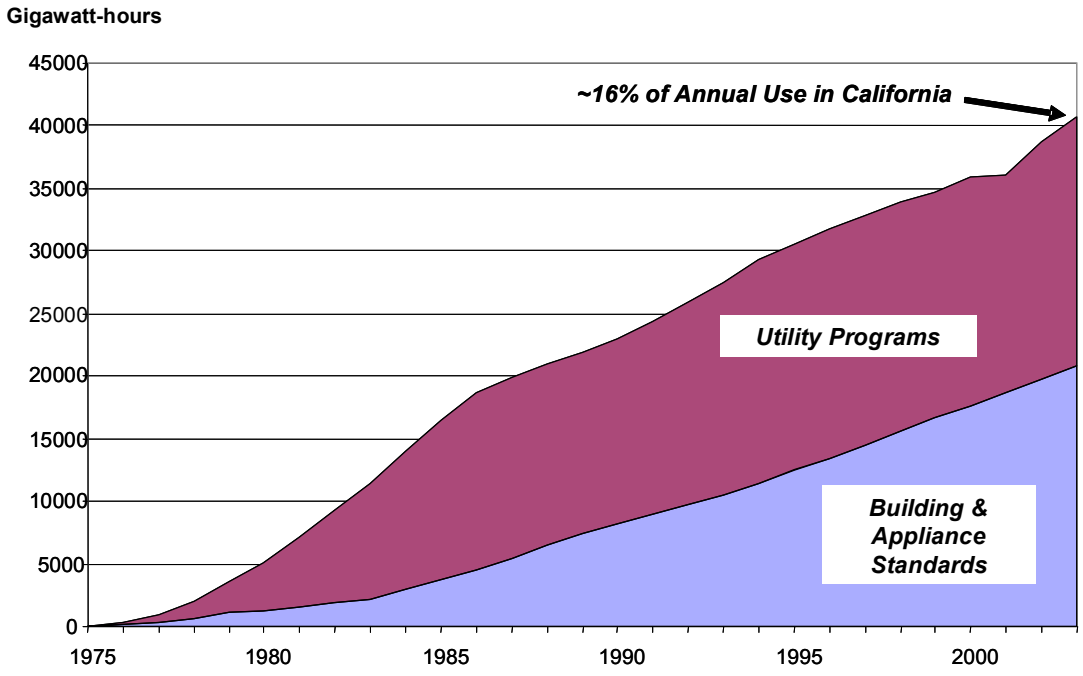
Energy Efficiency

Since the late 1970s, the Energy Commission has advocated energy efficiency through standard setting, market incentives, and utility-funded programs. Efforts to reduce energy consumption, and therefore the use of fossil fuels, in California have

important climate change benefits. In addition, California has been successful in holding per capital energy consumption steady over the past 25 years, while per capita energy consumption in the rest of the country has increased by nearly 50 percent.[44]

California's building and appliance standards are internationally recognized as an example of the state's leadership in saving energy through more efficient appliances, building design, equipment, and building materials. These standards have saved individuals and businesses in California $56 billion through 2003 and are expected to save another $23 billion by 2013.[45] Figure 5 shows the energy savings from California's energy efficiency programs, a savings of 16 percent of annual energy use (expressed in gigawatt hours) since 1975.

Figure 5—Energy Savings from California's Efficiency Programs



Source: California Energy Commission, May 2005.

The building efficiency standards require new and remodeled buildings to incorporate cost-effective energy efficiency measures. These standards are updated every three years. The most recent, the 2005 building efficiency standards, were adopted in November 2003.[46] Savings from the standards increase over time, as buildings are constructed or retrofitted.

California was the first state to develop and enforce efficiency standards for appliances. During 2004, the Energy Commission adopted new appliance efficiency standards for 19 appliances, including residential clothes washers. The 2004 appliance standards, to be phased in over the next few years, will provide significant energy savings.[47] Additionally, many manufacturers find it problematic to provide special models just for California, and therefore have sold more efficient models throughout the country.

