APPENDIX W

CAT and CARB GHG Strategy and Early Action Measures Reports

California Environmental Protection Agency

CLIMATE ACTION TEAM PROPOSED EARLY ACTIONS TO MITIGATE CLIMATE CHANGE IN CALIFORNIA

Draft for Public Review

CALIFORNIA

Climate

ACTION TEAM

INTRODUCTION: Climate Action Team Early Actions

The California Air Resources Board, under the California Global Warming Solutions Act of 2006 (Section 38560.5 of the Health and Safety Code) has the primary responsibility for reducing Greenhouse Gas Emissions. However, actions by many other state agencies are essential to meeting the emission reduction requirements of the Act. A substantial portion of the GHG emission reductions proposed in the 2006 Climate Action Team Report to reach 1990 emission levels by 2020 are strategies to be taken by agencies other than CARB.

By July 1, 2007 the statute calls for ARB to submit a list of early action measures that can be adopted and implemented by January 1, 2010. This report supplements the ARB report on early actions and is a status report on early actions being taken by the participating departments and agencies of the Climate Action Team.

The Climate Action Team (CAT) was created and is chaired by the Secretary of the California Environmental Protection Agency. Members include: the California Environmental Protection Agency (Cal/EPA), Business Transportation and Housing Agency (BTH), California Department of Food and Agriculture (CDFA), State and Consumer Services Agency (SCSA), Air Resources Board, California Department of Forestry and Fire Protection (CalFire), California Energy Commission (CEC), Department of General Services (DGS), Department of Water Resources (DWR), Integrated Waste Management Board (IWMB) and the California Public Utilities Commission (CPUC).

All members of the CAT contributed to this report which describes ongoing and expected efforts to reduce and mitigate GHG emissions in the near term. In describing the items listed under Group 1 as "Discrete Early Actions", the CAT members considered the definition provided by the Global Warming Solutions Act of 2006. It should be noted however that only the ARB has a legal responsibility to enumerate early actions under this statute. The Group 1 items in this report are those where there is a reasonable belief that regulations would be in place by January 1, 2010. It should be noted that the Group 1 strategies of all CAT members except for ARB account for GHG emissions reductions of over 17 million metric tons of CO_2 equivalent by 2020 (emissions reductions for several strategies have not yet been determined).

Action items included in Group 2 are those for which a regulatory deadline of January 1, 2010 is not appropriate or achievable but where there are ongoing or expected efforts focused on GHG emissions reductions. Group 2 is titled: "Additional Early Action Measures to Reduce GHGs Already Underway or to be Initiated by CAT Members in 2007-2009". These items include many of the strategies outlined in the 2006 Climate Action Team report, additional strategies that have been formulated in the intervening months or strategies proposed by stakeholders in the development of the CARB's early action measures. The Group 2 strategies of all CAT members except for ARB account

for GHG emissions reductions of over 60 million metric tons of CO_2 equivalent by 2020 (emissions reductions for several strategies have not yet been determined).

There are several other items which comprise actions which, although not directly focused on GHG emission reductions, have significant co-benefits for climate change mitigation efforts. These Group 3 actions are described as: "Regulations for 2007-2009 Adoption with Potential GHG Reductions or Other Climate Co-Benefits".

GROUP 1: Discrete Early Action Measures:

In describing the items listed under Group 1 as "Discrete Early Actions", the CAT members have used the definition provided by the Global Warming Solutions Act of 2006. It should be noted however that only the ARB has a legal responsibility to enumerate early actions under this statute. The Group 1 items in this report are those where there is a reasonable belief that regulations would be in place by January 1, 2010 (although there is no requirement in the law that any CAT member other than the ARB adhere to this deadline).

Business, Transportation, and Housing

- Cement Manufacture: Caltrans has changed its cement specification to allow 2.5 percent interground limestone concrete mix in cement use. This will result in a GHG emissions reduction of <1 million metric tons of CO_2 equivalent ($MMTCO_2E$) per year, based on 2004 production levels. Investigations are being conducted to examine the use of concrete blends containing 5 percent interground limestone.

California Department of Food & Agriculture

- Hydrogen Fuel Standards: The CDFA Division of Measurement Standards, under SB 76 of 2005, is developing hydrogen fuel standards for use in combustion systems and fuel cells. These standards are to be completed by 2008.

Air Resources Board

- (for details see ARB report: "Early Actions for Climate Change Mitigation in California")

California Energy Commission

- SB1368 (Regulation of greenhouse gases from load serving entities): In response to SB 1368, the CEC and the CPUC have been collaborating on utility procurement practices to address ways to transition away from carbon-intensive electricity sources. The CPUC adopted its regulations for the investor-owned utilities in January, 2007. The CEC intends to adopt regulations by June, 2007

requiring municipal utilities to transition away from carbon-intensive generation. These strategies implemented by the CEC and CPUC under SB1368 are expected to result in a combined GHG emissions reduction of over 15 $MMTCO_2E$ by 2020.

- Energy Efficient Building Standards: The CEC has been actively engaged in its "Building Energy Efficiency Standards in Progress" effort. The next phase of the project is to conduct public workshops on mark-ups of the "Express Terms" of the Standards, plus the supporting technical rules for software developers and the extensive technical data appendices that are required for showing compliance. The CEC intends to adopt these regulations in 2008. The GHG emissions reductions from this strategy are still to be determined. (The GHG emissions reductions associated with ongoing energy efficient building standards are expected to be 3 $MMTCO_2E$ by 2020.)
- Energy Efficient Appliance Standards: (Specific mention of lighting standards). CEC has the authority to regulate light bulb efficiency. The California Energy Commission is considering options for light bulb standards and anticipates adopting standards by January 1, 2010. The GHG emissions reductions from this strategy are still to be determined. (The GHG emissions reductions associated with other ongoing energy efficient appliance standards are expected to be 7 $MMTCO_2E$ by 2020.)
- Tire Efficiency: Implementation of California's tire efficiency law, Chapter 8.7 Division 15 of the Public Resources Code. The CEC, in consultation with the California Integrated Waste Management Board, will implement a replacement tire efficiency program of statewide applicability for replacement tires for passenger cars and light-duty trucks, to ensure that replacement tires sold in the state are at least as energy efficient, on average, as the tires sold in the state as original equipment on these vehicles. This strategy is expected to result in GHG emissions reduction of <1 $MMTCO_2E$ by 2020.
- New Solar Homes Partnership: In late 2006, the Energy Commission approved implementation rules for new residential solar installations. Effective in January 2007, approved solar systems will receive incentive funds based on system performance above building standards. This program will result in 400 MW of new, emissions-free generating capacity. The GHG emissions reductions from this strategy are still to be determined.

Department of Water Resources

- Water Use Efficiency: DWR will adopt standards for projects and programs funded through water bonds that would require consideration of water use efficiency in construction and operation. This strategy is expected to result in GHG emissions reduction of 1 MMTCO2E by 2020.
- State Water Project: DWR will evaluate the State Water Project (SWP) energy resources and include feasible and cost-effective renewable energy in the SWP's portfolio. As DWR completes a GHG assessment through membership with the Climate Action Registry, and investigations of cleaner energy sources to replace reliance on the Reid Gardner power plant (see below), the SWP will be able to

significantly reduce its GHG emissions. The GHG emissions reductions from this strategy are still to be determined.

- Cleaner Energy for Water Supply: In renewing energy supply contracts for the State Water Project, it is DWR's goal not to renew contracts supplied by conventional coal power generation. One specific example of this is DWR's ownership interest in the Reid Gardner power plant near Las Vegas, Nevada. Upon expiration of the contract in 2013, DWR will not extend its ownership interest in the Reid Gardner plant. The GHG emissions reductions from this action are still to be determined.

Integrated Waste Management Board

- Landfill Gas Recovery: The IWMB is jointly developing a regulatory measure that will be implemented by ARB and will require landfill gas recovery systems on the few dozen small to medium landfills that do not have them and upgrade the requirements at landfills with existing systems to represent best capture and destruction efficiencies. Going forward this will be considered as an ARB measure. The GHG emissions reductions from these strategies are expected to be 2-4 $MMTCO_2E$ by 2020.

California Public Utilities Commission

- SB1368 (Regulation of greenhouse gases from load serving entities): Please see this heading under CEC.
- IOU Energy Efficiency Programs: Planning has begun for 2009-2011 energy efficiency portfolios. In 2007, CPUC is evaluating the design of a risk/reward incentive mechanism for utilities to encourage additional investment in energy efficiency. Also in 2007, CPUC will develop new aggressive targets for efficiency between 2007 and 2020. In developing 2009-2011 portfolios, CPUC will evaluate new technologies and new measures that could deliver additional energy savings through these programs; new ideas include new options for encouraging compact fluorescent lighting in residential and commercial buildings. This strategy is expected to result in GHG emissions reduction of 4 $MMTCO_2E$ by 2020.

GROUP 2: Additional Early Action Measures To Reduce GHGs Already Underway or to be Initiated by CAT members in 2007-2009

Action items included in Group 2 are those for which a regulatory deadline of January 1, 2010 is not appropriate or achievable but where there are ongoing or expected efforts focused on GHG emissions reductions. Group 2 is titled: "Additional Early Action Measures To Reduce GHGs Already Underway or to be Initiated by CAT members in 2007-2009". These items include many of the strategies outline in the 2006 Climate

Action Team report as well as additional strategies that have been formulated in the intervening months.

Business, Transportation, and Housing (BTH)

- Transportation Efficiency (2006 CAT Report strategy): The Department of Transportation (Caltrans) will reduce congestion, improve travel time in congested corridors, and promote coordinated, integrated land use-transportation decisions through desired regional growth plans and smart land use measures. Caltrans will implement the Strategic Growth plan and infrastructure investment Plan, Regional Blueprint Planning, and the Caltrans Climate Action Program. This strategy is expected to result in GHG emissions reduction of 9 $MMTCO_2E$ by 2020.
- Smart Land Use and Intelligent Transportation (2006 CAT Report strategy): Caltrans will integrate consideration of GHG reduction measures and energy efficiency factors into planning, project development, etc. Caltrans is developing a Director's Policy on Climate Change and GHG emissions analysis will be integrated into transportation plans and projects. Caltrans will work with the California Transportation Commission (CTC) to include GHG emissions criteria into regional transportation planning guidelines. BTH intends to join the California Climate Action Registry which will complement efforts to determine GHG emissions from transportation. This strategy is expected to result in GHG emissions reduction of approximately 10 $MMTCO_2E$ by 2020.

California Department of Food & Agriculture

- Conservation Tillage and Enteric Fermentation (2006 CAT Report strategy): With funding from ARB, CDFA will develop and implement actions to quantify and reduce enteric fermentation emissions from livestock and sequester soil carbon using cover crops and conservation tillage. This strategy is expected to result in GHG emissions reduction of 1 $MMTCO_2E$ by 2020.
- Dairy Digesters (2006 CAT Report strategy): CDFA is participating in the CCAR process to develop a dairy digester protocol to document GHG emission reductions from these facilities. The GHG emissions reductions from this action are still to be determined.

State and Consumer Service Agency (Department of General Services)

Green Building Initiative and Other Related Efforts (2006 CAT Report strategy)

- Retro-commissioning: There are 27 retro-commissioning projects underway or completed that will yield an 8 percent to 10 percent reduction in energy usage and corresponding GHG emission reductions for each building. At least 21 more buildings will be retro-commissioned during calendar year 2007. DGS is putting substantial efforts into retro-commissioning state buildings owned and operated by DGS and other departments including: Corrections and Rehabilitation, Motor

Vehicles, Transportation, Developmental Services, Veterans Affairs, Technology Services, Parks and Recreation, Health Services, Food and Agriculture, the California Highway Patrol and the California State Lottery. This work is ongoing and will yield substantial energy savings and GHG emissions reductions in the next 18 months.

- Development of a Tool for Automating Data Collection of Energy Usage and GHG Emissions: The Department of General Services and the California Energy Commission have been working with US EPA Energy Star™ and the California Investor Owned Utilities to determine how to automate the uploading of utility generated energy usage data into the Energy Star™ Portfolio Manager benchmarking database. Most of the 1600 state owned buildings waiting benchmarking will have their energy usage data uploaded in this manner. Additional coordination with the Climate Action Registry will determine how to convert this information to GHG emission reductions
- Solar Generation: Within the last year, the State has implemented over 3 megawatts of clean solar power generation, with another 1 megawatt coming on line this year. The second round of solar generation implementation is anticipated to total 10 additional megawatts and may include UC/CSU campuses and state fairgrounds.
- Energy Efficiency Benchmarking: The DGS has benchmarked its 52 state-owned buildings for energy efficiency and is leading an effort to support other state agencies in benchmarking the remainder of 1,600 state-owned facilities by June 1, 2007.
- Desktop Power Management: The DGS has implemented server-based desktop power management software that will reduce electricity use by desktop computers by up to 40 percent. The California Environmental Protection Agency, Department of Motor Vehicles and Department of Transportation are implementing the software as well.
- LEED Certification: The State now has 9 buildings that are certified by the Leadership in Energy and Environmental Design (LEED) program, totaling more than 2 million square feet. LEED buildings have lower energy usage and lower GHG emissions. LEED certification is being pursued on 85 additional new and renovated buildings totaling over 5.4 million square feet, as well as eight existing buildings totaling over 2.6 million square feet. Additionally, all smaller buildings less than 50,000 square feet in size are being designed and constructed to meet LEED standards.
- Hydrogen Fuel Cells: Initiatives are underway to incorporate clean hydrogen fuel cells in stationary applications at State facilities and as back-up generation for emergency services radios.
- High Performance Schools: The State has adopted new guidelines for energy and resource efficient schools and is currently processing the first applications for up to $100 million in bond money for construction of sustainable, high performance schools.
- Contracting for Environmentally Preferable Products: New State contracts have been or are being created for more energy and resource efficient IT goods, copiers, low mercury florescent lamps, the California Gold Carpet Standard, and

office furniture all of which lower GHG emissions due to environmentally preferable design and manufacturing standards

These combined strategies are expected to result in GHG emissions reduction of 2 $MMTCO_2E$ by 2020.

Transportation Policy Implementation (2006 CAT Report strategy)

- Ultra Low Emission Vehicles: A new long-term commercial rental contract was released in March 2007 requiring a minimum Ultra Low Emission Vehicle (ULEV) standard for gasoline vehicles and require alternative fuel and hybrid-electric vehicles.
- Flex Fuel Vehicles: The DGS fleet purchased 1,134 flex-fuel, E-85 vehicles last year. DGS will replace 800 additional vehicles this year with new, more efficient vehicles, reducing GHG emissions by 370 metric tons of CO2, .85 metric tons of Methane, and 1.14 metric tons of Nitrous Oxide. DGS has committed to purchasing at least 50 percent of new vehicles as flex-fuel vehicles by 2010.
- Climate Registry: The Department of General Services joined the Climate Registry on February 9, 2007. This includes the benchmarking and reduction of GHG emissions for 55 state-owned buildings totaling 15 million square feet, 100 leased buildings totaling 1 million square feet, and over 7,000 light duty vehicles.

The GHG emissions reductions from these combined strategies are still to be determined.

Air Resources Board

- (for details see ARB report: "Early Actions for Climate Change Mitigation in California")

California Department of Forestry & Fire Protection

- Urban Forestry (2006 CAT Report Strategy): CalFire is working with the U.S. Forest Service's Center for Urban Forestry Research (CUFR), CCAR and others to develop a new forestry protocol for urban forestry. An initial draft protocol outline for measuring Urban Forestry emission reductions has been completed and is being reviewed by the task group assigned. Partnering with local government and private sector entities the objective of this strategy is to expand efforts with the end result of five million additional trees in urban areas by 2020. This strategy is expected to result in GHG emissions reduction of 1 $MMTCO_2E$ by 2020.
- Fuels Management/Biomass (2006 CAT Report Strategy): CalFire is working with the Tahoe Conservancy and the California Conservation Corps on the Lake Tahoe program. Placer County is also participating to provide biomass from forest fuel treatments to existing biomass utilization facilities. This strategy is expected to result in GHG emissions reduction of 3 $MMTCO_2E$ by 2020.
- Forest Conservation and Forest Management (2006 CAT Report Strategy): CalFire is participating with the Wildlife Conservation Board and stakeholders in

discussions that include looking at opportunities for carbon sequestration in the Prop 84 forest land conservation program to conserve and additional 75,000 acres of forest landscape by 2010. CalFire is working with the U.S. Forest Service on the Lake Tahoe program, and has met to discuss other opportunities for contributing to CAT forestry goals, particularly those related to fuels management and reforestation. These combined strategies are expected to result in GHG emissions reduction of 10 $MMTCO_2E$ by 2020.

- Afforestation/Reforestration (2006 CAT Report Strategy): CalFire has met several times with the ARB to discuss carbon protocols for reforestation that have been approved by CCAR. PG&E has an accepted voluntary tariff to subsidize tree planting. Southern California Edison has contacted CalFire to discuss carbon sequestration opportunities through voluntary forest projects. This strategy is expected to result in GHG emissions reduction of 2 $MMTCO_2E$ by 2020.
- WESTCARB Activities: CalFire is working with West Coast Regional Carbon Sequestration Partnership (WESTCARB) to evaluate fuels management and biomass use. CalFire continues to work with WESTCARB to evaluate terrestrial carbon sequestration opportunities by looking at reforestation and forest conservation management at its LaTour State Forest.

California Energy Commission

- Municipal Utilities Electricity Sector Carbon Policy (2006 CAT Report Strategy): The CPUC and the CEC have initiated a joint proceeding to provide a set of GHG emissions cap policy guidelines to the ARB for California's electricity sector as a whole (IOUs and POUs). The ARB is actively involved in this proceeding. The GHG emissions reductions from this strategy are included in the numbers associated with the efforts on SB1368, enumerated in Group 1.
- Appliance Energy Efficiency Standards in Place (2006 CAT Report Strategy): The CEC will be updating its appliance regulations to re-institute appliance and equipment efficiency certification and data collection after successfully defending California's right to require such data in federal appellate courts. This strategy is expected to result in GHG emissions reduction of 7 $MMTCO_2E$ by 2020.
- Alternative Fuels: Non-Petroleum Fuels (2006 CAT Report Strategy): The CEC is will complete, by June 30, 2007, a state plan to increase the use of alternative fuels for transportation. The plan will also evaluate alternative fuels on a full fuel-cycle assessment, set goals for 2012, 2017, and 2022 for increased alternative fuel use, and recommend policies to ensure goals are attained. The GHG emissions reductions from this strategy are still to be determined.
- Land Use/Smart Growth. CEC will be leading the Land Use/Smart Growth subgroup of the CAT. This group will investigate potential strategies related to smart growth that will be included in the 2008 CAT report. This will include examining programs such as the California Regional Blueprint Program, the Local Development / Intergovernmental Review process and transportation planning grants. The GHG emissions reductions from this strategy are still to be

determined but some portion of the reduction will fall under the BTH Smart Land use strategy enumerated above.