In the early 1990s, the U.S. Department of Energy adopted California's appliance standards as national efficiency standards. The standards were credited with having achieved 5,380 megawatts of peak reduction during the electricity crisis of 2000-2001.[48]

California's mild climate and progressive state energy efficiency programs have contributed to California's relative low energy intensity (use per capita), compared to the rest of the U.S. This lower energy intensity supports the state's economic growth and provides direct savings from energy use reductions to residential and commercial customers.

The CPUC adopted energy savings goals targets in September 2004.[49] These aggressive targets require that the investor-owned utilities invest first in cost-effective energy efficiency programs to meet incremental increases in overall energy demand. The cumulative targets set for program years 2004-2013 are 26,508 Gigawatt-hours (Gwh), 6,892 Megawatts (MW), and 290 million therms. In addition, energy efficiency savings are included and emphasized in the utilities' overall procurement plans.

These energy efficiency goals are the most progressive goals in the country and will more than double the level of savings from utility programs over the next decade. Combined, the estimated electricity and natural gas savings will reduce CO_2 emissions by more than nine million tons per year by 2013. The energy savings goals will save nearly 5,000 MW and 444 million therms by 2013, and cut electricity and natural gas consumption by the customers of the state's regulated utilities by more than half.[50]

Renewable Portfolio Standard

State policy has encouraged the use of renewable energy resources as a means of diversifying the electric generation mix. Today, California's Renewable Portfolio Standard (RPS) is the centerpiece of the state's strategy to diversify our electricity system and address our state's growing dependence on natural gas. State legislation [SB 1078 (Sher), Chapter 516, Statutes of 2002] currently requires that all retail suppliers of electricity in California supply at least 20 percent of their sales from renewable energy sources by 2017.

Both the *Energy Action Plan* and the *2003 Energy Report* recommend accelerating the 20 percent target to 2010. In the *2004 Energy Report Update,* the Energy Commission has further recommended a more ambitious post-2010 goal of 33 percent to sustain momentum and investment in renewable energy development to meet California's electricity demand.

The Energy Commission and the CPUC are collaborating to implement the state's RPS. Supplemental energy payments for RPS power costs above the CPUC-determined market prices will be offered for base load and peaking power plants, with these prices to be re-calculated for each RPS procurement cycle.

The CPUC has implemented a series of policy decisions since January of 2003 to develop the RPS program. The first RPS solicitation commenced in the summer of 2004, and the first contracts for new renewable generation infrastructure, totaling approximately one percent of retail electric sales, are being finalized now. The CPUC has set aggressive targets for renewable procurement to reach the 20 percent target by 2010, which in the aggregate will amount to displacing more than 35,000 Gwh of carbon-intensive generation with clean renewable resources.

California Climate Action Registry

State legislation [SB 1771 (Sher), Chapter 1018, Statutes of 2000] created the California Climate Action Registry, a non-profit organization, charged with annual voluntary reporting of GHG emissions by its member companies and agencies. The Registry was launched in September 2002 and has more than 40 participants from business, industry, government, and non-governmental organizations.

The Energy Commission has supported the work of the California Climate Action Registry by providing technical guidance in the development of GHG reporting protocols. The Registry allows member companies to voluntarily report and independently verify their GHG emissions and to obtain credit for these emissions under any future federal regulatory regime.

The Sacramento Municipal Utility District (SMUD) was the first Registry participant to complete all the necessary steps in determining their GHG emissions inventory, including independent verification, and has posted their results on the Registry's website. Pacific Gas and Electric Company and the Calpine Corporation were the next members to complete their emissions certification.

Participants are required to report entity-wide GHG emissions that must be certified as accurate and complete by third-party certifiers. To date, the Registry has issued reporting protocols for the power sector, forestry sector, and the oil and gas sector, with input from the Energy Commission and member companies. The State of California is encouraged to provide "appropriate consideration" for the emissions certified through the Registry's process under any future regulatory regime. All of the investor-owned utilities are members of the Registry.