Department of Water Resources

- Water Delivery Planning: DWR has begun a five year analysis and modeling effort to determine the impacts of climate change on California's water systems. The GHG emissions reductions from this strategy are still to be determined.
- Water-Energy Nexus: DWR will consider options that would compel local agencies to incorporate climate change adaptation into regional water planning. Such options would ensure that local agencies consider water-energy nexus in Integrated Regional Water Management Plans and construction and operation fo facilities. DWR expects to include consideration of GHG emissions as a part of the application criteria for future water management plan Proposal Solicitation Processes. The GHG emissions reductions from this strategy are still to be determined.

Integrated Waste Management Board

- Zero Waste/High Recycling Strategy (2006 CAT Report strategy): Building off of the successful 50% Statewide Recycling Goal, efforts to move toward zero waste through high level recycling and waste prevention are projected to provide an additional 3 $MMTCO_2e$ by 2020. In January 2007, the IWMB approved a Scope of Work for a Lifecycle Assessment and Economic Analysis to help identify which materials to focus diversion efforts to achieve both maximum diversion and GHG reduction at the lowest possible cost. This strategy is expected to result in GHG emissions reduction of 5 $MMTCO_2E$ by 2020.
- Landfill Methane Capture Strategy (2006 CAT Report strategy): The IWMB is analyzing increasing the efficiency of existing landfill methane systems and examing the implementation of earlier placement of final cover. The IWMB is collaborating with the CEC on a study to obtain field data and improve the estimates for the proposed strategy. The IWMB is conducting an emissions inventory that will be crucial in quantifying the GHG emissions reductions associated with this strategy. The GHG emissions reductions from this strategy are included in the Landfill Gas Recovery item enumerated above in Group 1.
- Organic Materials Management: IWMB will develop a market incentive program to encourage the organic materials management industry to increase organics diversion to the agricultural industry. The GHG emissions reductions from this strategy are still to be determined.
- Landfill Gas Energy: IWMB is providing funding for demonstration grants for Landfill Gas to Energy & LNG/biofuels projects. The GHG emissions reductions from this strategy are still to be determined.
- Target Recycling: IWMB is focusing on industry/public sectors with high GHG components to implement targeted commodity recycling programs. The GHG emissions reductions from this strategy are still to be determined.

California Public Utilities Commission

- Accelerated Renewable Portfolio Standard (RPS) (2006 CAT Report Strategy): In 2006, the PUC approved the IOUs' procurement and solicitation proposals, streamlined the market price benchmark calculation used to evaluate renewable projects, and adopted RPS participation criteria for non-utility load-serving entities. In 2007, the PUC will also examine RPS long-term planning as part of utility overall procurement planning, review and act on utility RPS contracts submitted for approval, and address the use of tradable renewable energy credits for RPS compliance. The GHG emissions reductions from this strategy are included in the efforts related to SB 1368 item enumerated above in Group 1.
- California Solar Initiative. (2006 CAT Report Strategy): In late 2006, the PUC finalized implementation rules. The Initiative is designed to deliver approximately 2,000 megawatts of clean, emissions-free energy to the California grid by 2016. Beginning in January 2007, solar systems will receive incentive funds based on system performance. This strategy is expected to result in GHG emissions reduction of 1 $MMTCO_2E$ by 2020.
- Transmission Infrastructure:: The PUC will consider approval of over $3 billion in utility transmission investment in 2007 that will help facilitate renewable goals. The Tehachapi Renewable Transmission Project is currently under review. The GHG emissions reductions from this strategy are still to be determined.
- Water Energy Issues: CPUC required energy utilities to file pilot program proposals in January 2007 to partner with water utilities to deliver energy efficiency programs. The CPUC is evaluating proposals now. New programs should encourage additional energy savings through augmentation of water conservation measures. CPUC is also considering adoption of a methodology to evaluate level of additional energy savings generated through water conservation measures. The GHG emissions reductions from this strategy are still to be determined.
- Water Conservation: CPUC adopted a Water Action Plan in December 2005. The Plan includes a number of initiatives to encourage water conservation, including: rate design reform, conservation program investment by water utilities, and partnering with energy utilities. CPUC is also acting as participating agency in the DWR Water Plan development. The GHG emissions reductions from this strategy are still to be determined.
- Additional RPS: The CPUC is evaluating options for RPS requirements beyond 20% (including 33%). CPUC is evaluating the use of renewable energy certificates (RECs) for RPS compliance. CPUC is evaluating interaction between RPS program requirements and greenhouse gas emissions cap. This is a strategy that may be amenable to a market based approach. This strategy is expected to result in GHG emissions reduction of 11 $MMTCO_2E$ by 2020.

GROUP 3: Regulations for 2007-2009 Adoption With Potential GHG Reductions or

Other Climate Co-Benefits

There are several other action items noted which comprise actions which, although not directly focused on GHG emission reductions, have significant co-benefits for climate change mitigation efforts. These Group 3 actions are described as: "Regulations for 2007-2009 Adoption with Potential GHG Reductions or Other Climate Co-Benefits".

California Department of Food & Agriculture

- Salt Recapture: The Proposition 204, Drainage Water Source Reduction, Reuse and Salt Utilization Program, will improve water use efficiency, produce salt tolerant energy crops and recapture salt from drainage as a possible energy source. This program is funded through 2011 and is also pursuing options for growing salt tolerant bio-energy crops.
- Rice Straw: The Rice Straw Tax Credit Program provides $15 per ton of rice straw used off-field, reducing open-field burning of rice straw and methane emissions from rice straw decomposition in the field. This program is slated to sunset at the end of 2008 but CDFA is supporting current legislation to extend and expand this program.
- Dairy Management Practices: CDFA is leading the effort to develop a strategic plan for dairy research and demonstration for on-farm management practices that protect water quality and air quality. These practices go well beyond just digesters and will have ancillary global warming benefits.
- Photovoltaic Installation: The CDFA Division of Fairs and Expositions directly funds about 90% of the operating budget of the Joint Powers Authority (the Ca Construction Authority) that installs photovoltaic systems at county and agricultural fairgrounds. Over 5 MW has been installed in is operating to date, with another 3 MW that are in construction to be completed this summer.

California Energy Commission

- Report to the Legislature on AB1007 (Increased use of alternative fuels): The CEC will adopt policy recommendations based on the results of all technical analyses performed in response to AB 1007, and submit those adopted recommendations to the ARB for its use in fulfilling the requirements of AB 32. Expected reductions of GHG emissions resulting from these recommendations will be provided in the third quarter report for 2007.

California Department of Forestry & Fire Protection

- Wildfire Control Program: CalFire has developed a comprehensive program to control wildfires with the objective to control 95 percent of fires at ten acres or less through firefighting and forest management. It is estimated that every acre consumed by wildfire emits between 35 and 75 tons of carbon dioxide. Additional analysis will determine the full GHG emission reduction from this objective.

- Biomass Energy: CalFire promotes the use of wood to diversify energy supplies and is working with the CEC and CPUC on obtaining energy from forest residue (biomass). The Department is working toward the development of two small (1 megawatt) wood-to-electricity plants to demonstrate how renewable forest residue can generate energy.

Department of Water Resources

- Urban Best Management Practices: DWR will promote the implementation of Urban Best Management Practices that are locally cost-effective.

Integrated Waste Management Board

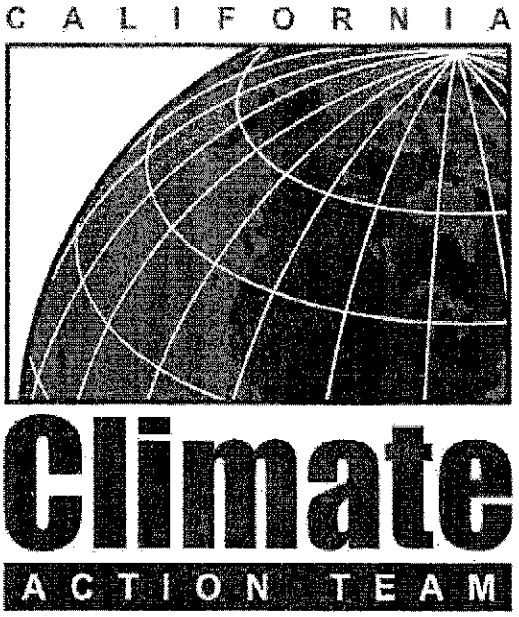
- Commercial Recycling: Focus local government efforts to require commercial recycling.
- Multi-Family Recycling: Focus local government efforts to require multi-family recycling.

California Public Utilities Commission

- Carbon Capture and Sequestration: Several proposals for power plants with integrated gasification combined cycle (IGCC) and/or carbon capture are expected in the next 18 months. If projects proposed to sell to California IOUs, CPUC would need to approve the contracts. This item falls under the auspices of SB1368. The project approval process will be handled on a case by case basis as it relates to reaching the GHG emissions goals of SB 1368.

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

Climate Action Team Report to Governor Schwarzenegger and the Legislature



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1 INTRODUCTION

California has a long history of environmental leadership. Motivated by the stunning natural beauty of our coastline, inland valleys, forests and mountains, as well as by the public health and environmental challenges brought on by increasing levels of pollution, California's citizens have repeatedly called for and supported measures to protect California's environmental heritage. Our political leadership and governmental institutions have responded with a variety of initiatives that restore, protect, and enhance the environment to ensure public health, environmental quality, and economic vitality. Often these California initiatives have provided a benchmark and template for further action both nationally and internationally.

This tradition of environmental leadership continues to this day. In 2005, recognizing that global warming will impose compelling and extraordinary impacts on California, the Governor signed Executive Order S-3-05 which established climate change emission reduction targets for the state and set in motion a process to ensure the targets are met. This Executive Order also recognized the importance of preparedness in that it directed the Secretary of the California Environmental Protection Agency (Cal/EPA) to lead an effort to evaluate the impacts of climate change on California and to examine adaptation measures that would best prepare the state to respond to the adverse consequences of climate change.

1.1 Organization of the Report

The report begins (Section 2) with an overview of the scientific evidence regarding climate change and its potential effects in California. Section 3 outlines the long history of previous actions that California has taken to understand and address the threat of climate change. Section 4 provides an overview of the scenario analysis that was done to evaluate the impacts of climate change on California, potential adaptation measures that can be taken to best respond to those impacts, and an economic assessment of the impacts. Section 5 presents the Climate Action Team recommendations regarding strategies the state should pursue to reduce climate change emissions.

Section 6 outlines market-based options for the state and includes a discussion of design choices that need to be further evaluated prior to adoption of a market-based program for the state. Section 7 discusses all possible emission reduction implementation options that were considered by the Climate Action Team, including market-based options. Section 8 covers a broad assessment of the economic implications of state actions to reduce climate change emissions. Section 9 looks specifically at potential impacts on minority and low-income communities. Section 10 contains the Climate Action Team's recommendations to the Governor and the Legislature.

2 CLIMATE CHANGE OVERVIEW

The Earth's climate has always evolved—the extremes of the 100,000-year ice-age cycles in both climate and climate change emissions over the last half million years are well documented. The period of the last 10,000 years has been warm and stable, and the last millennium, over which current societies have developed, has been one of the most stable climates observed. Yet, during the 20th century, we have observed a rapid change in the climate and climate change pollutants that is attributable to human activities.

These recent changes in climate change pollutants far exceed the extremes of the ice ages, and the global mean temperature is warming at a rate that cannot be explained by natural causes alone. Human activities are directly altering the chemical composition of the atmosphere through the buildup of climate change pollutants.

It is true that levels of natural climate change pollutants have fluctuated in the past. However, there are several reasons for attributing the rise in climate change pollutants to anthropogenic, rather than natural emissions. The first indicator comes from comparing the current increase with changes that have occurred in the past.

At the end of the last ice age, the concentration of CO_2 increased by around 100 ppm (parts per million) over about 8,000 years, or approximately 1.25 ppm per century. Since the start of the industrial revolution, the rate of increase has accelerated markedly. The rate of CO_2 accumulation currently stands at around 150 ppm/century—more than 200 times faster than the background rate for the past 15,000 years.

The heat-trapping property of climate change pollutants is undisputed. Although there is uncertainty about exactly how and when the Earth's climate will respond to increasing concentrations of climate change pollutants, combining observations with climate models indicates that detectable changes are underway. There most likely are and will continue to be changes beyond global mean warming, such as changes in regional temperature extremes, precipitation, soil moisture, and sea level, all of which could have significant adverse effects on many ecological systems, as well as on human health and the economy.

This section first presents the causes and projections for climate change, then discusses climate change pollutants. It includes a definition of global warming potentials and climate change pollutants. The section concludes with a brief discussion of abrupt climate change.

2.1 Climate Change Causes and Projections

Climate change is a shift in the "average weather" that a given region experiences. This is measured by changes in the features that we associate with weather, such as temperature, wind patterns, precipitation, and storms. Global climate change means change in the climate of the Earth as a whole. The Earth's natural climate has always been, and still is, constantly changing. The

climate change we are seeing today, however, differs from previous climate change in both its rate and its magnitude.

The temperature on Earth is regulated by a system commonly known as the "greenhouse effect." Naturally occurring climate change pollutants, primarily water vapor, CO_2, CH_4, and N_2O, absorb heat radiated from the Earth's surface. As the atmosphere warms, it in turn radiates heat back to the surface to create the greenhouse effect. The Earth's surface temperature would be about 34°C (61°F) colder than it is now if it were not for the natural heat trapping effect of climate change pollutants like CO_2, CH_4, N_2O, and water vapor.

Human activities are exerting a major and growing influence on some of the key factors that govern climate by changing the composition of the atmosphere and by modifying the land surface. The concentration of CO_2 in the atmosphere has risen about 30 percent since the late 1800s (National Assessment Synthesis Team [NAST], 2001). This increase has resulted from the burning of coal, oil, and natural gas, and the destruction of forests around the world to provide space for agriculture and other human activities.

Global projections of population growth and assumptions about energy use indicate that the CO_2 concentration will continue to rise, likely reaching between two and three times its late-19th-century level by 2100. Figure 2-1 shows the atmospheric CO_2 concentration from year 1000 to year 2000 from ice core data and from direct atmospheric measurements during the past few decades. Projections of CO_2 concentrations for the period 2000 to 2100 are based on model predictions.

Figure 2-1: Past and future CO_2 atmospheric concentrations. (Source: IPCC 2001 Synthesis report)

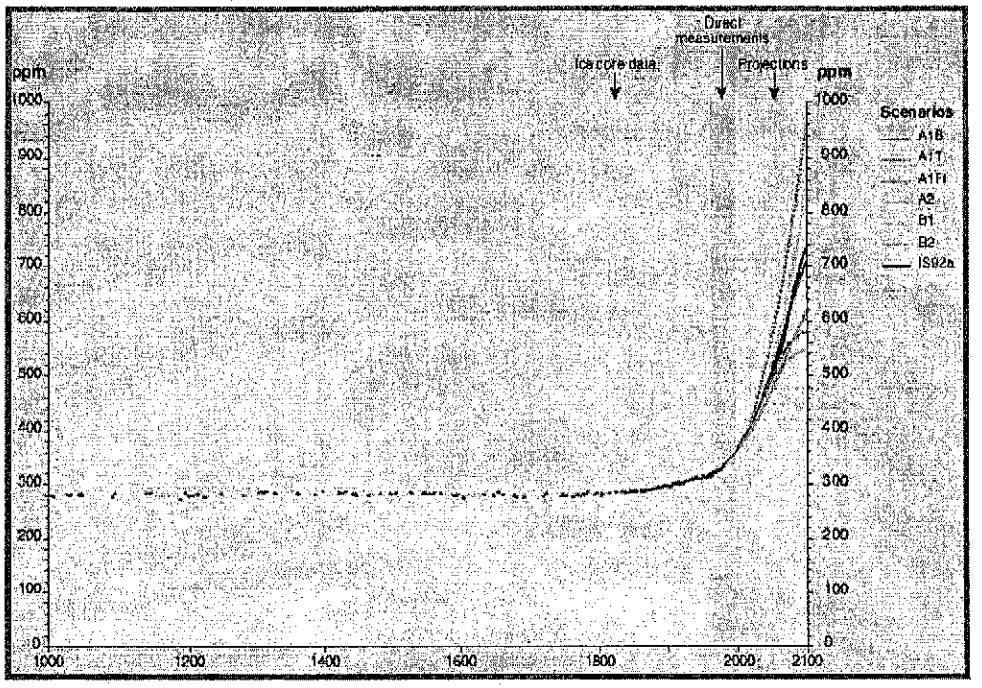
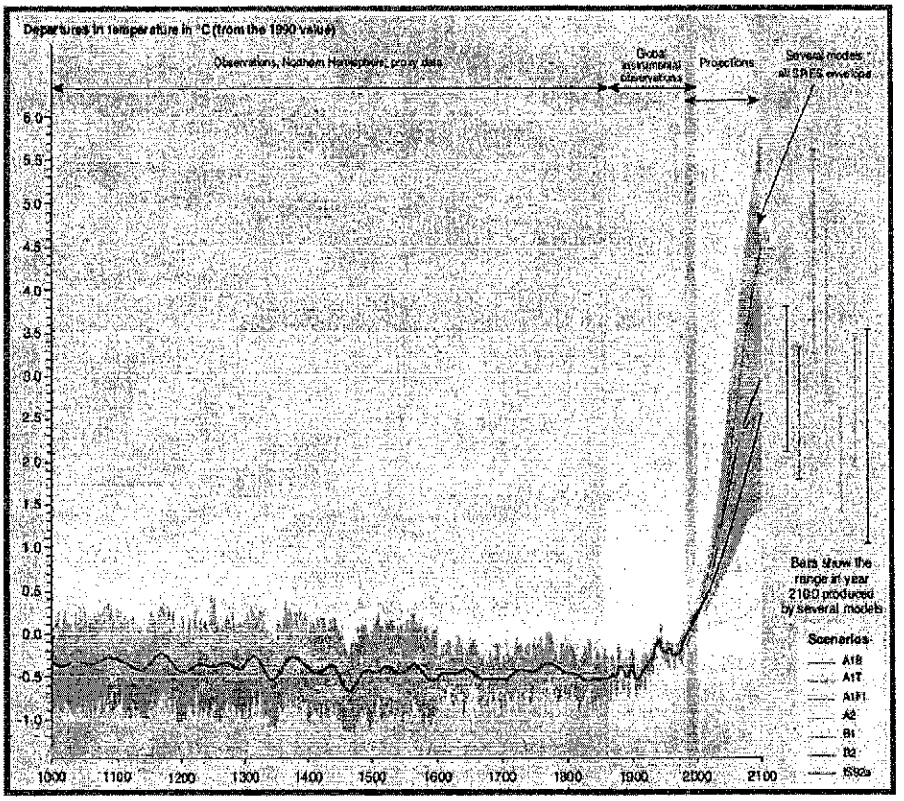


Figure 2-2 shows variations of the Earth's surface temperature for years 1000 to 2100. From year 1000 to year 1860 variations in average surface temperature of the Northern Hemisphere are reconstructed from proxy data (tree rings, corals, ice cores, and historical records). The line shows the 50-year average; the gray region, the 95 percent confidence limit in the annual data.

For the period 1860 to 2000, the figure shows variations in observations of globally and annually averaged surface temperature from the instrumental record; the line shows the decadal average. For 2000 to 2100, projections of globally averaged surface temperature are shown for several model scenarios using a global climate model.

The Third Assessment Report of the International Panel on Climate Change (IPCC, Synthesis Report, 2001) and the National Research Council of the National Academies (NRC, 2001) conclude that the global climate is changing at a rate unmatched in the past 1,000 years. The IPCC assessment cites new and stronger evidence that most of the global warming observed over the last 50 years is attributable to human activities and that anthropogenic climate change will persist for many centuries.

Figure 2-2. Variations of the Earth's surface temperature: years 1000 to 2100 (Source: IPCC 2001 Synthesis report)



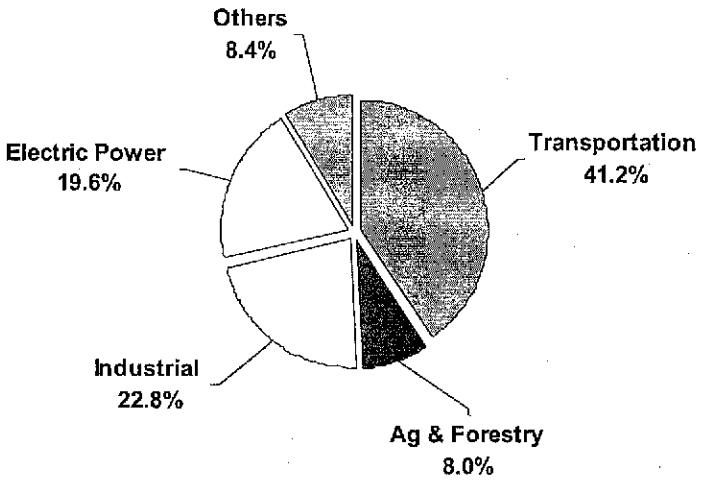
Many sources of data indicate that the Earth is warming faster than at any time in the previous 1,000 years. The global mean surface temperature has increased by 1.1° F since the 19th century (IPCC Synthesis report, 2001). The 10 warmest years of the last century all occurred within the last 15 years.

For example, 2002 and 2003 are tied as the second warmest years on record, according to a year-end review of climate data by the National Oceanic and Atmospheric Administration. Both the IPCC (2001) and the NAST (2001) reports project that warming in the 21st century will be significantly larger than in the 20th century. Scenarios examined in these assessments indicate that temperatures in the U.S. will rise by about 5° to 9°F (3° to 5°C) on average in the next 100 years.

2.2 Climate Change Emission Sources and Pollutants

As shown in Figure 2-3, fossil fuel consumption in the transportation sector was the single largest source of California's climate change emissions in 2002, with the industrial sector as the second-largest source. Electricity production, from both in-state and out-of-state sources, was the third-largest source. Agriculture, forestry, commercial, and residential activities comprised the balance of California's climate change emissions (CEC, 2005).

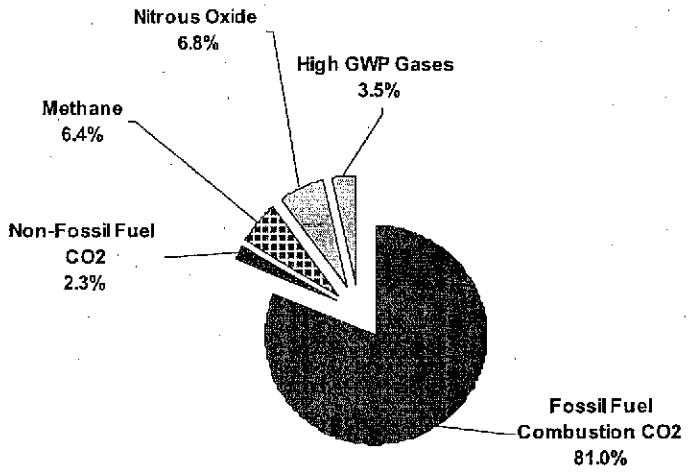
Figure 2-3: Sources of California's Climate Change Emissions, 2002 Expressed in Terms of CO2 Equivalence (adapted from CEC, 2005).



As previously indicated, human activities are altering the chemical composition of the Earth's atmosphere through the release and build-up of climate change emissions. However, climate change pollutants such as water vapor, CO2, CH4, N2O, and O3 can also be associated with natural sources. Conversely, several classes of halogenated substances that contain fluorine, chlorine, or bromine are also climate change emissions, but they are, for the most part, solely a product of industrial activities.

Figure 2-4 provides a distribution of California anthropogenic climate change pollutants by gas in 2002, expressed in terms of CO_2 equivalence. In addition, there are a number of other pollutants such as carbon monoxide, nitrogen oxides, and aerosols that have direct or indirect effects on terrestrial or solar radiation absorption. Individual climate change species are briefly discussed in the following section.

Figure 2-4: California Composition of Gross Climate Change Pollutants, 2002 Expressed in Terms of CO2 Equivalence (adapted from CEC, 2005).



Carbon Dioxide (CO_2)

In the atmosphere, carbon generally exists in its oxidized form, as CO_2. Increased CO_2 concentrations in the atmosphere have been primarily linked to increased combustion of fossil fuels. Fossil fuel combustion accounted for 98 percent of gross California CO_2 emissions. California's total CO_2 emissions from fossil fuel combustion in 2002 were 360 million metric tons CO_2, which accounts for approximately 7 percent of the U.S. emissions from this source. The transportation sector accounted for the largest portion of CO_2 emissions with gasoline consumption accounting for the greatest portion of emissions.

Methane (CH_4)

Methane accounted for approximately 6 percent of gross 2002 climate change emissions in California (CO_2 equivalent). Methane is produced during anaerobic decomposition of organic matter in biological systems. Decomposition occurring in landfills accounts for the majority of anthropogenic CH_4 emissions in California and in the United States as a whole. Agricultural processes such as enteric fermentation, manure management, and rice cultivation are also significant sources of CH_4 in California.

Nitrous Oxide (N_2O)

Nitrous oxide emissions accounted for nearly 7 percent of climate change emissions (CO_2 equivalent) in California in 2002. The primary sources of anthropogenic N_2O emissions in California are agricultural soil management and fossil fuel combustion in mobile sources.

Nitrous oxide is a product of the reaction that occurs between nitrogen and oxygen during fuel combustion. Both mobile and stationary combustion emit N_2O, and the quantity emitted varies according to the type of fuel, technology, and pollution control device used, as well as maintenance and operating practices. U.S.EPA estimates from 2003 suggest that in 2001, N_2O emissions from mobile combustion were 13 percent of U.S. N_2O emissions, while stationary combustion accounted for 3 percent.

Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), and Sulfur Hexafluoride (SF_6)

HFCs, PFCs and SF_6 accounted for about 3.5 percent of gross 2002 climate change emissions in California (CO_2 equivalent). HFCs are primarily used as substitutes for ozone-depleting substances (ODS) regulated under the Montreal Protocol. PFCs and SF_6 are generally emitted from various industrial processes including aluminum smelting, semiconductor manufacturing, electric power transmission and distribution, and magnesium casting. There is no aluminum or magnesium production in California; however, the rapid growth in the semiconductor industry leads to greater use of PFCs.

Other Radiatively Important Gases

In addition, there are a number of man-made pollutants, emitted primarily as by-products of combustion (both of fossil fuels and of biomass), that have indirect effects on terrestrial or solar radiation absorption by influencing the formation or destruction of other climate change emissions. These include carbon monoxide (CO), nitrogen oxides (NO_X), nonmethane volatile organic compounds (NMVOCs), and sulfur dioxide (SO_2).

These compounds, regulated in the U.S. and California pursuant to the Clean Air Act, are often referred to as "criteria pollutants." The criteria pollutants are reactive compounds, and they tend to remain in the atmosphere for a much shorter time (typically hours to months) than the previously discussed gases. As shown in Table 2-1, CO_2, N_2O, CH_4, and HFC-134a have atmospheric lifetimes ranging from a century to 10 years.

The sequence of reactions that removes CO, NO_X, and NMVOCs from the atmosphere, however, tends to promote the formation of tropospheric O_3 which is also a potent climate change emission. At present, there is large scientific uncertainty in estimating the radiative forcing effects of criteria pollutants.

Aerosols

Aerosols are extremely small particles or liquid droplets found in the atmosphere. Various categories of aerosols include naturally produced aerosols (e.g., soil dust, sea salt, biogenic aerosols, and volcanic aerosols), and anthropogenic aerosols (e.g., sulfates, ammonium nitrate, industrial dust, and carbonaceous aerosols including black carbon and organic carbon). Anthropogenic aerosols are derived directly or indirectly from transportation, coal combustion, cement manufacturing, waste incineration, and biomass burning.

Aerosols affect radiative forcing in both direct and indirect ways: directly by scattering and absorbing solar and thermal infrared radiation; and indirectly by altering the cloud properties and atmospheric heating rates that in turn modify the formation, precipitation efficiency, and radiative properties of clouds. The effect of aerosols on regional and global climate is complex: in general, sulfate aerosols enhance the reflection of sunlight and cool the Earth, while black carbon aerosols enhance the absorption of sunlight and warm the Earth.

Understanding the role of aerosols in climate change requires inclusion of realistic representations of aerosols and their radiative forcings in climate models. However, uncertainty in aerosol radiative forcing arises because neither emissions, atmospheric abundance, optical properties, nor indirect effects are well characterized. The IPCC (2001) and the NACIP (2002) have identified the total (direct and indirect) radiative forcing due to aerosols, and in particular light absorbing aerosols, as one of the most uncertain components of climate change models.

Water Vapor

It should be noted that just because water vapor is the most important contributor to the natural greenhouse effect does not mean that human-made climate change emissions are unimportant. However, human activities do not seem to be appreciably changing the atmospheric concentration of water vapor in any direct way on the global average.

A simple comparison of the relative greenhouse efficiencies of water vapor and CO_2 quickly becomes problematic because water vapor enters the climate system mostly as a "feedback" gas. Further, water stays in the atmosphere for a few days, while other climate change emissions linger for decades or centuries. The overall impact of water vapor with respect to global climate change is not well understood as it can lead to both warming (absorption of long-wave radiation from Earth) and cooling (cloud formation/reflection of solar radiation).

2.3 Global Warming Potentials

Radiative forcing is often defined as a net imbalance in energy flux in the atmosphere, and is expressed in watts per square meter (W/m^2), i.e. heat per area of the Earth's surface. Radiative forcing of the surface-troposphere system, resulting, for example, from a change in climate change pollutant concentrations, is the change in the balance between radiation coming into the atmosphere and radiation going out. A positive radiative forcing tends, on average, to warm the surface of the Earth, and negative forcing tends, on average, to cool the surface.

The impact of a climate change pollutant upon the atmosphere is related not only to radiative properties of the gas and its initial abundance, but also to the length of time the climate change pollutants remain in the atmosphere. Radiative properties control the absorption of radiation per kilogram of gas present at any instant, but the lifetime of the gas controls how long an emitted kilogram remains

in the atmosphere and hence its cumulative impact on the atmosphere's thermal budget.

Gases in the atmosphere can contribute to the greenhouse effect both directly and indirectly. Direct effects occur when the gas itself is a climate change pollutant. Indirect radiative forcing occurs when chemical transformations of the original gas produce other climate change pollutants, when a gas influences the atmospheric lifetimes of other gases, and/or when a gas affects atmospheric processes that alter the radiative balance of the Earth (e.g., cloud formation).

The concept of a Global Warming Potential (GWP) has been developed in parallel to the concept of ozone depletion potential developed under the Montreal Protocol to compare the ability of each climate change pollutant to trap heat in the atmosphere relative to another gas.

Carbon dioxide, as the primary anthropogenic climate change pollutant, has been chosen as the reference gas. GWP is defined as the ratio of the time-integrated radiative forcing from the release of 1 kilogram of a trace substance relative to that of 1 kg of CO_2 (IPCC 2001). While any length of integration can be selected, the 100-year GWPs are recommended by the IPCC and will be employed for policy-making and reporting purposes.

GWP values allow a comparison of the impacts of emission changes (reductions or increases) of different gases. According to the IPCC (2001), GWPs typically have an uncertainty of ±35 percent. In addition to communicating climate change pollutants in units of mass, we have also chosen to use GWPs to reflect their inventories in CO_2-equivalent terms because it effectively places all of the climate change pollutants on the same comparative scale.

Table 2-1 lists GWPs for CO_2, CH_4, N_2O, and HFC-134a for the 20-, 100-, and 500-year time horizons. It should be noted that when the lifetime of the species in question differs substantially from the response time of CO_2 (nominally about 150 years), then the GWP becomes very sensitive to the choice of time horizon. The GWP concept is only relevant for compounds that have sufficiently long lifetimes to become globally well-mixed. Therefore, short-lived gases and aerosols with varying atmospheric distributions and lifetimes pose a problem in the simple GWP framework.

Table 2-1. Numerical Estimates of Global Warming Potentials Compared with CO_2 (Kilograms of Gas Per Kilogram of CO_2 adapted from IPCC 2001).

Climate Change Pollutants	Lifetime (years)	Global Warming Potential		
		20 years	100 years	500 years
CO_2	~150	1	1	1
CH_4	12	62	23	7
N_2O	114	275	296	156
HFC-134a	14	3,300	1,300	400

2.4 Abrupt Climate Change

When most people think about climate change, they imagine gradual increases in temperature and only marginal changes in other climatic conditions, continuing indefinitely or even leveling off at some time in the future. It is assumed that human societies can adapt to gradual climate change. However, recent climate change research has uncovered a disturbing feature of the Earth's climate system: it is capable of sudden, violent shifts. This is a critically important realization.

Climate change will not necessarily be gradual, as assumed in most climate change projections, but may instead involve relatively sudden jumps between very different states. A mounting body of evidence suggests that continued increasing climate change emissions may push the oceans past a critical threshold and into a drastically different future.

Abrupt climate change is the subject of reports commissioned by the National Academy of Science (NRC 2002) and the U.S. Department of Defense (Schwartz and Randall, 2003). Thus, in addition to the gradual (albeit accelerated) climate changes projected by current climate models, Californians need to be aware of the possibility of much more sudden climate shifts.

2.5 Summary

There is little doubt that climate change is happening today, that human-caused increases in the atmospheric abundance of climate change pollutants are a large cause of that change, and the 21st century climate change will be greater than that we have experienced in the 20th century. Much of that projected climate change is as yet unrealized warming from the climate change pollutants in the atmosphere today. Nevertheless, actions taken to reduce climate change emissions today can reduce the magnitude and rate of climate change this century.

There is no scientific uncertainty about the fact that human activities have increased the atmospheric abundance of climate change pollutants. The uncertainties center on predicting exactly what the climate changes will be in various local areas of the Earth and what the effects of clouds will be in determining the rate at which the mean temperature will increase.

There are also uncertainties associated with characterizing the timing and magnitude of other consequences of a warmer planet: sea level rise, spread of certain diseases out of their usual geographic range, the effect on agricultural production, water supply, sustainability of ecosystems, increased strength and frequency of storms, extreme heat events, air pollution episodes, and the impact of these effects on human health and the economy.

3 CALIFORNIA ACTIONS TO ADDRESS CLIMATE CHANGE

The State of California has traditionally been a pioneer in efforts to reduce air pollution, dating back to 1963 when the California New Motor Vehicle Pollution Control Board adopted the nation's first motor vehicle emission standards. California likewise has a long history of actions undertaken in response to the threat posed by climate change.

Beginning in 1988, legislation was enacted that directed the California Energy Commission, in consultation with the Air Resources Board and other agencies, to study the implications of global warming on California's environment, economy, and water supply.

This effort continued with Governor Schwarzenegger's June 2005 Executive Order creating climate change emission reduction targets for the state. The Order requested a report that specifically addresses the impacts of climate change on the state and includes adaptation measures the state can implement to best respond. California state government has consistently recognized the necessity for state action on climate change to protect California's interests.

3.1 Summary of California Activities Underway

California has a long history of environmental leadership and has continued that leadership in the efforts to reduce climate change emissions. Table 3-1 indicates those strategies that are underway in California.

Section 2.1 asserted that the transportation sector is the largest source of emissions in California. The motor vehicle standards of the Air Resources Board (ARB) provide significant emission reductions in this sector in the 2020 time frame. Two other key strategies in the state are the Renewable Portfolio Standard and the Energy Efficiency Programs. These strategies have been instrumental in California's efforts to provide energy security for the state and have also provided significant climate change emission reductions. The state's Energy Efficiency Programs have resulted in a stable per-capita energy use in the state even while California's economy has soared.

It is important to note that these strategies, though underway, will require continuing efforts by the responsible agencies as well as strong leadership to ensure they remain in place. Governor Schwarzenegger has pledged his support of the ARB's motor vehicle regulations and the acceleration of the Renewable Portfolio Standard. The Governor's support and the continuing support of the Legislature will be essential as the state implements these strategies successfully.

Table 3-1 Emission Reduction Strategies Underway in California

Agency Responsible / Strategies	Climate Change Emission Reductions (Million Tons CO_2 Equivalent)	
	2010	2020
Air Resources Board		
Vehicle Climate Change Standards	1	30
Diesel Anti-idling	1	1.2
Public Utilities Commission		
Accelerated Renewable Portfolio Std to 33% by 2020 (including load-serving entities [LSE])	5	11
California Solar Initiative	0.4	3
Investor Owned Utility Energy Efficiency Programs(including LSEs)	4	8.8
Integrated Waste Management Board		
Achieve 50% Statewide Recycling Goal	3	3
Energy Commission		
Building Energy Efficiency Standards	1	2
Appliance Energy Efficiency Standards	3	5
Fuel-efficient Replacement Tires & Inflation Programs	1.5	1.5
State and Consumer Services and Cal/EPA		
Green Buildings Initiative	0.5	1.8
Air Resources Board andCal/EPA		
Hydrogen Highway	Included*	
Total Potential Emission Reductions	22	68

* The benefits of the Hydrogen Highway have been captured in other programs such as the motor vehicle regulations and green buildings initiative.