The Registry is seeking to harmonize its reporting protocols with those of other states and regions of the country, as a first step toward a mandatory GHG reporting system. If and when international or national requirements are instituted, these reporting protocols could become a useful model for enforcing voluntary goals or mandatory targets for reducing GHG emissions.

Statewide Inventory of GHG Emissions

In September 2000, the California Legislature passed legislation (Senate Bill (SB) 1771 [Sher], Chapter 1018, Statutes of 2000), requiring the Energy Commission to update the state's inventory of GHG emissions in consultation with other agencies. The statute required the Energy Commission to update the inventory in January 2002, and every five years after that.

The Energy Commission prepared its first statewide inventory in response to SB 1771, *Inventory of California Greenhouse Gas Emissions and Sinks: 1990-1999*,[51] based on the best information available at the time of publication. The inventory was developed using guidelines adopted by the Intergovernmental Panel on Climate Change and was consistent with the methods being used by the U. S. Environmental Protection Agency.

The Energy Commission staff has recently updated the inventory to incorporate 2002 data and information, which was the most recent data available. The 2005 inventory update compares California's emissions of GHG emissions with emissions of other states. Limited information was available to allow a complete and thorough analysis and discussion of the impact of air quality and energy policies and programs on GHG emissions. See *Inventory of California Greenhouse Gas Emissions and Sinks: 1990 to 2002 Update*.[52]

In October 1990, the California Energy Commission published[53] the first inventory of greenhouse gas emissions for the State of California. This inventory was prepared only for one year (1988) and only for carbon dioxide. The estimated emissions for 1988 were estimated at 481 million metric tons of carbon dioxide, including imported electricity. In March 1997 the California Energy Commission published[54] its second inventory of greenhouse gas emissions.

This second inventory was prepared only for the year 1990 but included an estimate for methane and nitrous oxide emissions in addition to carbon dioxide. Estimated in-state emissions for 1990 were estimated at 463 million metric tons of carbon dioxide equivalent emissions. This inventory also included GHG emissions from imported electricity.

In January 1998 the California Energy Commission published[55] its next GHG inventory. This inventory covered the period from 1990 through 1994 and included methane and nitrous oxide in addition to carbon dioxide. Estimated in-state 1990

emissions were 470 million metric tons of carbon dioxide equivalent emissions, including emissions from imported electricity. In-state 1994 emissions were estimated to be 416 million metric tons of carbon dioxide equivalent emissions.

Power Plant Licensing

The West Coast states are taking different approaches to incorporating climate change considerations in the licensing of new power plants.

In California, the Energy Commission has begun to require power plant developers to report GHG emissions as an important first step in identifying mitigation opportunities. In the *2003 Integrated Energy Report*, the Energy Commission recommended that developers be required to report GHG emissions as a condition of state licensing of new electricity generation facilities. A rulemaking is underway to revise current regulations for power plant licensing and compliance to incorporate these requirements.

The state of Oregon currently sets CO_2 emissions standards for power plants, based on their electrical power output. In addition, Oregon requires that GHG emissions from power plants be mitigated through "offsite mitigation". Under the auspice of the Oregon Climate Trust, power plant developers can choose to either purchase emissions offsets from a third party or to buy emissions reductions from non-power projects. Such projects can include energy conservation, transportation savings (such as the purchase of hybrid vehicles), and biological sequestration projects.

The state of Washington enacted legislation in 2004 which established CO_2 mitigation requirements for fossil-fueled thermal power plants with a generating capacity of 25 Megawatts or more. Under this legislation, power plant developers must offset 20 percent of the CO_2 emissions from a proposed power plant as a condition of state licensing.