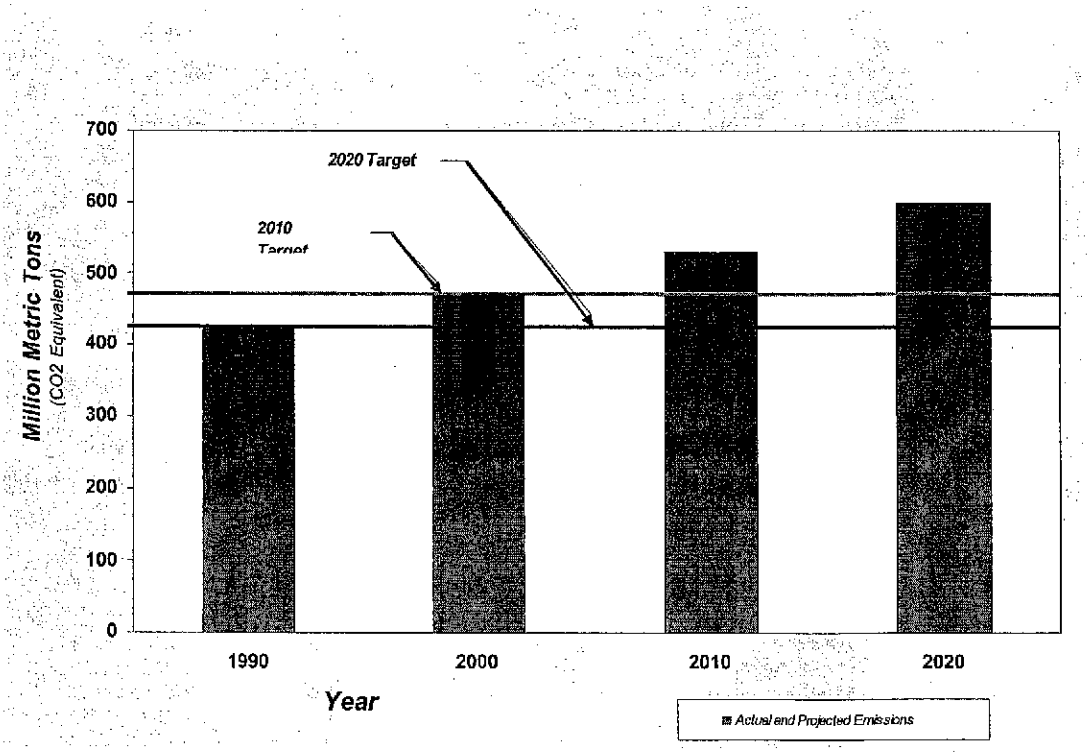
3.2 Executive Order S-3-05

On June 1, 2005, Governor Schwarzenegger signed Executive Order S-3-05 (EO) during the United Nations World Environment Day event in San Francisco. The EO established climate change emission reduction targets for California and was heralded in the nation and around the world as a landmark event signaling that California is taking a leadership role in the United States in addressing the issue of climate change. The Governor said in his remarks preceding the signing of the EO, "...the debate is over. We know the science. We see the threat. And we know the time for action is now."

This quote appeared in the media throughout the world. Internationally the developed nations agree that the issue of climate change must be addressed. It is no exaggeration to say that the world had been waiting for a strong signal that the state which has led a nation on so many public health and environmental issues would continue that leadership in addressing climate change.

The targets established by the EO are shown in Figure 3-1. The 2010 and 2020 targets are based on an ambitious estimate of how much the state can reduce emissions with strong top-down leadership and a coordinated effort amongst various state agencies. Cal/EPA worked with the ARB, CEC and Tellus, a technical contractor, to develop the targets in the 2010 and 2020 timeframes. The 2050 target is based on emission reductions the science indicates will be necessary from all developed nations to ensure protection of the planet in the 100-year time frame.

Figure 3-1. California's Climate Change Emissions and Targets



In addition to setting targets for the state, the EO placed Cal/EPA in the lead to coordinate efforts to meet these targets among the following agencies: Business, Transportation and Housing Agency (BT&H), Department of Food and Agriculture (CDFA), Energy Commission (CEC), Resources Agency, and Public Utilities Commission (PUC). A coordinated effort is essential to success in climate change emission reduction strategies. Programmatic, incentive-based, or market-based strategies will require the efforts of agencies whose purview stretches across all sectors of the economy, from transportation to energy to agriculture to waste management.

Finally, the EO directed Cal/EPA to lead an evaluation of the impacts of climate change in California, mitigation strategies to reduce emissions, and adaptation measures that can be taken by the state to best respond to the adverse impacts of climate change. This effort is built upon the work of the CEC under the Public Interest Energy Research plan.

The CEC is currently about half way through a five-year plan that responds to many of the same directives included in the EO. Cal/EPA worked with CEC and other agencies to incorporate a broader scope and provide the Governor and Legislature with a mid-point estimate of what California can expect as a result of climate change and how the state can best respond to the adverse consequences.

3.3 Climate Action Team

In response to the EO, the Secretary of Cal/EPA created the Climate Action Team (CAT). The CAT includes knowledgeable representatives from Air Resources Board; Business, Transportation, & Housing; Department of Food and Agriculture; Energy Commission; California Integrated Waste Management Board (CIWMB), Resources Agency, and Public Utilities Commission (PUC). The CAT has prepared a recommended list of strategies for the state to pursue to reduce climate change emissions in the state. This list in described in detail in Section 0. The CAT has also contributed to and reviewed the scenario analysis described in Section 4.

There are two subgroups of the CAT, the market-based options subgroup and the scenario analysis subgroup. Both subgroups are made up of representatives appointed by the CAT and experts as appropriate. The market-based options subgroup was created by the Secretary of Cal/EPA because of the cross-cutting nature of a market-based program for the state. The scenario analysis subgroup addressed the directive in the EO to evaluate the impacts of climate change on the state and adaptation measures that can be taken by the state to best prepare for the adverse consequences of climate change.

4 SCENARIO ANALYSIS

In California and throughout western North America, signs of a changing climate are evident. Over the last 50 years, observations reveal trends toward warmer

winter and spring temperatures, a smaller fraction of precipitation falling as snow instead of rain, a decrease in the amount of spring snow accumulation in lower and middle elevation mountain zones, an advance in snowmelt of 5 to 30 days earlier in the spring, and a similar shift in the timing of spring flower blooms.

These changes are consistent with much broader scale global measures. From 1900 through 1970, the average global temperature rose by about 0.1°F (0.06 °C) per decade, but since then the rate of warming has increased markedly, to about 0.5°F (0.3°C) per decade. During the last 1,000 years, available observations suggest that the 10 warmest years all occurred after 1990. Much of the warming during the last four decades is attributable to the increasing atmospheric concentrations of climate change emissions due to human activities.[1]

It is now evident that even if actions could be taken to immediately curtail climate change emissions, the potency of emissions that have already built up, their long atmospheric lifetimes, and the inertia of the Earth's climate system could produce as much as 1.1°F (0.6°C) of additional warming.[2] As a result, some impacts from climate change are now unavoidable.

For example, studies show that some unique ecosystems, such as coral reefs, and those in artic and alpine regions, have been or will be severely damaged or lost as a result of climate changes already underway.[3] However, depending on the amount of climate change emissions emitted over the next few decades, an opportunity remains to avoid the most severe impacts that are expected with greater rises in temperature.

The scientific community is striving to determine how vulnerable human society and the earth systems on which it depends are to future climate changes. Although no consensus has been reached as to what constitutes "dangerous" climate change, there has been increasing warning about the impacts of global average temperatures rising over 3.6°F (2°C). These include a rapid increase in global hunger, health risks, and water shortages[1]. Temperature rises above

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[1] Hare, W.: 2003, 'Assessment of Knowledge on Impacts of Climate Change – Contribution to the Specification of Art. 2 of the UNFCCC'. Potsdam, Berlin, WBGU - German Advisory Council on Global Change.
http://www.wbgu.de/wbgu_sn2003_ex01.pdf

3.6°F (2°C) also increase the risk of abrupt climatic changes such as rapid sea level rise from continental ice including the disintegration of the West Antarctic Ice Sheet.[4]

Linking specific temperature changes—such as the proposed 3.6°F (2°C) dangerous threshold—with particular levels of global warming emissions in the atmosphere, is complicated. Although all climate models project increased temperatures to result from higher concentrations of climate change pollutants, these models vary in their sensitivity of the global and regional temperatures and other climate measures to changes in climate change pollutant concentrations.

For example, temperature rises between 2.7°–8.1°F (1.5°–4.5°C) have been projected for a doubling of the atmospheric CO_2 concentration above pre-industrial levels. This wide range of temperature rise projections is the result of differences in the way the models represent key processes within the climate system, particularly in characterizing clouds which can lead to either damping or reinforcing of global warming.

Society can neither control nor precisely determine the sensitivity of the earth's climate system to rising climate change emission concentrations. As a result, it is critical to carefully consider implications of a range of climate sensitivities when evaluating the risks of climate change and devising policies to manage the one factor we can control: our own climate change emissions.

For example, the United Kingdom (UK) adopted a target to limit the maximum atmospheric CO_2 concentration to 550 parts per million (ppm) and determined that reaching this target would require the industrialized world to decrease emissions by approximately 60 percent by the year 2050.

However, because of the uncertainty in climate model sensitivity, it is unclear if this 550 ppm target will keep global temperatures below a 3.6°F (2°C) dangerous threshold. Although the Intergovernmental Panel on Climate Change (IPCC) suggests that the UK concentration target is consistent with several recent climate model simulations, the 3.6°F upper warming limit under the 550 ppm threshold holds up under the lower- but is exceeded under the higher-climate

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Arctic Climate Impacts Assessment (ACIA) 2004, Impacts of a Warming Arctic - Arctic Climate Impact Assessment, Cambridge University Press, Cambridge, UK

sensitivity models. This suggests that a lower concentration target, and therefore greater emission reductions, could be needed.

This chapter summarizes findings of recent analyses that explore the implications of various climate change scenarios for California. The studies focus on comparing the implications of different scenarios of climate change emissions given a range of climate sensitivities. The projections reported are driven by three climate change emission scenarios—a lower emissions, medium-high emissions, and higher emissions scenario.

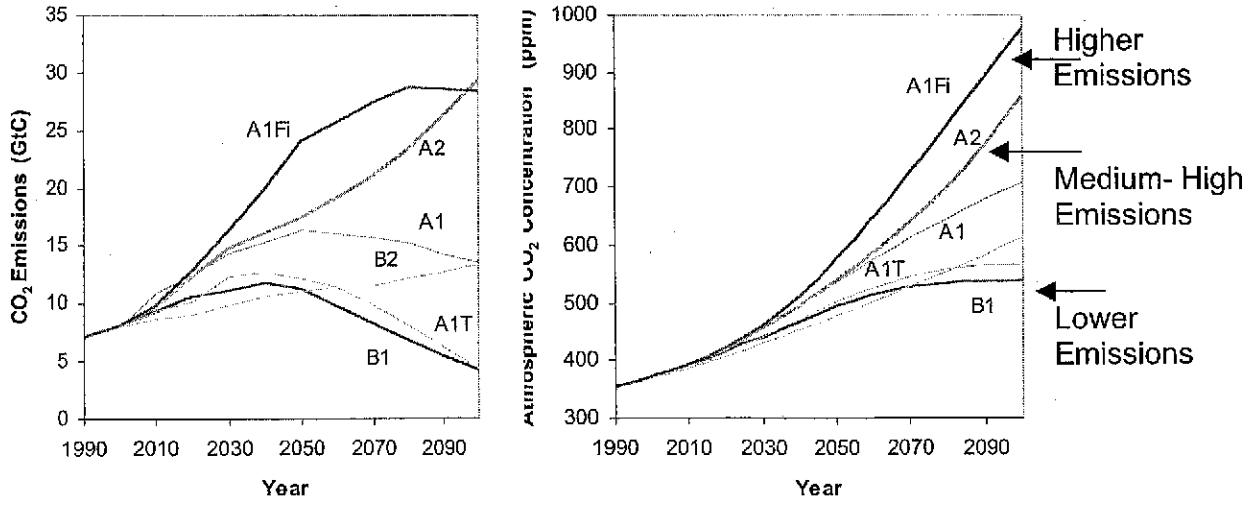
The sensitivity of the climate system to increasing atmospheric concentrations of climate change pollutants is explored by comparing the projected temperature rise from three different global climate models, each containing somewhat different representations of some crucial physical processes that result in levels of climate sensitivity.

The following section describes the global warming emission scenarios and climate projections reported in this chapter. Other sections report on the projected impacts of the specific climate projections across six sectors—coasts, water resources, agriculture, forests/fire, public health, and electricity. The chapter concludes with a discussion of the implications of these projections for mitigation and adaptation.

4.1 Climate Change Scenarios [5]

The Intergovernmental Panel on Climate Change Special Report on Emissions Scenarios (SRES) developed a set of possible future emissions scenarios based on different assumptions about global development paths (Figure 4-1). This section relies upon the results from recent analysis for California of three SRES emission scenarios—a higher emissions scenario (A1Fi), a medium-high emission scenario (A2), and lower emission scenarios (B1).

Figure 4-1. Special Report on Emissions Scenarios



The higher emissions scenario (A1fi) represents a world of rapid fossil-fuel-intensive economic growth, global population that peaks mid-century then declines, and the introduction of new and more efficient technologies toward the end of the century. Global warming emissions grow rapidly, reaching about 25 gigatonnes per year (Gt/yr), more than 3 times the present rate of emissions, by 2050.

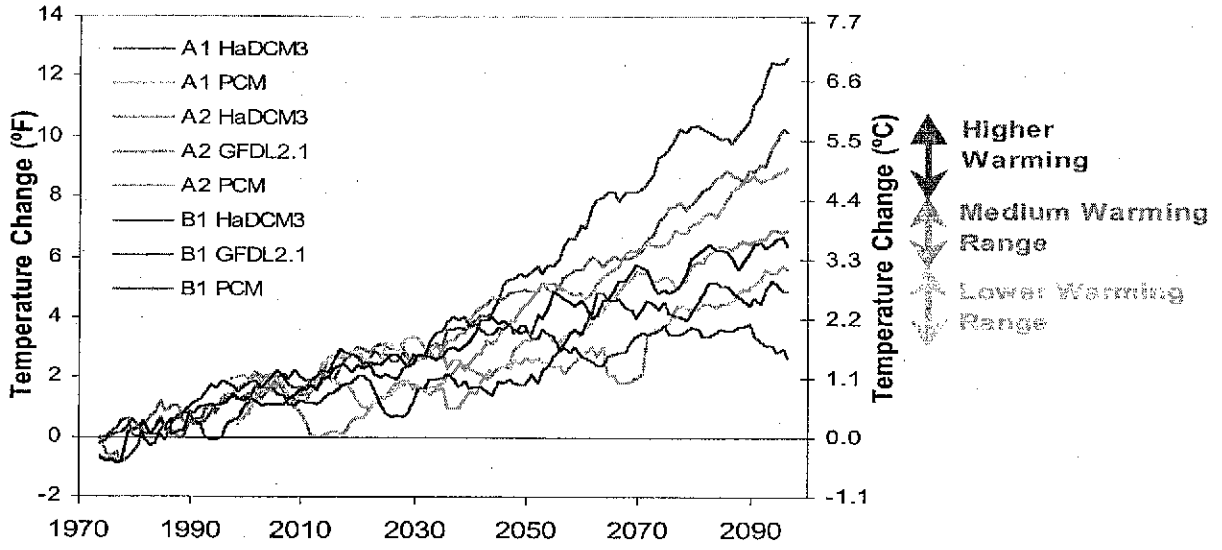
The medium-high emissions scenario (A2) projects continuous population growth with slower economic growth and technological change than in the other scenarios. In contrast, the lower emissions scenario (B1) characterizes a world with population growth similar to the highest emissions scenarios, but with rapid changes towards a service and information economy and with the introduction of clean and resource-efficient technologies. The B1 scenario has CO_2 emissions peaking just below 10 Gt/yr in mid-century before dropping below the current-day level of 7 Gt/yr by 2100. Under the B1 scenario, the CO_2 concentration would double, relative to its pre-industrial level, by the end of this century.[6] For the range of climate sensitivities reported on here, the B1 scenario leads to global temperature rises between 1.8-3.1 °C, capturing yet mostly rising above the "dangerous" threshold of 2°C described above. Importantly, in the B1 scenario simulations, while the upward trend of temperature tends to level off or slow down during the last few decades of the 21st Century, in the A2 and A1fi simulations the rising trend in temperature continues at a high rate, indicating that more warming would occur under these higher scenarios before an equilibrium is reached.

To capture a range of uncertainty among climate models, this chapter reports on projections from three state-of-the-art global climate models (GCMs)—a low-sensitivity model, the Parallel Climate Model (PCM1)[7] from the National Center for Atmospheric Research (NCAR) and the Department of Energy (DOE) groups; a medium-sensitivity model, the Geophysical Fluids Dynamic Laboratory (GFDL) CM2.1 (NOAA Geophysical Dynamics Laboratory, Princeton NJ)[8] model; and the slightly higher-sensitivity U.K. Met Office Hadley Centre Climate Model, version 3 (HadCM3)[9].

Temperatures are projected to rise significantly over the 21st century. The magnitude of projected warming varies between models and the emission scenarios. The temperature rise (2000 to 2100) projections are from approximately 1.7°C to 3.0°C (3.0°F-5.4°F) in the lower range of projected warming, 3.1°C-4.3°C (5.5°F-7.8°F) in the medium range, and 4.4°C to 5.8°C (8.0°F-10.4°F) in the higher range. To comprehend the magnitude of these projected temperature changes, over the next century, the lower range of projected temperature rise is slightly larger than the difference in annual mean temperature between Monterey and Salinas, and the upper range of project warming is greater than the temperature difference between San Francisco and San Jose, respectively (Figure 4-2). There is no clear trend in precipitation

projections for California over the next century. However the consensus of the recent IPCC model projections, including several models that were not selected for the present study, is for relatively little change in total precipitation, with a tendency toward a slightly greater winter and lower spring precipitation.

Figure 4-2. Change in California Annual Average Daily Mean Temperature Relative to 1961-1990



Change in California annual mean temperature (°F and °C) by year from 1961 to 2100 relative to 1961–1990 average—7-year running mean.

HadCM3 = Hadley Climate Model version 3

PCM = Parallel Climate Model

GFDL2.1 = Geophysical Fluid Dynamics Laboratory model 2.1

A1, A2, and B1 refer to global emission scenarios explained in Section 4. They are higher (A1), medium-high (A2), and lower (B1) emission scenarios.

4.2 Public Health Impacts[10]

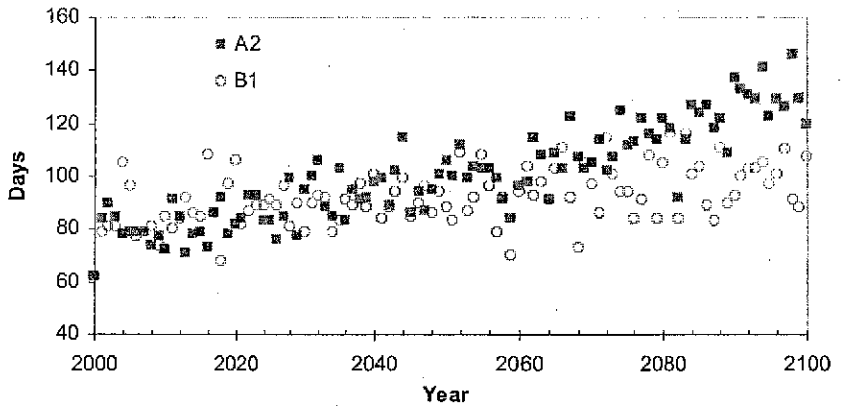
Climate change will affect the health of Californians due to increases in the frequency, duration, and intensity of conditions conducive to air pollution formation, oppressive heat, and wildfires. The primary concern is not the change in average climate, but rather the projected increase in extreme conditions that are responsible for the most serious health consequences.

Californians experience the worst air quality in the nation, with annual health and economic impacts estimated at 9,000 deaths and $60 billion per year. Ozone and particulate matter (PM) are the pollutants of greatest concern, and the current control programs for motor vehicles and industrial sources cost about $10 billion per year.

Maximum ozone levels are about double the current air quality standards. Climate change will slow progress toward attainment and increase control costs by boosting emissions, accelerating chemical processes, and raising inversion temperatures during summertime stagnation episodes. Results from statistical analyses indicate that the number of days meteorologically conducive to pollution formation may rise by 75 to 85 percent in the high ozone areas of Los Angeles (Riverside) and the San Joaquin Valley (Visalia) by the end of the century if

temperatures rise to the higher projected warming range, and by 25 to 35 percent if temperature increases stay within the lower warming range.

Figure 4-3. Projected Days at Riverside Meteorologically Conducive to Exceedances of the 1-Hour California Ambient Air Quality Standard for Ozone of 0.09 Parts Per Million (ppm)



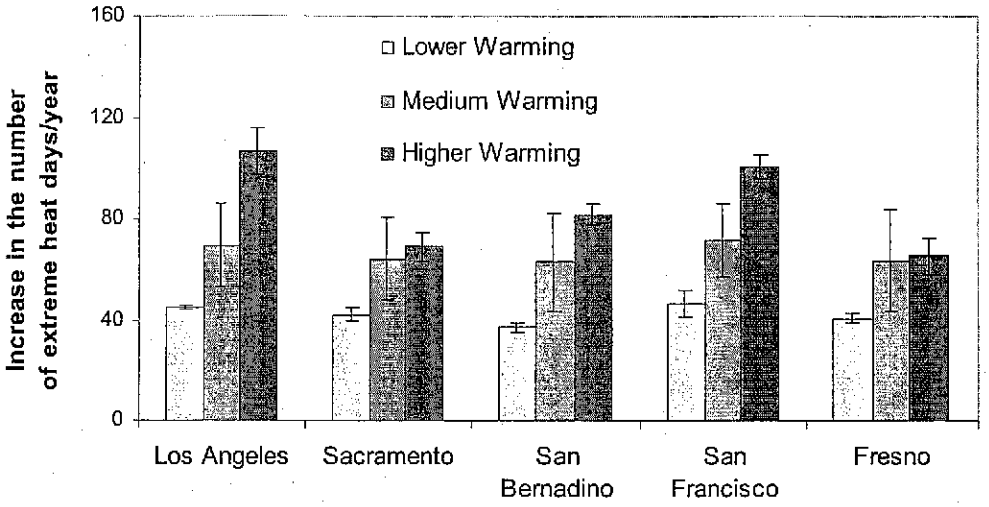
Geophysical Fluid Dynamics Laboratory (GFDL). Source: Kleeman and Cayan, 2006

In addition, global background ozone (primarily formed from methane and nitrogen oxides from fuel combustion) is projected to increase by 4 to 10 percent (lower emissions scenario) to 25 percent (higher emissions scenario) by 2100. If background ozone increases by the amount projected for the higher scenario, the ozone targets would be impossible to attain in much of California, even with near-zero local emissions.

The future trend for PM is not as clear, as increasing temperatures reduce some particle types while others show no change or increase slightly. In general, increased temperatures tend to reduce atmospheric nitrate, an important contributor to levels of PM2.5 (particles less than 2.5 microns) in California. However, a preliminary study by Kleeman and Cayan (2006) suggests that if global background ozone levels double, there would be an increase in PM2.5 levels despite the corresponding increase in temperature. Rainy days, wildfires, global dust storms, humidity, and other factors also affect PM and are the subject of ongoing study.

Analyses of various climate change scenarios project that the future will have a greater number of extremely hot days and fewer extremely cold days, with large increases in heat-related deaths predicted for the five cities studied.

Figure 4-4. Projected increase in extreme heat days relative to 1961–1990. "Extreme heat" defined as by the average temperature which is exceeded less than 10% of the days during the historical period (1961-1990), or approximately 36 days a year.



Source: Drechsler et al., 2006

For the higher warming range, the number of days with temperatures above 90°F in Los Angeles and higher than 95°F in Sacramento will increase to about 100 days by the end of the century, almost twice the increase projected if the temperatures stay within the lower warming range. Individuals likely to be the most affected include the elderly, already ill, and poor. On peak demand summer days in 2100, California would need at least 10 percent more electricity, compared to total generation capacity today, for air conditioning alone. Ongoing studies are investigating the relative contribution of air pollution to heat-related death, and refining the air conditioning demand estimates.

Climate change could affect asthma prevalence and attacks, but this is difficult to predict for several reasons. The most common asthma triggers are dust mites and molds, both of which are higher indoors than outdoors and require a relatively humid environment for survival. Consequently, if the climate becomes drier, these triggers will become less important, but they respond to higher humidity with increased growth. Many asthmatics are allergic to various plant pollens. Plants and trees typically have pollination seasons that last a few weeks per year. To the extent that pollen seasons lengthen or become more intense in response to climate change, increased asthma exacerbation could result.

Climate change has the potential to influence the incidence of infectious disease spread by mosquitoes, ticks, fleas, rodents, and food. More study is needed as research to date has focused on short-term changes in weather patterns (primarily in ambient temperature and rainfall), rather than long-term trends.

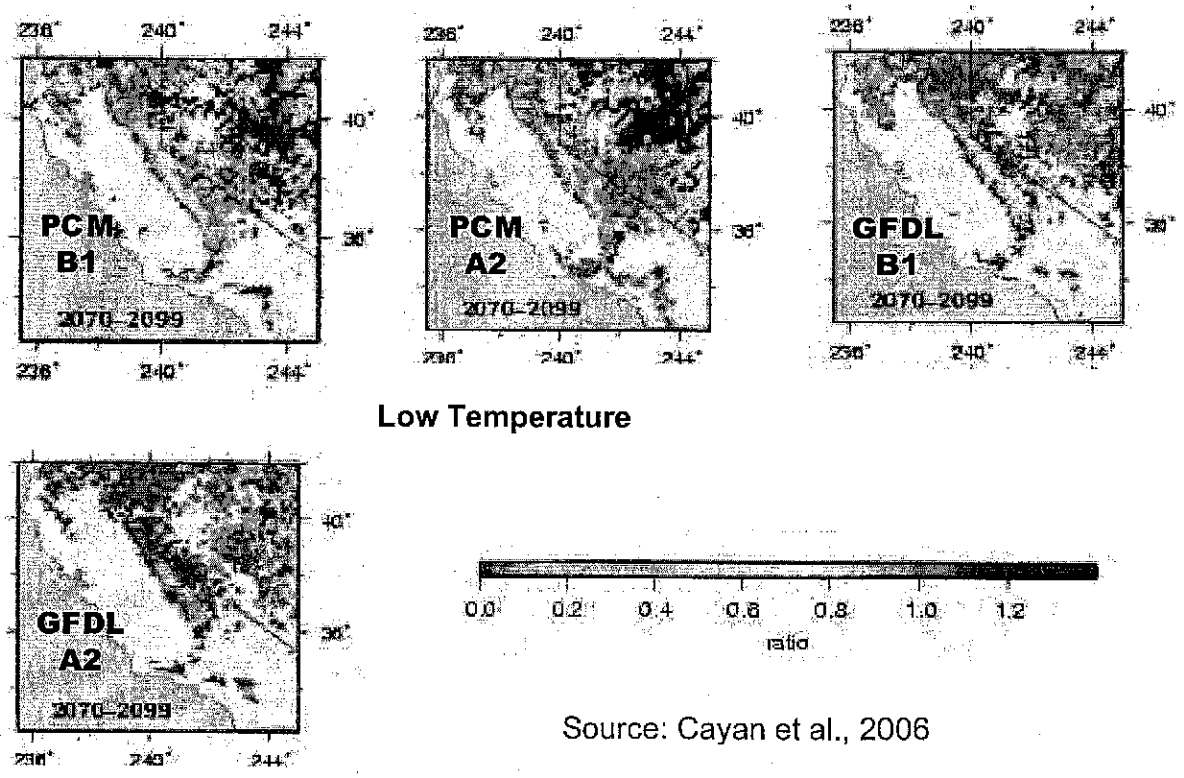
4.3 Water Resources Impacts[11]

Although precipitation is projected to change only modestly over this century, rising temperatures are expected to diminish snow accumulation in the Sierra Nevada and other mountain catchments in California. Higher temperatures will result in more precipitation as rain instead of snow and earlier melt of the snow that does fall. Reductions in snow accumulation and earlier snowmelt will have cascading affects on water supplies, natural ecosystems, and winter recreation.

Snowpack

The projected losses in snowpack increase with temperature. Each of the simulations shows losses of spring snow accumulation, largely over the Sierra Nevada, to become progressively larger during the 21st century. By the 2035–2064 period, snowpack in the Sierra Nevada could decrease 10 to 40 percent depending on the amount of warming and precipitation patterns. By the end of century, snowpack could decrease by as much as 90 percent if temperatures rise to the higher warming range, almost double the loss is expected if temperature rises stay within the lower warming range.

Figure 4-5. April 1 Snow water equivalent 2070-2099 fraction of 1961–1990



Low Temperature

Source: Cayan et al., 2006

Medium Temperature

Water Supply

Declining snowpack will aggravate the already overstretched water resources in California. The snowpack in the Sierra Nevada provides natural water storage

equal to about half the storage capacity in California's major man-made reservoirs. The snowpack holds the winter precipitation in the form of snow and, historically, has released it in the spring and early summer as the snow melts. This loss in storage could mean more water shortages in the future. However, the full effect of this storage loss will depend in part on whether reservoirs can be managed to capture the earlier snowmelt while loosing flood control capacity.

Under most scenarios stream flows are projected to decrease slightly by mid-century with more dramatic changes by the end of the century. Flows into the major Sierra Nevada reservoirs could decline between 25 to 30 percent if temperatures rise to the medium warming range and precipitation decreases by approximately 20%. This is almost double the decrease projected if temperatures are confined to within the lower warming range. However, in one model run, projections suggest a slight increase in precipitation and a corresponding rise in projected stream flows.

After mid-century, the change in the volume and timing of runoff reduces the ability of the major projects to deliver water to agricultural users south of the Delta. The projected changes in water supply may be further exacerbated by increasing demand. By the end of century, increasing temperatures are expected to increase the crop demand for water between 2 and 13 percent in the lower and medium warming ranges, respectively.

Winter Recreation

Declines in Sierra snowpack will also have widespread implications for winter tourism. Toward the end of the century, in lower temperature scenarios the ski season could shorten by as much as a month while projected climatic changes under the higher temperature scenario suggest that the minimum snow conditions for ski resort operation might be eliminated entirely. Many resorts would be forced to rely on snowmaking or move their operations.

4.4 Agriculture Impacts[12]

Agriculture, along with forestry, is the sector of the California economy that is most likely to be affected by a change in climate. California agriculture is a $68 billion industry.[13] California is the largest agricultural producer in the nation and accounts for 13 percent of all U.S. agricultural sales, including half of the nation's total fruits and vegetables.

Regional analyses of climate trends in agricultural regions of California suggest that climate change is already in motion. During the period 1951 to 2000, the growing season has lengthened by about a day per decade, and warming temperatures have resulted in an increase of 30 to 70 growing degree days per decade, with much of the increase occurring in the spring. Climate change affects agriculture directly through increasing temperatures and rising CO_2 concentrations and indirectly through changes in water availability and pests.

The agriculture sector is likely to bear a disproportionate share of any water scarcity due to any reduced water availability from climate change. A preliminary

analysis suggests that a drier climate would impose significant costs on agricultural production in the Central Valley.

Temperature

Temperature influences crop growth through its impact on photosynthesis and respiration, as well as growing season length and water use. Temperature also serves as a controlling factor for developmental processes, such as flowering and fruit maturation, which may be threatened if lengthening of the growing season introduces asynchrony between the timing of flowering and the life cycle of important insect pollinators.

In general, a warming from a low to a higher temperature raises yield at first but then becomes harmful. Possible effects of excessively high temperature include decreased fruit size and quality for stone fruits, premature ripening and possible quality reduction for grapes, reduced fruit yield for tomatoes, increased incidence of tip burn for lettuce, and similar forms of burn for other crops.

As temperatures rise toward the medium warming range, by the end of this century, the local winter climate is expected to approach critical chill-hour thresholds for many species of fruit trees. (Chill hour is the number of hours below a critical temperature.)

Carbon Dioxide (CO_2)

From a variety of studies in the literature, photosynthesis increases when a plant is exposed to a doubling of CO_2. However, whether this translates into increased yield of economically valuable plant product is uncertain and highly variable. Also, elevated CO_2 levels are associated with decreased concentrations of mineral nutrients in plant tissues, especially a decrease in plant nitrogen, which plays a central role in plant metabolism.

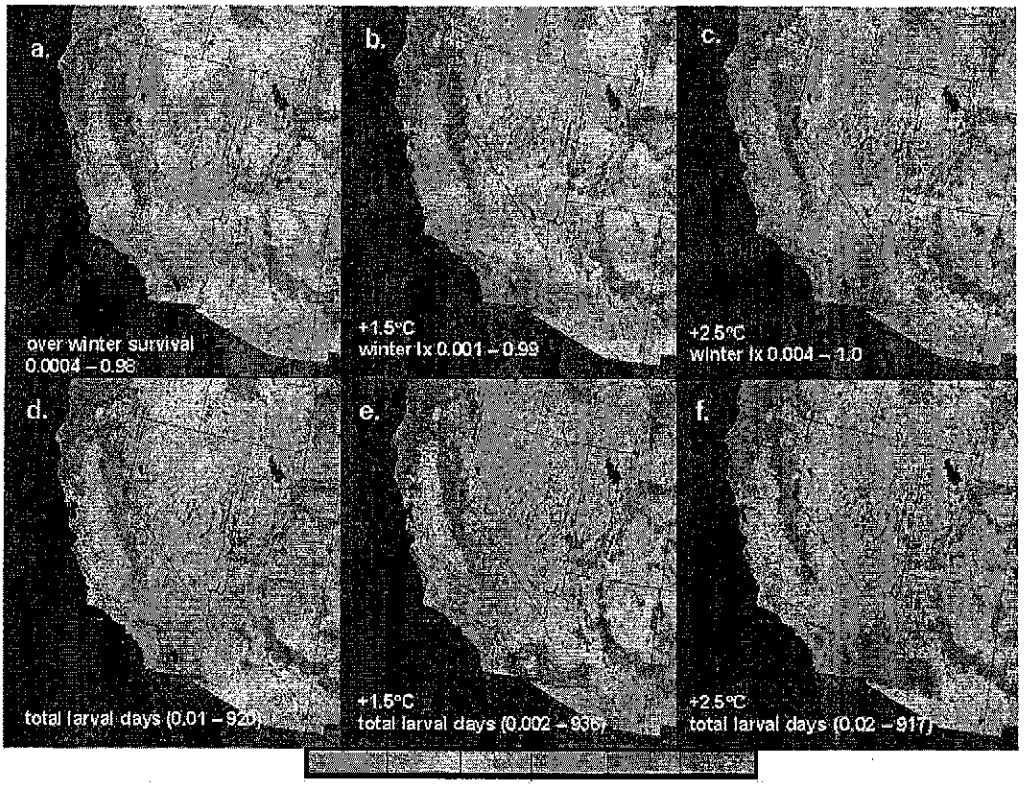
Some crops may benefit in quality from an increase in CO_2; for example, the fruit flavor of strawberries improves. Some crops are harmed by an increase in CO_2; for example grain protein in crops decreases and, in the case of wheat, bread-making quality decreases.

Pests and Weeds[14]

Growth rates of weeds, insect pests, and pathogens are also likely to increase with elevated temperatures, and their ranges may expand. A relatively new area of research involves the use of physiologically-based dynamic models to fully understand the effects of weather (e.g., temperature, rainfall, solar radiation, etc.) on species dynamics.

One of these models was used to estimate the potential impacts of a pest (pink bollworm, or PBW) on cotton cultivation in the state. At the present time this pest is of importance only in the southern desert valleys (e.g., Imperial and Coachella Valleys) because winter frost restricts the invasion of PBW to the million acres of cotton grown in the San Joaquin Valley. However, if winter temperatures rise by 3.6°–4.5°F (2°–2.5°C), the range of PBW of this pest would likely expand northward.

Figure 4-6. Cotton/pink bollworm (PBW): Predicting areas favored by PBW



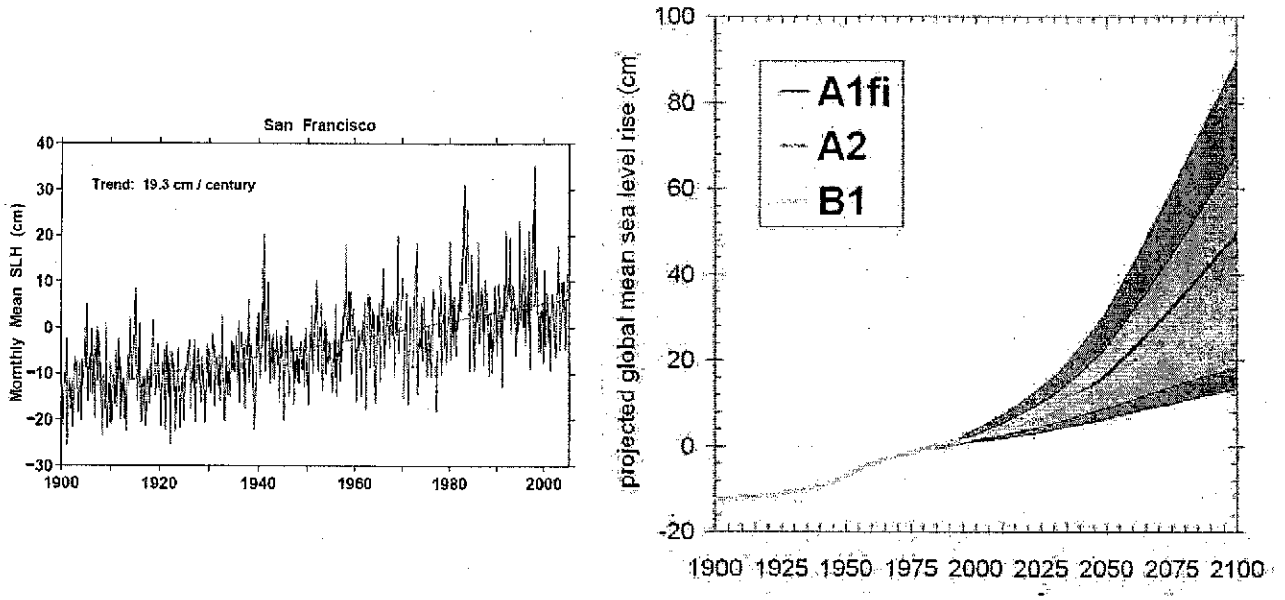
The effects on winter survival (a-c) and total seasonal pest PBW larval densities (larval days, d-e) under current weather (a,d) and with 1.5°C (b,e) and 2.5°C (c,f) increases in daily temperatures respectively (Gutierrez et al. in press).

4.5 Coastal Sea Level Impacts[15]

California's coastal observations and global model projections indicate that California's open coast and estuaries will experience increasing sea levels during the next century. These changes could amplify the sea level rise which has historically affected much of the coast of California, including the Southern California coast, the Central California open coast, and the San Francisco Bay and upper estuary. These trends, quantified from a small set of long-duration California tide gages, show rises of about 2 mm/year (Figure 4-6). They are very similar to trends estimated for global sea level.