State Level Coordination

The Joint Agency Climate Team, an interagency committee with representatives from state agencies involved in climate change activities, was established in response to state legislation[56] [SB 1771 (Sher), Chapter 1018, Statutes of 2000]. The Team, which was originally formed in 2001 and co-chaired by the State Resources Agency and the California Environmental Protection Agency, has formulated 11 categories of recommendations to reduce GHG emissions through a combination of short-term mitigation options and longer-term adaptation measures:

- Improve the capacity to quantify GHG emissions and emission reduction measures;
- Develop, commercialize and export environmentally sound energy technologies;

- Achieve cleaner, more efficient transportation;
- Improve energy efficiency in the residential, commercial, industrial and agricultural sectors;
- Shift energy demand toward processes, services and products with low GHG emissions;
- Sequester carbon as a GHG emissions mitigation measure;
- Broaden and accelerate the use of renewable energy;
- Assess impacts and evaluate adaptive solutions to climate change.
- Enhance the capacity to project future climate changes;
- Collect better hydrologic and environmental data;
- Enhance water management planning capacity.

The Team has successfully advocated that state agencies include climate change considerations into state planning and policy documents. For example, Cal Trans and the State Department of Water Resources are including climate change considerations in their state plans.

Regional and International Partnerships

Many states are recognizing the importance of forging regional partnerships to address global climate change. In September 2003, the governors of California, Washington, and Oregon endorsed the West Coast Governors' Global Warming Initiative as a way of addressing global warming through joint regional actions. The three governors recognized that states can act "individually and regionally to reduce GHG emissions" through strategies that "provide long-term sustainability for the environment, protect public health, consider social equity, and expand public awareness." [57]

In November 2004, the West Coast Governors asked their staffs to work together to explore more comprehensive regional measures to reduce GHG, highlighting four specific areas which hold the most promise:

- Adopt comprehensive state and regional goals for GHG emissions reductions.
- Adopt standards to reduce GHG emissions from vehicles.
- Develop a market-based carbon allowance program.
- Expand the markets for energy efficiency, renewable resources, and alternative fuels.

The Governors concluded that states can demonstrate global leadership in reducing GHG emissions, while achieving strong, long-term economic growth. When the three West Coast states are taken together, their combined GHG emissions are significant when compared to emissions from countries around the globe. Regional efforts to address global warming can, therefore, have a measurable global effect.

The Regional GHG Initiative (RGGI) is another example of state government leadership in addressing global climate change. This initiative was launched in April 2003 by the Northeastern and Mid-Atlantic States under the leadership of Governor Pataki of New York. These nine states as a region represent 14 percent of U.S. GHG emissions and 3.4 percent of global emissions. Some of these same states have since announced state GHG reduction goals.

The goal of RGGI is to design a regional "cap and trade" program, which initially focuses on CO_2 emissions from power plants. A model rule is being proposed for release in April 2005, for the nine participating states to use.

The Energy Commission has formed partnerships with other states and countries who are addressing climate change. The Energy Commission has supported the work of the Center for Clean Air Policy (CCAP), a not-for-profit organization established in 1988 to promote innovative solutions to energy and environmental problems. Through its membership in CCAP, the Energy Commission has received the benefit of climate change work in other regions of the country, partnering with several states in the Northeast and with the European Union.

The Energy Commission is a charter member of the Climate Change Group, an international organization with the mission of activating new momentum in the worlds of politics, trade and finance. The Climate Group is assembling a growing, global circle of greenhouse gas reducers and supporters and pooling this group's experience of cost-effective and profitable reduction strategies.

State-Sponsored Scientific Research

While several state agencies support climate change research at some level, ARB and the Energy Commission are the most active.

ARB is funding studies to characterize black carbon (i.e., soot) and other carbon releases, investigating emission levels from cars and trucks, improving emission inventory methods for both CO_2 and non-CO_2 gases, and evaluating the potential public health effects of climate change. ARB is also sponsoring research to determine the climate change benefits of air pollution control activities.

The Energy Commission has developed a long-term strategic research plan, which funds scientific studies that complement national and international research efforts. Core research is taking place at Scripps Institution of Oceanography and the University of California, San Diego and Berkeley.

Key research areas address the economic impacts from climate change, impact and adaptation analyses, regional climate modeling, and the potential for geologic and terrestrial carbon sequestration measures and techniques.

Climate Change Advisory Committee

The Energy Commission established a Climate Change Advisory Committee in July 2004 in response to state legislation [SB 1771 (Sher), Chapter 1018, Statutes of 2000]. This Advisory Committee is charged with advising the Energy Commission on "the most equitable and efficient ways to implement national and international climate change requirements."[58]

The Energy Commission has requested the Advisory Committee to provide input on the following key policy questions:

- What strategies beyond existing state policies and programs should California pursue to address global climate change?
- What criteria should be applied to develop and select recommended policy options?
- What options warrant further evaluation by the staff and its consultants?
- What business opportunities exist for California companies to become corporate leaders on climate change, while achieving operational efficiencies and cost savings?

The Committee has met quarterly since July 2004 to examine a comprehensive set of strategies for addressing climate change at the state, regional and national levels. Its membership represents key sectors of the California economy that will be affected by climate change.

Options for Addressing Climate Change

The Energy Commission has begun to identify the most promising options for reducing GHG by first identifying those end-use sectors with the greatest potential for reductions. For this analysis, the Energy Commission is using the most recent update of the state's GHG inventory as a starting point to determine where the greatest opportunities to reduce emissions exist at the lowest cost.

Next, the Energy Commission will apply selection criteria to examine the relative merit of the proposed options; including technical feasibility, cost-effectiveness, political acceptability, practicality, cost or ease of implementation, timing, and the potential GHG reduction benefits. The Energy Commission will also consider the effect on international or interstate competitiveness of options employed in California.

A preliminary list of strategies, organized by end-use sectors, is described below. The Energy Commission is relying on research and analysis by the Center for Clean Air Policy (CCAP), the Tellus Institute, and other consultants funded through the Public Interest Energy Research (PIER) program to evaluate and rank these

potential strategies. The first phase of this analysis will be available by mid-July 2005.

Transportation Sector Options

The transportation sector produces a significant portion of the GHG emissions in California. The untapped potential for reducing emissions is large; however, with the exception of the state's proposed motor vehicle emission standards, appropriate policy instruments do not yet exist. In 2002, transportation sources represented approximately 42 percent of California's GHG emissions, with the largest fraction from motor gasoline burned in light duty vehicles.

In an August, 2003 Joint Report to the California Legislature, the Energy Commission and ARB concluded that use of alternative fuels, where cost effective, should be increased as an alternative to conventional petroleum fuels. The two agencies further concluded that blending ethanol in gasoline, using Fischer-Tropsch diesel in existing diesel engines, and using propane and liquefied and compressed natural gas in heavy-duty vehicles appeared to be cost-effective options for reducing petroleum use.[59]

The Joint Report also identified expanding the existing fueling infrastructure as a key market barrier to using these fuels. Over the longer term, expanding the use of hydrogen in fuel cell vehicles has the benefit of high efficiency, zero tailpipe emissions, and reduced climate change impacts. In addition, fuel production from bio-fuels, such as ethanol produced from renewable feedstock, has the potential to produce climate change benefits.

The Energy Commission is examining a number of options for reducing GHG emissions from the combustion of gasoline, diesel and jet fuel in cars, trucks, airplanes, and freight vehicles. Among the options under evaluation are:

- Reducing freight-sector emissions in California's ports, rail, and heavy-duty trucks.
- Using alternative fuels in niche markets, including public and private fleets.
- Reducing vehicle miles traveled.
- Encouraging vehicle efficiency through incentives and fees.
- Using bio-fuels, such as bio-diesel, or increasing the use of ethanol in gasoline.
- Improving the fuel economy of light, medium, and heavy-duty vehicles.