In addition to long-term trends, sea levels along the California coast undergo shorter period variability above or below predicted tide levels. Highest sea levels have usually occurred when winter storms and Pacific climate disturbances such as El Niño[2] have coincided with high astronomical tides. So far, there is little evidence that the rate of global sea level rise has accelerated (the rate of rise at California tide gages has actually flattened during the last several years), but climate models suggest strongly that this may change.

Figure 4-7. Observed Change in Sea Level in San Francisco during the last century and Projections of Global Mean Sea Level during next century.



Source: Cayan et al., 2006

Global sea level rise is projected to range from 4 to 33 inches during the 2000 to 2100 period. This compares to a rate of approximately 7.6 inches (19 cm) per

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[2] El Niño: A phenomenon in the equatorial Pacific Ocean characterized by a positive sea surface temperature departure from normal. Water in the eastern Pacific Ocean close to the equator gets warmer than normal, which results in changes in weather patterns. In some cases, El Niño results in significant increases in precipitation in California. For example the 1982-1983 El Niño event.)

century observed at San Francisco and San Diego during the last 100 years. Superimposed on these rising seal levels will be astronomically-driven tides, and fluctuations from weather, El Niño and other influences, so that, the occurrence of extreme events will increase as sea level rises.

The frequency that sea level exceeds a stationary threshold, as projected over future decades for locations such as the San Francisco tide gage, increases markedly as the mean sea level increases. Thus, historical coastal structure design criteria may be exceeded, the duration of events will increase, and these events will become increasingly frequent as sea level rise continues. On the open coast, impacts during these events will continue to be exacerbated by high surf from wind, waves, and, in the Sacramento/San Joaquin Delta of the San Francisco Bay estuary, by floods that may further jeopardize levees and other structures.

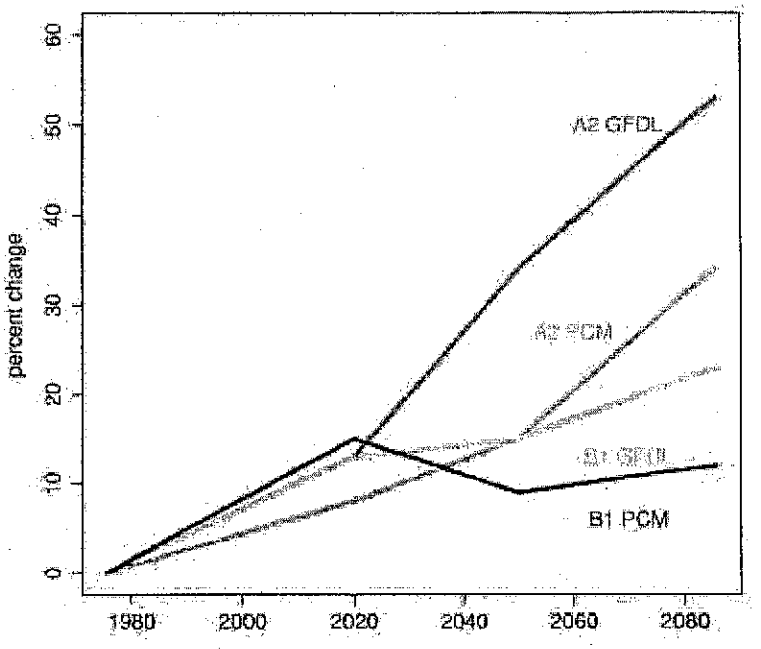
4.6 Forests and Natural Landscapes Impacts[16]

Climate changes and increased CO_2 concentrations are expected to alter the extent and character of forest and other ecosystems. The distribution of species is expected to shift, the risk of climate-related disturbance such as wildfires, disease, and drought is expected to rise, and forest productivity is projected to increase or decrease depending on species and region. The ecosystems most susceptible to temperature rise are the alpine and sub-alpine forest cover. In addition, changes in fire frequency are expected to lead to an increase in grasslands, largely at the expense of woodland and shrub-land ecosystems.

Wildfires[17]

The changing climate may modify the natural fire regimes in ways that could have social, economic and ecological consequences. The most recent analysis, which is a conservative estimate that does not include the effects of extreme fire weather, indicates that wildfire will increase, especially as warming intensifies. These projections suggest that the risk of large wildfires statewide may rise almost 35 percent by mid-century, 55 percent by the end of the century under a medium-high emissions scenario, and almost twice that expected under lower emissions scenarios.

Figure 4-8. Percent change in the expected minimum number of large fires per year in California



Source: Westerling et al., 2006

These increases in fire season severity could lead to more "bad air" days as well as increased damage costs of approximately 30 percent above current annual damage

Although society has developed a number of ways to adapt to wildfires, climate change, along with the multiplying impacts of other stresses such as population growth and land-use change, may be pushing California outside of its coping range.

However, in the short-term, California can take actions to improve its ability to live within the state's fire-prone landscapes while maintaining the functioning and structure of the ecosystems upon which its residents depend. These include[18]: 1) the adoption of a risk-based framework for fire management; 2) the reintroduction of fire to fire-prone ecosystems (managing natural fires in some regions rather than suppression); 3) creation of new and flexible policies that are able to differentiate between the diverse ecosystems in California; and 4) a re-evaluation of urban planning and building in the wildland-urban interface.

Pests and Pathogens[19]

Historically, pests and disease have caused significant damage to California forests. The changing climate may exacerbate these effects by expanding the range and frequency of pest outbreaks. For example, the introduced pathogen, pine pitch canker (Fusarium subglutinans f. sp. pini), once limited to coastal

areas of California, has expanded to the El Dorado National Forest in the Sierra Nevada. Rising winter temperatures in the Sierra Nevada would make conditions more favorable for pitch canker and could result in increased disease severity and economic loss.

Forest Productivity[20]

Several studies have projected increases in forest productivity under future climate change. However, recent studies indicate that it is uncertain how trees will respond to elevated CO_2 concentrations, and that there will be increased risk and susceptibility to catastrophic loss. Thus, the implications for the forest productivity and the timber industry may be less optimistic.

The most recent assessment of the impact of climate change on the California forest sector used an industry standard planning tool to forecast 30-year tree growth and timber yields for forest stands in El Dorado County under a high and medium temperature scenario.

Conifer tree growth was reduced under all climate change scenarios. If temperatures rise to the projected medium warming range, productivity in mature stands is expected to decline by 20 percent toward the end of the century. The reductions in yield were more severe (30 percent) for pine plantations. Projections further indicate that the reduced growth rates could lead to substantial decrease in tree survival rates.

4.7 Electricity Sector Impacts[21]

Changes in temperature and other meteorological variables will affect both the generation of and demand for electricity. This section discusses the potential effects of climate change on hydropower production and electricity demand in California.

Energy Supply—Hydropower

Changes in precipitation levels, should they occur, and patterns and timing of snowmelt would alter the amount of electricity that hydroelectric facilities could generate. It would also affect seasonal availability, with less water available for hydroelectric generation in the late spring and summer months when demand is the highest.

In addition, there is a high likelihood that changes in precipitation and runoff patterns would lead to changes in broader water policies and end-use priorities, such as water supply and flood control, which could impose further limitations on hydroelectric production. Currently, hydropower generation contributes about 15 percent of the in-state electricity production, with a range from 9 to 30 percent due to variations in climatic conditions.

Past studies have suggested that annual hydropower generation will increase or decrease with increasing or decreasing precipitation levels in California. The most recent study using an economic-engineering optimization model of the state water system suggests that under a medium range of temperature increase and decreased precipitation levels, annual generation by the end of this century

would decrease by about 30 percent and stream flows would decrease by 28 percent.

Another new study prepared by the Department of Water Resources (DWR) simulating the State Water and Central Valley Projects suggests reductions of approximately 7 percent in hydropower unit electricity generation for most scenarios by mid-century. However, one exception is the low temperature scenario in the less dry model, where electricity generation is projected to increase by approximately 4 percent.

It is important to emphasize that even relatively small changes in in-state hydropower generation results in substantial extra expenditures for energy generation, because losses in this "free" generation must be purchased from other sources.

For example, assuming a decrease of 10 percent from the current average in-state generation level from this renewable energy source, and assuming a price of about 10 cents per kilowatt-hour, this decrease would result in an additional $0.35 billion per year in net expenditures to purchase sufficient electricity to replace the electricity that otherwise would be generated using hydroelectric resources.

Electricity Demand

Electricity demand is projected to rise between 3 to 20 percent by the end of this century. These results are based on correlation functions relating electricity demand with temperatures in key areas in California and future climate projections assuming current socio-economic conditions, including no change in present day population. In the next 20 years electricity demand would increase from 1 to 3 percent from the baseline, and peak electricity demand would increase at a faster rate.

Since annual expenditures of electricity demand in California represent about $28 billion, even the relatively small increases in energy demand would result in substantial extra energy expenditures for energy services in the state. For example, assuming a linear increase in electricity expenditures from the historical period, a 3 percent increase in electricity demand by 2020 would translate to about $1.2 billion a year in extra electricity expenditures.

Potential Coping Strategies

There are several options to reduce the negative effect of climate change on the electricity system. The use of modern probabilistic hydrological forecasts for the management of water reservoirs in the state is a promising option being studied. Some options needed to reduce climate change emissions can be seen as coping strategies. They include, for example, enhanced energy efficiency programs, increased penetration of photovoltaic systems, and the implementation of measures designed to reduce the heat island effect.

4.8 Implications for Mitigation and Adaptation[22]

Continued climate change would have widespread impacts on California's economy, ecosystems, and the health of its citizens. However, analyses from the present study, summarized in Figure 17, suggest that many of the more severe impacts projected under the medium and higher warming ranges could be avoided by following the lower emissions pathway. It should be noted though, that, if the actual climate sensitivity to climate change emissions reaches the level of the more sensitive global climate models employed here, an even lower emissions path than the B1 scenario may be required to avoid the medium warming range. How much would climate change emissions have to be reduced to stay below the lower emissions pathway (B1) and insure against temperatures rising to the medium and higher warming ranges presented in this study? The Governor's Executive Order #S-3-05, calls for an 80% reduction in CLIMATE CHANGE emissions, relative to 1990 levels, by 2050. If the industrialized world were to follow California's lead and the industrializing nations transitioned to a lower emissions energy system as characterized by the B1 pathway, global emissions would remain below the lower emissions scenario (B1),[3] increasing the likelihood that California and the world would be on track to avoid the more severe impacts by preventing temperatures from rising to the medium warming ranging.[4] This estimate of the impact of an 80% reduction by the industrialized world on global emissions depends crucially on the development patterns of the Industrializing Nations. The SRES B1 scenario assumes development proceeds with a "high level of environmental and social consciousness" with a transition to "alternative energy systems" (Nakicenovic et al. 2000). Emission reductions targets such as the one set by the Governor's Executive Order could spur the innovation necessary to lead the World to a transition to alternative energy systems.

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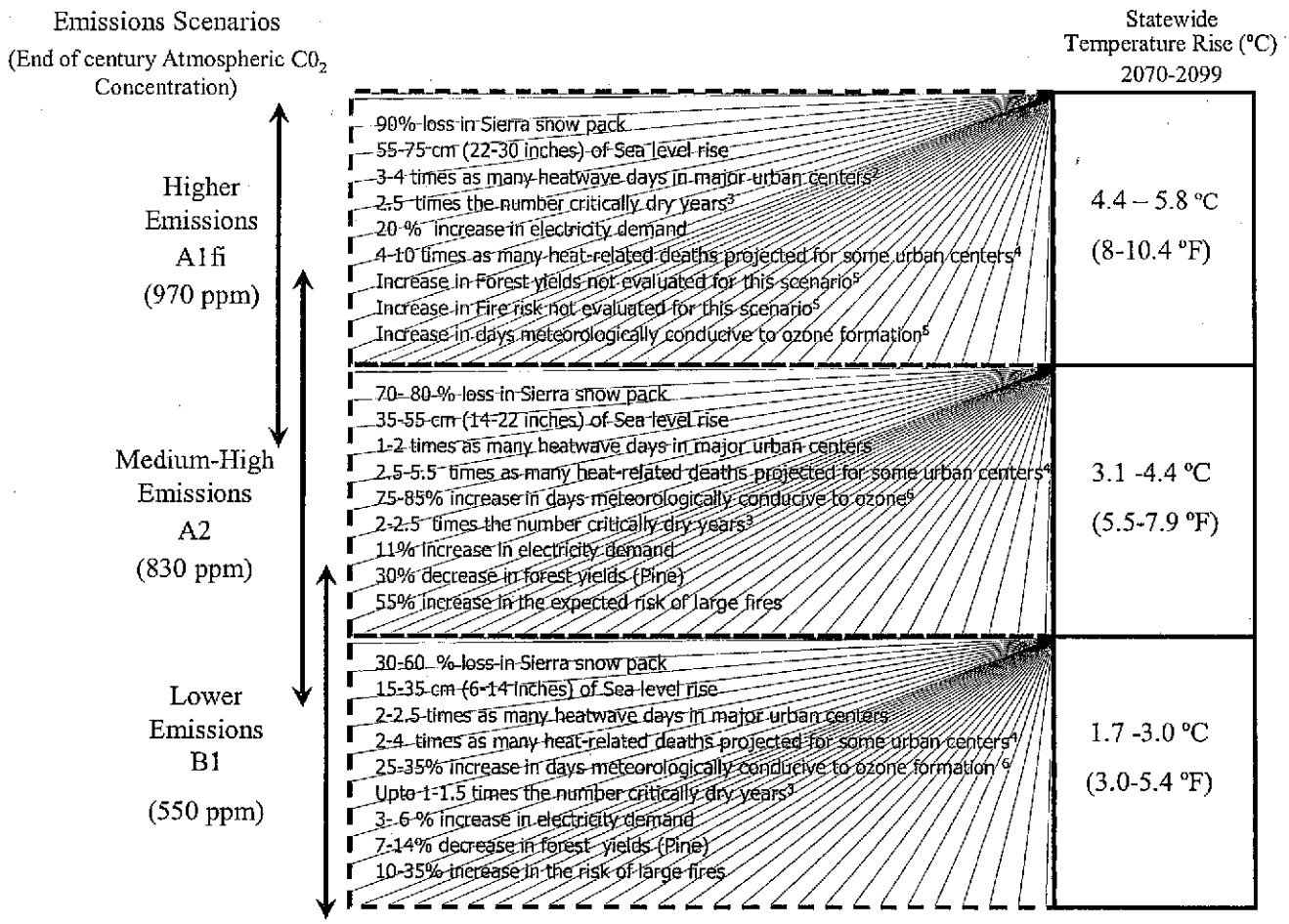
[3]This was calculated as follows: 1) OECD population and total emissions were based on SRES B1 IMAGINE runs (Nakicenovic et al. 2000). OECD total emission in 1990 were 2.83 GtC; 2) 80% below this value is 566MtC; 3) Total global emissions was calculated by adding the 566 MtC to the total emissions for non-OECD countries, as projected by SRES B1. This value is approximately 10GtC; 4) This 10 GtC/yr was compared to the global emission projected in the B1 scenario (approximately 11 GtC/yr).

[4] As illustrated in figure 1,beyond 2050 global emissions will need to decrease substantially below 10 GtC/yr to stay on the B1 pathway out to the end of the century. The SRES B1 pathway assumes Global emissions decrease to 4.23 GtC/yr by 2100. However, stabilizing atmospheric concentrations will require even lower emissions as natural uptake is estimated between 0.7-2.9 GtC/yr (IPCC 2001).

Figure 4-9. Projected Impacts End of Century



1. Impacts presented relative to 1961–1990.
2. Los Angeles, San Bernardino, San Francisco, Sacramento, and Fresno.
3. Measures for the San Joaquin and Sacramento basins.
4. For Los Angeles, Riverside, and Sacramento.
5. Impacts expected to be more severe as temperatures rise. However, higher temperature scenarios were not assessed for the project.
6. Formation in Los Angeles and the San Joaquin Valley.

Climate projections show little difference between the emissions scenarios prior to 2035 due to the inertia of the climate system, indicating that even under the lower emissions path some further impacts from climate change are inevitable. Consequently, although it is not the solution to global warming, it is becoming clear that adaptation is an essential complementary strategy to manage some of the projected impacts of climate change. While there are many opportunities for California to increase its capacity to cope with the projected changes, these are often costly.

Furthermore, there are limits to adaptation, especially in addressing the threats of abrupt climate changes or in dealing with those impacts on natural, unmanaged species and ecosystems. These species may not be able to keep up with the increasingly rapid and severe climate change expected in future decades. Finally, the ability to cope and adapt is differentiated across populations, economic sectors, and regions within the state. As a result, without appropriate actions climate change will likely aggravate existing equity issues within California and the rest of the U.S.

For example, the most vulnerable populations to the health impacts of climate change are children, elderly people, and residents of minority and low-income communities—the same groups that already face the greatest health and environmental risks.

The Department of Water Resources and other State agencies have already started to include climate change considerations in their long-range plans. However, no cities in California have a heat emergency action plan; such plans are especially crucial to assist the elderly, especially those living in housing without air conditioning, who may be the most at risk from heat waves.

Thus, the Department of Health Services should develop heat emergency action plans for California (with a focus on protecting the economically disadvantaged) before the need arises. Existing air pollution control programs do not consider the effect of climate change on vulnerable populations; children and the elderly (especially those with pre-existing heart disease) are among the groups most vulnerable to air pollution episodes. Those that live closer to freeways and other emission sources (disproportionately in low-income and minority communities) are exposed to higher levels of pollution.

The Air Resources Board should work with the U.S. Environmental Protection Agency to begin to build climate change considerations into efforts to attain and maintain the health-based air quality standards over the long term.

Better monitoring of California's climate and sensitive climate related sectors will be crucial to detecting and understanding a complex chain of impacts. Finally, the State should continue to generate public discussion and build awareness of the need to manage climate change, develop enabling (or eliminating constraining) adaptation policies, and foster the political will necessary to critically assess and ultimately realize the State's significant adaptive potential.

5 RECOMMENDATIONS FOR EMISSION REDUCTION STRATEGIES

The CAT evaluated a significant number of strategies that could be implemented in California to reduce climate change emissions. The strategies listed in the section represent the recommendations of the CAT regarding activities that should be undertaken in the state agencies to ensure the Governor's targets are met. Most of these strategies can be implemented with existing authority of the state agencies represented on the CAT.

5.1 Process for Strategy Selection

As a starting point for emission reduction strategy selection, the CAT relied upon information provided by the Tellus Institute, Center for Clean Air Policy, CEC's Integrated Energy Policy Report, and other existing evaluations of climate change emission reduction policies. The CAT agency representatives then went through a brainstorming exercise and each representative contributed to a larger list of potential emission reduction strategies that either their own agency or other agencies could implement.

The CAT as a whole discussed each strategy and reviewed work plans that included implementation steps, a timeline, and estimated potential emission reductions and costs. From these work plans it was determined which emission reduction strategies could be recommended to the Governor and Legislature at this time and which were either infeasible or would require further analysis.

The CAT then held two public workshops to review the strategies with the public. CAT representatives also met with representatives from low-income and minority communities, environmental organizations, industry representatives, and non-government organizations to review and discuss the list of strategies. Based on comment received at those workshops and meetings, the group made revisions and developed a final list of recommended strategies included in this document.