In October 2004, the CCAP presented its preliminary analysis to the Advisory Committee on Climate Change that suggested:

- Changes in the movement of freight and goods present significant opportunities to reduce GHG emissions;

- Truck traffic from over 40,000 diesel trucks operating on the state's highways is expected to triple by 2025, and cause over six percent of total GHG emissions;
- Use of advanced truck technologies, improvements in port equipment, and expanded use of rail could offset expansion at California's major ports;
- Use of alternative fuels in heavy-duty trucks and truck stop electrification are among the measures that show the greatest promise.[60]

California is already pursuing a combination of incentives and regulatory measures along these lines, such as the ARB truck idling regulations. In addition, the state is undertaking activities to stimulate the electrification of truck stops at key ports and along the state's highways. These pilot efforts should be expanded and funding should be secured. For example, innovative financing options, such as a port-emission reduction grant program, would allow California ports to mitigate their diesel emissions and provide climate change reduction benefits as well.

Vehicle miles traveled (VMT) in California is growing at a rate of over 1.8 percent per year, a rate lower than the national average.[61] Limiting the growth in VMT can best be achieved at the regional, state, or local level, using a combination of public transit, transit-oriented land-use development, in-fill development (i.e., urban development in open space to avoid urban sprawl), and urban revitalization.

Reducing VMT has been the purview of metropolitan or regional planning agencies in San Diego, Sacramento, Los Angeles, and San Francisco. A review of five regional planning documents conducted in 2001 for the Energy Commission revealed that low-VMT policies produced a two to 10 percent statewide savings of total statewide transportation energy demand from "smart growth" land use planning measures at the local level.[62] Furthermore, the survey found that consistent methods for reporting and monitoring GHG reductions from "smart growth" measures are needed to ensure that regional planning priorities and goals are achieved.

The Energy Commission and CCAP are evaluating the impact of policies to reduce emissions from aircraft and airport equipment. According to the CCAP, changes in the airline industry from the added cost of homeland security concerns and airline bankruptcies make it difficult to project airport growth accurately. Nevertheless, the Federal Aviation Administration is projecting that aircraft operations in California will grow by 54 percent by 2020, and result in growth in air taxi and commuter traffic.

One option to reduce emissions related to air travel is to shift from aircraft use to high-speed rail. Another is a regulatory approach, such as capping emissions at airports. A preliminary analysis by CCAP concluded that GHG reductions may be possible through a combination of measures, including:

- Air traffic and communication system improvements.
- Reduced intervals for aircraft maintenance.
- Reduced aerodynamic deterioration.

- Installation of winglets (i.e., small wing extensions) on aircraft.
- Reduced weight of commercial jets and aircraft.

Industrial Sector Measures

The industrial sector was the second largest source of GHG emissions in California in 2001, contributing 22 percent of the total.[63] Nearly 67 percent of direct industrial emissions are produced from fossil fuel combustion, with the largest sources of industrial emissions from petroleum refining, oil and gas extraction, and manufacturing (including the semiconductor and cement industries).

Work is underway by the Energy Commission to analyze options to reduce non-CO_2 GHG emissions; including methane, nitrous oxide, refrigerants, and sulfur hexafluoride. For CO_2, CCAP is analyzing three primary approaches for addressing industrial GHG emissions:

- Measures to reduce CO_2 emissions in petroleum refining.
- Combined heat and power options associated with power generation that can be applied in numerous industries.
- Measures to reduce CO_2 emissions from the cement industry.

In addition, opportunities may exist to reduce GHG emissions from natural gas compressor stations and the food and semi-conductor industries.[64]

The cement industry offers potential reduction benefits through the use of “blended” cement and through energy efficiency improvements in manufacturing cement in California, although tradeoffs between operating efficiencies and the cost of changes in the manufacturing processes need to be taken into account. Further, changes in cement performance standards over the last 20 years tend to favor “blended” cement.[65]

Petroleum refining is the largest industrial consumer of energy in California, ranking first in electricity consumption and second in natural gas consumption. While public data on total energy consumption in California’s refining industry are not readily available or precise, some estimates have been made from available information which approach 500 trillion British Thermal Units (BtU).[66] Sufficient data exist on petroleum refining in California to permit only rough estimates of the potential for CO_2 emissions reduction.[67]

Refineries are highly complex and integrated industrial processes, and include hydrogen production, crude oil distillation, and hydro treating. These processes are energy intensive and produce both direct and indirect GHG emissions. As a result, measures to reduce CO_2 emissions from these integrated processes cannot be simply added together.[68] Data are needed to characterize the types of processes

used in refineries, the estimated energy consumption of these processes, and the costs of options for reducing energy consumption and resulting CO_2 emissions.

Finally, the use of combined heat and power (CHP) from a single combustion source promises to be an effective strategy to reduce GHG emissions. Installing CHP processes at facilities that purchase electricity from the grid and use significant amounts of heat or process steam is expected to produce net cost savings. To make this successful, though, new policy instruments will need to be devised to provide incentives to encourage CHP in existing industrial processes in California.

Power Sector Options

As discussed above, in-state combustion of fossil fuels in power generation exceeded 11 percent of total GHG emissions in California in 2001. While this percentage is small relative to other states, out-of-state power, especially coal imports, increases this percentage to nearly 21 percent.

CCAP is exploring several measures to address power sector GHG emissions, drawing from experience with the Northeastern States and the European Union, including:

- Regional or statewide emissions caps.
- Emissions portfolio standards.
- Offset requirements.
- Cap on electricity production from load serving entities.

Beyond existing state policies, the CCAP analysis will consider establishing a regional cap on electricity-related emissions, adding the effect of near-term measures, such as more aggressive energy efficiency programs and an expansion of the RPS. Using scenarios, the analysis will also consider the effect of a statewide cap on GHG emissions from electricity production. [69]

Other variations in setting statewide and regional caps on GHG emissions will involve modeling the effects of such caps on a variety of industry sectors, including the semiconductor, cement, and refining industries, each of which has their own process heat, steam, and power requirements.[70]

In addition, some members of the Advisory Committee have recommended including options involving advanced power generation technologies, such as use of Integrated Gasification Combined Cycle technology.

Agriculture and Forestry Sector Measures

Opportunities for reducing GHG emissions in agriculture and forestry exist in manure management and expanding agricultural and forestry carbon sinks. Using Energy

Commission data and preliminary analysis by CCAP, the Energy Commission estimates that methane emissions in California were 6.3 percent of GHG emissions attributable to California.[71] The largest sources of methane emissions include:

- Landfills.
- Enteric fermentation (i.e., methane produced from livestock feeding).
- Manure management.
- Petroleum and natural gas supply systems.
- Wastewater plants.

Of these sources, methane emissions from manure management is the fastest growing source, with a growth rate of over five percent a year.[72] Reducing methane from liquid livestock waste through use of biogas recovery appears to be a cost-effective option. The Energy Commission and the CCAP are exploring several implementation strategies, including economic incentives and sector-specific emission caps, to achieve the potential reductions.

California's forestry and agricultural sectors also provide a net sink for carbon in the state. In 2001, land use changes and forestry sinks offset four percent of the state's GHG emissions in that year, including power imports.[73] Recent data indicate that the quantity of carbon sequestered is declining, however, due to land use changes and de-forestation. Specific measures being evaluated include:

- Improved forest management.
- Measures to reduce de-forestation in existing forests.
- Ways to keep forest land in production.
- Soil erosion management.
- Land conversion and restoration.
- Low or no-till agriculture.
- Bio-fuels production.
- Crop rotation and winter cover.
- Linking carbon sequestration to a broader multi-sector, emissions trading program.