5.2 Strategies Cal/EPA Will Implement Over the Next Two Years

Table 5-1Table 5-2 lists all of the strategies that Cal/EPA will implement over the next two years. By 2020, the Air Resources Board's vehicle climate change emission standards will provide the largest emission reductions of any of the strategies being recommended by the Climate Action Team. The large auto manufacturers are currently challenging California's right to set climate change emission standards for vehicles. Governor Schwarzenegger has pledged his support in defending the State's right to require the sale of cleaner cars. The Integrated Waste Management Board will continue to pursue stringent waste reduction and recycling goals and is working towards better understanding of landfill gas emissions and best practices for capture and use of those emissions.

Table 5-1. Environmental Protection Agency

Climate Change Emission Reductions (Million Metric Tons CO_2 Equivalent)	2010	2020
Air Resources Board		
Vehicle Climate Change Standards	1	30
Diesel Anti-Idling	1	1.2
Other New Light Duty Vehicle Technology	0	4

Improvements		
HFC Reduction Strategies	2.7	8.5
Transport Refrigeration Units, Off-road Electrification, Port Electrification (ship to shore)	<1	<1
Manure Management	1	1
Semi Conductor Industry Targets (PFC Emissions)	2	2
Alternative Fuels: Biodiesel Blends	<1	<1
Alternative Fuels: Ethanol	<1	3.2
Heavy-Duty Vehicle Emission Reduction Measures	0	3
Reduced Venting and Leaks in Oil and Gas Systems	1	1
Hydrogen Highway	Included[2]	
Integrated Waste Management Board		
Achieve 50% Statewide Recycling Goal	3	3
Landfill Methane Capture	2	3
Zero Waste—High Recycling		3

[1] These estimates are based on best available current information and will be updated as needed.

[2] The benefits of the Hydrogen Highway have been captured in other programs such as the motor vehicle regulations and green buildings initiative.

A summary description of each of the strategies in Table 5-1 is included below:

Vehicle Climate Change Standards

With the passage of AB 1493, Pavley, Chapter 200, Statutes of 2002, California moved to the forefront of reducing vehicle climate change emissions. This bill required the state to develop and adopt regulations that achieve the maximum feasible and cost-effective reduction of climate change emissions emitted by passenger vehicles and light duty trucks. Regulations were adopted by the ARB in September 2004.

The ARB analysis of this regulation indicates emissions savings of 1 million tons CO_2 equivalent ($MMtCO_2e$) by 2010 and 30 million tons CO_2 equivalent by 2020.[23] This analysis also suggests that operating cost savings will more than offset the incremental costs of improved technologies, resulting in consumer savings of $5 billion annually by 2020.

Diesel Anti-Idling

Reduced idling times and the electrification of truck stops can reduce diesel use in trucks by about 4 percent, with major air quality benefits. In July 2004 the ARB adopted a measure to limit diesel-fueled commercial motor vehicle idling.[24] ARB

analysis indicates that anti-idling measures could reduce climate change emissions by 1.2 MMtCO2e in 2020.[25] ARB also estimates that the proposed measures would provide savings of up to $575 million (NPV through 2013) to California businesses as a result of fuel savings and reduced engine maintenance costs.

Other New Light Duty Vehicle Technology Improvements

In September 2004 the California Air Resources Board approved regulations to reduce climate change emissions from new motor vehicles. The regulations apply to new passenger vehicles and light duty trucks beginning with the 2009 model year. The standards adopted by the Board phase in during the 2009 through 2016 model years. When fully phased in, the near term (2009–2012) standards will result in about a 22 percent reduction as compared to the 2002 fleet, and the mid-term (2013–2016) standards will result in about a 30 percent reduction.

New standards would be adopted to phase in beginning in the 2017 model year (following up on the existing mid-term standards that reach maximum stringency in 2016). Assuming that the new standards call for about a 50 percent reduction, phased in beginning in 2017, this measure would achieve about a 4 MMT reduction in 2020. The reduction achieved by this measure would significantly increase in subsequent years as clean new vehicles replace older vehicles in the fleet—staff estimates a 2030 reduction of about 27 MMT.

Hydrofluorocarbon Reduction Strategies

ARB staff has identified five possible measures to reduce HFC emissions from vehicular and commercial refrigeration systems:

1. *Ban the retail sale of hydrofluorocarbon (HFC) in small (mostly 12-oz.) cans.* This would end the loss of can "heels" (small amounts of HFCs remaining in the can after service is complete) and prevent do-it-yourself re-filling of vehicular air conditioning systems.

2. *Require that only low-GWP refrigerants be used in new vehicular systems.* For vehicles subject to the ARB motor vehicle climate change emission reduction regulations, this requirement would take effect in 2017 because the adopted regulations already specify standards and compliance options through 2016. For medium- and heavy-duty vehicles not subject to the AB 1493 regulation, the requirement would take effect in the 2010 timeframe.

3. *Adopt specifications for new commercial refrigeration.* Limit the global warming potential of refrigerants used in refrigerators in retail food stores, restaurants, and refrigerated transport vehicles (trucks and railcars) and/or require that centralized systems with large refrigerant charges and long distribution lines be avoided in favor of systems that use much less refrigerant and lack long distribution lines.

4. Add refrigerant leak-tightness to the "pass" criteria for vehicular Inspection and Maintenance programs (all vehicles) and adopt an "inspect

and repair" measure for commercial systems. Require that systems either be leak-free at smog-check or be empty and inoperable.

5. *Enforce the federal ban on releasing HFCs.* This measure would focus on reducing emissions during the servicing and dismantling of vehicular air conditioners and commercial refrigeration systems.

Transportation Refrigeration Units, Off-road Electrification, Port Electrification (ship to shore)

Transportation Refrigeration Units

Require all new transportation refrigeration units (TRU) to be equipped with electric standby.

Require cold storage facilities to install electric infrastructure to support electric standby TRUs.

The technologies to be employed in this measure include electric standby for TRUs and electric infrastructure at cold storage facilities.

Emission reduction estimates are about 0.14 MMT in 2020 assuming 50 percent electrification and TRU operation at a facility of about 30 percent.

Off-road Electrification

Off-road electrification would likely be achieved using a combination of regulatory and incentive approaches. ARB could conduct outreach to encourage replacement of diesel engines with electric motors to take advantage of the incentive rate structure and Moyer funding, and to comply with District and pending ARB regulations.

The in-use stationary diesel agricultural engine regulation currently under development at ARB will propose emission performance standards for engines rather than mandate electrification or any other specific technology. Staff believes that most engines will be replaced with new cleaner certified diesel engines or with electric motors. Retrofit and alternative fuels are other potential means of compliance.

Port Electrification

ARB would require phase-in of vessel modifications and infrastructure to support expanded use of shore-side power.

Technologies to be employed in this measure include vessel modifications and shore-side infrastructure.

Shore-side power could be used in 2 to 5 percent of ship visits in 2010 and 20 to 25 percent of ship visits in 2020. The reductions in CO_2 emissions are calculated as the difference between the CO_2 emissions resulting from the generation of shore-side power supplied by utility companies and the CO_2 emissions resulting from power generated by shipboard diesel generators.

2010

Goal: 5 percent of ship visits use shore-side power

Estimated CO_2 reduction: 0.016 MMT

2020

Goal: 25 percent of ship visits use shore-side power

Estimated CO_2 reductions: 0.18 MMT

Manure Management

Proposed San Joaquin Valley Rule 4570, Confined Animal Facilities, is intended to reduce volatile organic compounds (VOC) from confined animal facilities and is in the initial stages of development. Some general concepts that may appear in the rule include: (1) different requirements based on facility size; (2) specific control requirements included on a list of technologies; (3) a mix of control options selected from a list; and (4) a facility-wide control efficiency that will achieve a certain percentage reduction. Possible control options include management practices, manure handling practices, and lagoon/liquid waste control options.

Emission reduction estimates of approximately 1 million tons (MMT) could be achieved through the use of biogas digesters along with the production of electricity and/or heating applications. ARB estimates of climate change emission reductions through implementation of anaerobic digesters have yet to be determined.

Semi Conductor Industry Targets (PFC Emissions)

ARB could help target climate change emission reductions through development of a model rule to be considered for adoption by the districts. Based on the voluntary target outlined in the Memorandum of Understanding between the U.S. EPA and the Semiconductor Industry Association, emission reduction estimates of approximately 2 MMT for semiconductor operations in both 2010 and 2020 are possible.

Alternative Fuels: Biodiesel Blends

ARB would develop regulations to require the use of 1 to 4 percent biodiesel displacement of California diesel fuel. A climate change emission reduction of about 0.4 MMT would be achieved in 2010 based on 2 percent displacement of diesel fuel. ARB and CEC staff estimate that biodiesel could likely provide up to a 4 percent displacement of diesel fuel by 2020. This would provide about 0.8 MMT of climate change emission reductions. It is important to note, however, that current supplies of biodiesel are limited in California. Thus this strategy presumes significant market expansion in addition to regulatory steps.

Alternative Fuels: Ethanol

More than 200,000 flexible fueled vehicles are present in California today that could use E-85 without any equipment modifications. This number will increase as manufacturers continue to produce additional new cars that are E-85 compatible. If E-85 became widely available at prices competitive with gasoline, a significant portion of the fleet could be fueled primarily with ethanol by 2015.

The percentage of ethanol used in gasoline could be increased to the maximum 10 percent (E-10) that is compatible with current vehicles. (The current gasoline supply contains 5.7 percent ethanol). However, significant permeation emissions caused by low percentage ethanol blends used in the summertime suggest that low percentage blends are best limited to wintertime use. In addition, other fuel properties may need to be adjusted to ensure that the use of E-10 does not increase emissions of smog forming compounds.

If ethanol used in California continues to be derived from corn or other similar grains, the climate change emission benefits due to increased use of E-85 would be negligible in 2010 and 2.7 MMT in 2020 (assumes that about 10 percent of the entire light duty vehicle fleet uses E-85 regularly.) Use of ethanol derived from biomass or waste material would more than double the climate change emission reduction benefit.

Using 10 percent ethanol content in gasoline during the wintertime (six months) would result in ethanol use roughly equivalent to the level required under the recently adopted federal energy bill, and thus produce no additional climate change emission reduction benefits.

Heavy-Duty Vehicle Emission Reduction Measures

Climate change emissions can be reduced with improved aerodynamics, climate engine-based improved efficiency, vehicle weight reduction, and rolling and inertia resistance improvements. ARB has also identified other possible measures, such as an education program for the heavy duty vehicle sector as well as the light and medium duty vehicle sectors that would educate drivers as to how to optimize vehicle operation.

Emission reduction estimates of about 0.2 MMT for 2010 and about 3 MMT for 2020 were derived assuming an efficiency improvement of 65 percent from 1990 levels is possible by 2030. These estimates were based on ARB/CEC estimates of fleet-wide diesel-use reductions achievable under a national approach based on DOE's 21st Century Truck Program.

Reduced Venting and Leaks in Oil and Gas Systems

A model rule would be developed to be considered for adoption by the Air Pollution Control Districts. This measure involves improved management practices and does not rely on the application of new technology.

Estimated potential climate change emission reductions of 1 MMt CO_2 equivalent were derived assuming reduced leak and venting in the production, processing, transport, and distribution of oil and natural gas in 2010 and 2020. This goal is based on U.S.EPA estimates that approximately 33 percent of emissions from oil and gas systems can be avoided cost-effectively.

Hydrogen Highway

The California Hydrogen Highway Network (CA H2 Net) is a State initiative to promote the use of hydrogen as a means of diversifying the sources of transportation energy in order achieve a secure energy future, address

environmental, public health, and economic challenges, and work in partnership with other State programs to advance energy efficiency and renewable energy. The CA H2 Net mission is to assure that hydrogen infrastructure is in place as fuel cells and other hydrogen technologies reach commercial readiness.

Hydrogen can be derived from a variety of sources including petroleum based feedstock to a range of renewable resources. To assure that the production of hydrogen and operation of hydrogen fueled vehicles is environmentally beneficial the CA H2 Net has the clearly defined goals of utilizing at least 20 percent renewable resources in the production of hydrogen, reducing climate change emissions by at lease 30 percent, and to not increase smog forming and toxic pollutants relative to fossil fuel vehicle use.

Achieve 50% Statewide Recycling Goal

Achieving the State's 50 percent waste diversion mandate as established by the Integrated Waste Management Act of 1989, (AB 939, Sher, Chapter 1095, Statutes of 1989), will reduce climate change emissions associated with energy intensive material extraction and production as well as methane emission from landfills. Currently a diversion rate of 48 percent has been achieved on a statewide basis. This strategy would result in achieving an additional 2% waste diversion of recyclables from landfills using existing authorities and mandates, collection infrastructures, and recycling processes.

Landfill Methane Capture

Methane production varies greatly from landfill to landfill depending on site-specific characteristics such as the quantity of waste in place, waste composition, moisture content, landfill design and operating practices, and climate. Unless captured first by a gas recovery system, methane generated by the landfill is emitted when it migrates through the landfill cover to the atmosphere and becomes a potent climate change emission.

Landfills can install direct gas use projects or electricity projects with backup flare systems to capture and use methane. The technical applicability of any mitigation option is dependent on the amount of landfill gas generated by landfills in a given size category.

Zero Waste—High Recycling

Additional recovery of recyclable materials from landfills will reduce the climate change emissions associated with energy intensive material extraction and production as well as methane emission from landfills. Transforming organics/biomass and plastic waste into marketable products will also reduce the amount of material going to landfill, and therefore will further reduce climate change emissions. Currently, the State is mandated to divert 50 percent of waste going to landfills as established by the Integrated Waste Management Act of 1989. Efforts to exceed the 50 percent goal would allow for additional reductions in climate change emissions.

5.3 Strategies the Resources Agency will Implement over the Next Two Years

Table 5-2 lists all of the strategies that Resources Agency will implement over the next two years. The Forest management efforts promise not only climate change emission reductions but also protect biodiversity, water quality and habitat resources. For three decades the California Energy Commission has led the world with the most progressive new building and appliance efficiency standards. These efficiency standards have provided substantial climate change emission reductions and have saved consumers about $1,000 per household in California. Finally, by reducing the energy used to transport and deliver water in the State and increasing water use efficiency California can both protect our water supply and reduce climate change emissions.

Table 5-2. Resources Agency

Climate Change Emission Reductions (Million Metric Tons CO_2 Equivalent)	2010	2020
Department of Forestry		
Forest Management	1-2	2-4
Forest Conservation	4.2	8.4
Fuels Management/Biomass	3.4	6.8
Urban Forestry	0	3.5
Afforestation/Reforestation	0	12.5
Department of Water Resources		
Water Use Efficiency	0.4	1.2
Energy Commission		
Building Energy Efficiency Standards in Place	1	2
Appliance Energy Efficiency Standards in Place	3	5
Fuel-Efficient Replacement Tires & Inflation Programs	1.5	1.5
Building Energy Efficiency Standards in Progress	TBD	TBD
Appliance Energy Efficiency Standards in Progress	TBD	TBD
Cement Manufacturing	<1	<1
Municipal Utility Energy Efficiency Programs/ Demand Response	1	5.9

Municipal Utility Renewable Portfolio Standard	<1	3.2
Municipal Utility Combined Heat and Power	0	<1
Municipal Utility Electricity Sector Carbon Policy	3	9
Alternative Fuels: Non-Petroleum Fuels	TBD	TBD

[1] These estimates are based on best available current information and will be updated as needed.

A summary description of each of the strategies in Table 5-2 is included below:

Forest Management

Strategies for storing more carbon through forest management activities can involve a range of management activities such as increasing either the growth of individual trees, the overall age of trees prior to harvest, or dedicating land to older aged trees. With roughly 4 million acres of private managed forestland in California, changes in forest management can produce significant amounts of climate change emission reduction benefits for the state.

Inclusion of the forest sector in climate mitigation policy can lead to additional local environmental benefits that may help the state's resources adapt to potential negative effects of climate change. Overall changes in forest management can enhance and protect biodiversity, water quality, and habitat resources that the state will increasingly seek to protect in the advent of climate change.

Forest management projects could be included in a broader multi-sector climate change emission market-based program or climate trust system. In a market-based program, forest management projects could provide offsets that would be purchased by capped entities. In a climate trust program, the state would fund forest management projects and recapture the costs by selling carbon credits to industries needing to reduce their climate change emissions.

The regulatory framework for timber harvesting requires landowners to secure permits from a large number of agencies to meet the requirements of the Forest Practice Act, Endangered Species Act, and Clean Water Act. Together the time and cost of obtaining these permits have led to conversions of timberlands to other uses and made it more difficult and time consuming to implement forest management activities that would increase carbon storage. Simplification of the permitting processes for forest management and timber harvesting would result in additional carbon being stored over a larger number of acres.

Forest Conservation

Conservation projects are designed to minimize/prevent the climate change emissions that are associated with the conversion of forestland to non-forest uses by adding incentives to maintain an undeveloped forest landscape.

California is losing forestland at increasing rates: 35,000 to 40,000 acres of private forestland is converted annually to non-forest uses (Bill Stewart, 2005),

which could contribute as much as 12 million tons of CO_2 emissions annually. Policies designed to minimize or prevent forestland conversion to non-forest uses could provide significant benefits by 1) preventing or minimizing climate change emissions that are associated with increasing forestland conversion in California and 2) maintaining the opportunity to increase forest carbon stocks on these lands through additional sequestration over time.

Forest conservation can also enhance and protect biodiversity, water quality, and habitat resources that the state will increasingly seek to protect from the negative effects of climate change. Finally, in contrast to the other forest sector strategies such as reforestation, the climate benefits of forest conservation are immediate.

Specific actions that can be taken include establishing a state forest conservation program that operates independently from the federal Forest Legacy program; increasing Forest Legacy Program Funding with an $11 million annual investment that could prevent the conversion of 14,000 acres of forestland. Another step could include directing the Wildlife Conservation Board, the State Conservancies, and other state land acquisition and easement programs to consider climate benefits in evaluating and ranking projects to be funded. Finally, the state could include forestland conservation as an emission reduction project in a broader multi-sector climate change market-based program or climate trust system.

Fuels Management/Biomass

Large, episodic, unnaturally hot fires are an increasing trend on California's wild lands because of decades of fire suppression activities, sustained drought, and increasing insect, disease, and invasive plant infestations. Actions taken to reduce wildfire severity through fuel reduction and biomass development would reduce climate change emissions from wildfire, increase carbon sequestration, replace fossil fuels, and provide significant local economic development opportunities.

Fire management and biomass development projects could be accelerated by establishing a new state goal of thinning, removing, and treating 212,000 acres of public and privately owned forestland annually by 2010, and 275,000 acres by 2020. Such projects would: 1) reduce the intensity of wildfires and their associated climate change emissions; 2) increase the carbon stock of the remaining trees, 3) remove pests that create mortality of live stored carbon and reduce large damaging wildfires, 4) reduce state and local fire suppression costs; 5) provide a source of renewable alternative fuel; and 6) provide significant rural economic development opportunities.

Urban Forestry

This strategy would expand the State Urban Forestry Program. A new state-wide goal of planting 5 million trees in urban areas by 2020 would be achieved through the expansion of local urban forestry programs. At a cost of $100 per tree, $500 million would have to be invested by local urban forestry programs to meet this target.