Adaptation Strategies

Climate change is largely due to the long atmospheric lifetime of GHG emissions (e.g., 100 years for CO_2) and the high thermal inertia of the oceans. As the science of climate change demonstrates, our planet is already committed to some level of warming. For these reasons, a balanced approach, combining near-term mitigation options with longer term adaptation strategies, is the most prudent course of action.

Scientific research has identified a number of "no regrets" strategies to reduce any adverse effects of changing climate[74]:

- Increasing water use efficiency.
- Preserving vulnerable habitats, wetlands, and areas subject to fires, floods, and landslides.
- Creating nature reserves to accommodate future climate changes, range shifts and migrations of plants and animals.
- Reducing urban heat island impacts.
- Recharging groundwater systems by using pavements that are permeable to allow storm water runoff.

Additional research is being funded through both the Energy Commission's PIER program and other research efforts to identify robust adaptation strategies by:

- Developing probabilistic climate projections for the state.
- Creating a dynamic ecological model to develop biodiversity and conservation strategies.
- Demonstrating probabilistic seasonal forecasts to improve the management of water reservoirs in the state.
- Installing climate reference stations to track and detect climatic changes in the state.
- Developing a process-based shoreline model to estimate how our coastal area may change in the future with sea level rise.
- Improving a water system model to investigate potential adaptation measures under a wide variety of scenarios.

Recommended Next Steps

Analysis is underway to quantify the cost effectiveness of the selected policy options. Analytical results will be shared with the members of the Energy Commission's Climate Change Advisory Committee and other interested parties. The Advisory Committee is scheduled to meet on July 11, 2005, and an Energy Commission workshop on climate change is scheduled for July 12, 2005, to solicit public input on specific options proposed for the transportation, power, agriculture and forestry, and industrial sectors.

Researchers from the University of California Berkeley have developed a macroeconomic model to estimate, in an integrated fashion, the overall economic impacts of efforts designed to reduce GHG emissions in the state. This work will be available in mid-2005.

The Energy Commission is updating the state's inventory of GHG emissions to reflect data available for the year 2002. This paper has drawn on the updated data, and a staff paper documenting this update will be available in June 2005.

Finally, the Energy Commission is seeking input from the Advisory Committee on key policy questions and policy recommendations from the Climate Change Advisory Committee, which will be incorporated into the *2005 Integrated Energy Plan Report.*

End Notes

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[29] Values are expressed in millions of metric tons of carbon dioxide equivalents ($MMTCO_2E$).
[30] Gasoline related GHG emissions increased from 122.7 $MMTCO_2E$ in 1990 to 137.7 $MMTCO_2E$ in 2002, a 12.2% increase. Jet fuel GHG emissions include only domestic fuel use. In 1990 domestic jet fuel use GHG emissions were 24.4 $MMTCO_2E$. They peaked in 1998 at 27.1 $MMTCO_2E$ and then decreased to 25.9 $MMTCO_2E$ in 2002, for a net increase of 6.2% from 1990-2002. In 1990 diesel emissions were 18.3 $MMTCO_2E$. They increased to 27.2 $MMTCO_2E$ in 2002. Total transportation GHG emissions were 178.2 $MMTCO_2E$ in 1990 and increased to 203.2 $MMTCO_2E$ in 2002, for an overall increase of 14%.
[31] In-state electricity GHG emissions increased from 41.5 $MMTCO_2E$ in 1990 to 57.6 $MMTCO_2E$ in 2001, a 38.9% increase since 1990. Imported power emissions increased from 43.3 $MMTCO_2E$ in 1990 to 47.4 $MMTCO_2E$ in 2001, a 9.4% increase since 1990. Taken together, electricity emissions increased from 84.8 $MMTCO_2E$ in 1990 to 105 $MMTCO_2E$ in 2001, a 23.8% increase. These emissions include the release of sulfur hexafluoride (SF6) from transmission and distribution switchyard gear.
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[43] CPUC Ruling R.01-08-028 issued August 31, 2004, and CPUC Ruling R.04-04-003 for the March 7-9 workshops.
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