This could be achieved by issuing an Executive Order to establish a new state-wide goal and directing the Board of Forestry and California Department of Forestry to launch an aggressive public assistance and outreach campaign to expand local urban forestry programs. The state could request that the California Climate Action Registry develop and adopt a protocol for the certification of climate change emission reductions from local urban forestry programs.

This strategy would develop new urban biomass programs. The California Department of Forestry would develop an urban biomass utilization program to provide technical advice, planning, education, and seed money for local government marketing centers for biomass waste.

Afforestation (Planting Trees)/Reforestation Projects

Reforestation projects focus on restoring native tree cover on lands that were previously forested and are now covered with other vegetative types. Recent studies have estimated that approximately 9 million acres of land in California could be reforested to increase carbon stocks and provide other benefits. Each of these acres has the potential to store between 150 to 230 tons of carbon.

Specific actions that could be taken include: establishing a new statewide goal of reforesting 500,000 acres of forestlands by 2020, including 250,000 acres on private lands and 250,000 acres on federal lands; seeking $30 million annually, or $300 million in bond funds to meet these targets; establishing a long-term loan program to fund private land reforestation; establishing a multisector market-based program where reforestation projects can be included as offsets in a broader, mulit-sector climate change market-based program; and establishing a state-owned carbon bank, modeled after Oregon's Climate Trust, as part of a market-based program.

Water Use Efficiency

Approximately 19 percent of all electricity, 30 percent of all natural gas, and 88 million gallons of diesel are used to convey, treat, distribute and use water and wastewater. The California Energy Commission (CEC) estimates 44 million tons of CO2 emissions are expelled annually on average to provide the 44 million acre feet (MAF) of water used statewide.

The key to the reduction of climate change emissions through water use efficiency is strategic investment in measures tied to water energy intensity. When a unit of water is saved, so too is the energy required to convey, treat, affect local delivery, perform wastewater treatment and safely dispose of that unit of water. In short, saving water saves energy. Saving water that gets treated as wastewater saves more energy. Saving water that gets heated or additionally pressurized saves still more.

Region, elevation, water use sector, and energy source, among other factors, all influence water energy intensity. The statewide average for climate change emissions per acre foot is skewed by the wide local variation in the water energy intensity. Everything else being equal, a cooling tower condition meter installed in an industrial plant in Northern California will save 2,920 kWh compared to

9,270 kWh saved annually in a comparable plant south of the Tehachapi Mountains.

Increased water use efficiency is the key element in the California Water Plan Update (Bulletin 160-05) plans to meet the state's needs for water in 2030 with a growing population. The plan calls for reducing urban water use by 1.1 to 2.3 MAF per year and agricultural water use by 0.5 to 2.0 MAF per year by 2030. Accelerating the investment to attain that water use savings by 2015 would result in an estimated additional climate change emission reductions of approximately 30 million tons cumulatively by 2030. Accelerating the investment to 2010 would result in a further cumulative reduction of 10 million tons.

The California Bay-Delta Authority's larger estimated potential for 3.0 MAF per year urban water use reduction requires a greater rate of local and state/federal investment in conservation. Incentive driven advances in water-saving technology over the next 25 years potentially could further push savings beyond the levels indicated.

A comprehensive program focused on the state's water and wastewater agencies and their customers would yield significant benefits to the state including: meeting the state's water plan, increasing energy system reliability and price stability, meeting the state's renewable portfolio standard goals and reducing the state's climate change emissions. Following are measures to include in this comprehensive program:

- Accelerate investment in water use efficiency: Accelerate implementation of best management practices and efficient water management practices (EWMP) and incentives. Coordinate this accelerated investment with the state's investments in energy efficiency. Start in the areas of the state with most energy-intensive water use cycles.
- Increase the energy efficiency of all water and wastewater treatment operations. Develop long-term programs to better mesh with the long-term investments in water and wastewater infrastructure.
- Improve price signals so that water-related energy use can be shifted off periods of peak energy demand.
- Increase water storage to increase operational flexibility throughout the water use cycle and reduce peak electric system energy requirements.
- Identify suitable locations for new pumped storage facilities. Construct facilities at these locations.
- Increase energy production by water and wastewater agencies from renewable sources such as in-conduit hydropower and biogas. Add generation from solar and wind resources.

Building Energy Efficiency Standards in Place

Public Resources Code 25402 authorizes the Energy Commission to adopt and periodically update its building energy efficiency standards (that apply to newly constructed buildings and additions to and alterations to existing buildings). The

Energy Commission updates the standards at its discretion (i.e. three-year cycle for building standards). In addition to the long existing legislative mandates, recent policies have placed priority on and established specific goals for updating of the standards.

The Energy Action Plan and the Integrated Energy Policy Report both call for ongoing updating of the standards, including meeting energy efficiency goals, addressing demand response and promoting the combination of solar photovoltaics and high-energy efficiency buildings. The Energy Commission has also initiated work for the building standards that will go into effect in 2008 (i.e. the first of three update cycles that will occur prior to 2015).

Appliance Energy Efficiency Standards in Place

Public Resources Code 25402 authorizes the Energy Commission to adopt and periodically update its appliance energy efficiency standards (that apply to devices and equipment using energy that are sold or offered for sale in California). The Energy Commission updates the standards at its discretion. In addition to the long existing legislative mandates, recent policies have placed priority on and established specific goals for updating of the standards.

New standards for a variety of appliances were adopted in December 2004. Some standards under consideration in December were delayed to further consider manufacturer comments. Those standards are being developed by the Energy Commission at the present time. The estimates in Table 5-1 represent the expectation of full adoption of these standards.

Fuel-Efficient Replacement Tires and Inflation Programs

State legislation (Chapter 912, Statutes of 2001) directed the Energy Commission to investigate and to recommend ways to improve fuel efficiency of vehicle tires. The bill established a statewide program to encourage the production and use of more fuel efficient tires, and required the Energy Commission to:

- Establish a test procedure for measuring tire fuel efficiency.
- Develop a database on the fuel efficiency of existing tires in order to establish an accurate baseline of tire efficiency.
- Develop a rating system for tires that provides consumers with information on the fuel efficiency of individual tire models.
- Develop a consumer-friendly system to disseminate tire fuel-efficiency information as broadly as possible.
- Study the safety implications of different policies to promote fuel efficient replacement tires in the consumer market.
- Evaluate a mandatory fuel efficiency standard for all after-market tires sold in California.

- Develop consumer incentive programs that would offer a rebate to purchasers of replacement tires that are more fuel-efficient than the average replacement tire.
- Study ways to improve the fuel-efficiency of vehicles in the State's fleet.
- AB 844 later required tire manufacturers to report to the Energy Commission the rolling resistance and relative fuel economy of replacement tires sold in California.

Building Energy Efficiency Standards in Progress

As part of the process of updating the Building Energy Efficiency Standards, the Energy Commission evaluates new and emerging technology for possible inclusion in the standards. The CEC administers an ongoing "compliance option" process which evaluates to what extent compliance credit should be approved for new technologies and develops algorithms that can be used to properly evaluate their energy consequence within building simulation computer programs that are used for standards compliance.

Upon commission approval, compliance options can be used to demonstrate compliance with the performance approach in the standards. Once a compliance option has been in existence for a period of time, the commission often considers whether or not the compliance option should be made a requirement of the standards (as a prescriptive requirement and basis of the energy budget established for the performance standards).

Appliance Energy Efficiency Standards in Progress

As part of the process of updating the Appliance Energy Efficiency Standards, the CEC evaluates new and emerging technology for increasing the energy efficiency of appliances and equipment for possible inclusion in the standards. The Commission's Buildings and Appliances Office works on an ongoing basis with the Public Interest Energy Research (PIER) program and with the Utility Codes and Standards Programs to track promising new technologies and consider their appropriate inclusion in the standards.

Fundamentally, the standards updating process is achieved thorough technology assessment of the potential to include new technologies in the standards, and the program is continuously evaluating new technologies.

Cement Manufacturing

This strategy involves cost-effective reductions to reduce energy consumption and to lower carbon dioxide emissions in the cement industry. There is a large technical potential to improve energy efficiency in cement operations at a reasonable cost.

Climate change emissions from burning fossil fuels in the manufacturing of cement produces 1.5 to 2.0 percent of U.S. carbon dioxide emissions. Roughly half is from fossil fuel combustion and roughly half is from the conversion of limestone (45 million tons per year). California's cement industry produced 5.6

million metric tons in 2001; total statewide climate change emissions approached 500 million metric tons in 2001.

Annual emissions from the manufacturing of cement are growing at a rate of 2 percent per year, according to industry sources and using California-specific data. Direct emissions of carbon dioxide are estimated to rise from 10.4 million metric tons in 2005 to more than 15 million metric tons in 2025. Use of limestone Portland cement and the use of blended cement account for 70 percent of the potential emission reductions and would cost less than $10 per metric ton.

State policy options can take several forms, including technology mandates, financial incentives, negotiated agreements, voluntary commitments, emissions-intensity benchmarking, or mandatory measures. Policy changes would be needed to encourage the use of limestone and blended cement and to allow waste tires to be used as a fuel in cement manufacturing. Based on CEC's analysis, these measures have been shown to provide cost-effective climate change emission reduction benefits.

Municipal Utility Energy Efficiency Programs

The Energy Commission and the California PUC are collaborating on additional energy efficiency programs beyond those programs already adopted.

While the Energy Commission does not have regulatory authority over the publicly owned utilities in the way that the CPUC regulates the IOUs, the publicly owned utilities are required to report their energy savings to the CEC. A process to ensure comparability between public benefit program savings and funding data reported by public and investor-owned utilities will need to be established. Possible steps for implementing this strategy include:

- Pursuing statutory modifications or a cooperative agreement with the publicly owned utilities to achieve the needed CO_2 reductions.
- Seeking statutory modifications or the establishment of a formal memorandum of understanding (MOU) with the utilities to achieve these targets.
- Pursuing statutory modifications or another mechanism to ensure that all load-serving entities account for climate change emissions and emission reductions in a manner consistent with investor-owned utilities.

Municipal Utility Renewable Portfolio Standard

California's Renewable Portfolio Standard (RPS), established in 2002, requires that all load serving entities achieve a goal of 20 percent of retail electricity sales from renewable energy sources by 2017, within certain cost constraints. The *2003 Energy Action Plan* and the *2003 Integrated Energy Policy Report* (2003 *Energy Report*) accelerated the 20 percent goal from 2017 to 2010. The *2004 Energy Report Update* further recommended an increased goal of 33 percent renewable by 2020, which the California Public Utilities Commission (CPUC) and the California Energy Commission (Energy Commission) adopted in the *2005 Energy Action Plan II.*

The Energy Commission and the CPUC are responsible for implementing the RPS for the investor-owned utilities, electric service providers, and community choice aggregators. The publicly-owned utilities are responsible for implementing their own RPS programs.

The CPUC has undertaken a study to identify the steps necessary to achieve the 33 percent goal for the state's IOUs. The Energy Commission is undertaking a similar related study on RPS programs adopted by publicly-owned utilities, including barriers and policy options to accelerate those programs to reach the 20 percent goal by 2010 and 33 percent goal by 2020. Possible steps for implementing this strategy include:

- Pursuing a cooperative agreement with the publicly-owned utilities to achieve the needed climate change emission reductions.
- Seeking statutory modifications to require the publicly owned utilities to contribute proportionally to the state's RPS goals.
- Seeking statutory modifications or a cooperative agreement to ensure that publicly-owned utilities account for climate change emissions and emission reductions in a manner consistent with investor-owned utilities.

Municipal Utility Combined Heat and Power

This strategy constitutes cost-effective reductions from fossil fuel consumption in the commercial and industrial sector through application of on-site power production to meet both heat and electricity loads. To effectively implement this strategy, various policy instruments will likely be needed to attain the realistic market potential and subsequent climate change emission reductions.

These policy mechanisms may include regulatory incentives to encourage utilities to promote customer and utility-owned CHP, utility rate structures that are transparent and connected to market forces where externalities such as environmental impacts and transmission and distribution constraints are internalized, rules and regulations enabling easier access to wholesale markets, production tax credits for CHP, and other measures or incentives directed at key commercial and industrial activities in California.

Through existing efficiency commercialization programs at the CEC where relationships have been well established with the commercial and industrial sectors, a set of implementation activities will be developed that include:

- Utility tariffs to enable CHP owners to sell excess on-site electricity generation to the utility at prevailing wholesale prices. Existing analysis suggests this would be very effective in stimulating the near-team (next 5 years) market.
- Climate change emission reduction credits to reflect the net reduction of climate change emissions for the CHP systems compared to the avoided electricity and boiler fuel emissions.
- Transmission and distribution benefit payments that reflect the local and temporal benefits CHP provides utilities.

- Utility regulatory incentives to encourage utilities to promote installation of customer- and utility-owned CHP projects.

Municipal Utility Electricity Sector Carbon Policy

The Energy Commission and the CPUC are collaborating on additional programs to address ways to transition investor-owned utilities away from carbon-intensive electricity sources. Some publicly owned utilities have historically relied on coal-based generation, and many of these facilities will reach the end of their design life by 2020. The Energy Commission will explore options to encourage municipal utilities to transition away from carbon-intensive generation to low-carbon alternatives, and to reduce purchases of carbon-intensive power. Options include establishing emissions targets or caps, providing incentives for preferred generation options, and setting a climate change emission performance standard for new utility resource procurement, including both coal and non-coal resource additions.

In its recently adopted *2005 Integrated Energy Policy Report*, the Energy Commission recommends:

- Any climate change emission performance standard for utility procurement should be set no higher than emission levels achieved by a new combined-cycle natural gas turbines. In the case of coal-fired generation, the capacity to capture and store carbon dioxide safely and inexpensively is essential for meeting these standards.
- The state should specify a climate change emission performance standard and apply it to all utility procurement, including in-state generation and out-of-state purchases, coal, and non-coal resources.
- Additional consideration is needed before determining what role climate change emission offsets could play in complying with such a standard.
- The Energy Commission should work with the CPUC to develop a framework that accounts for the financial risk of reliance on carbon-based generation.
- California should have a consistent electricity carbon policy for all electric utilities within the state that applies to both in-state generation and out-of-state power purchases.

Alternative Fuels: non-Petroleum Fuels

This strategy involves increasing the use of non-petroleum fuels in California's transportation sector, as recommended in the Energy Commission's *2003 and 2005 Integrated Energy Policy Reports.* The Governor has also directed the Energy Commission to develop a workable, long-term transportation fuels plan that will result in significant reductions in gasoline and diesel use and that will establish realistic and achievable objectives. The Bio-Energy Interagency Working Group, which the Energy Commission is leading, has been asked to recommend options for optimizing the market potential for bio-fuels through a coordinated state level effort.

State policy options can take several forms, including technology performance standards, financial incentives, negotiated agreements, voluntary commitments, emissions-intensity benchmarking for fuel producers or automobile manufacturers, or other mandatory measures, such as fuels or motor vehicle standards or a market-based program. Based on our analysis, some alternative fuels have been shown to provide cost-effective climate change emission reduction benefits. But they face economic, market, or regulatory barriers that are impeding their use.

To achieve the benefits of this strategy, the following implementation issues would need to be overcome:

- The high first cost of alternative-fuel vehicles, when compared to conventional vehicles using internal combustion engines.
- The absence of a convenient retail fueling network to dispense alternative fuels to customers.
- Other regulatory and market barriers.

5.4 Strategies Other State Agencies will Implement over the Next Two Years

Table 5-3 lists all of the strategies that other state agencies will implement over the next two years. Many participants at the Climate Action Team public meetings, particularly in Southern California, indicated that smart land use and increased transit availability should be a priority in the state. The participation of Business, Transportation and Housing Agency on the Climate Action Team has highlighted the fact that such strategies can provide substantial climate change emission reductions. Similarly the efforts of the Department of Food and Agriculture and the State and Consumer Resources Agency provide benefits beyond their climate change emission reduction potential.

Table 5-3. Other State Agencies

Climate Change Emission Reductions (Million Metric Tons CO_2 Equivalent)	2010	2020
Business, Transportation and Housing		
Measures to Improve Transportation Energy Efficiency	1.8	9
Smart Land Use and Intelligent Transportation	5.5	18
Department of Food and Agriculture		
Conservation tillage/cover crops	TBD	
Enteric Fermentation	<1	<1

State and Consumer Services Agency		
Green Buildings Initiative	0.5	1.8
Transportation Policy Implementation	TBD	

[1] These estimates are based on best available current information and will be updated as needed.

A summary description of each of the strategies in Table 5-3 is included below:

Measures to Improve Transportation Energy Efficiency

This strategy builds on current efforts to provide a framework for expanded and new initiatives including incentives, tools and information that advance cleaner transportation and reduce climate change emissions.

The effort includes the following:

- Incorporating energy efficiency and climate change emissions reduction measures into the policy framework governing land use and transportation, including framework for developing energy element in state transportation and regional planning documents. Better coordination on cross-agency climate change and energy policy framework to ensure a concerted effort and synergy among state agencies' climate change emission reduction activities.
- Increasing incentives and accelerating technology applications to improve transportation system productivity and move toward cleaner and more efficient vehicles, especially for the public sector fleet. Enhancing outreach and educational programs to bring a coordinated message of sustainable transportation and root causes of climate change emissions.
- Diversifying transportation energy infrastructure and advancing measures to slow the rate of vehicle miles traveled growth and excessive reliance on petroleum.

Smart Land Use and Intelligent Transportation

Smart land use is an umbrella term for strategies that integrate transportation and land-use decisions. Such strategies generally encourage jobs/housing proximity, promote transit-oriented development, and encourage high-density residential/commercial development along transit corridors. These strategies develop more efficient land-use patterns within each jurisdiction or region to match population increases, workforce and socioeconomic needs for the full spectrum of the population.

Intelligent Transportation Systems (ITS) is the application of advanced technology systems and management strategies to improve operational efficiency of transportation systems and movement of people, goods and services. Smart growth/land use and ITS would minimize the need for major capital improvements and can provide a host of benefits including more livable communities, transportation energy efficiency, lower emissions from mobile sources, and a lower-cost provision of public services (e.g., sewer, water).

Governor Schwarzenegger is finalizing a comprehensive 10-year strategic growth plan with the intent of developing ways to promote, through state investments, incentives and technical assistance, land use, and technology strategies that provide for a prosperous economy, social equity, and a quality environment. The Administration is pursuing funding and budgetary measures to support the strategic growth plan.

Smart land use, demand management, ITS, and value pricing are critical elements in this plan for improving mobility and transportation efficiency. Specific strategies include: promoting jobs/housing proximity and transit-oriented development; encouraging high density residential/commercial development along transit/rail corridor; valuing and congestion pricing; implementing intelligent transportation systems, traveler information/traffic control, incident management; accelerating the development of broadband infrastructure; and comprehensive, integrated, multimodal/intermodal transportation planning.

Conservation/Tillage Cover Crops

Conservation tillage and cover crops practices are increasingly being used by California farmers for a variety of reasons, including improved soil tilth, improved water use efficiency, reduced tillage requirements, saving labor and fuel, and reduced fertilizer inputs. However, due to the wide diversity of California agriculture, these practices must be demonstrated in a wide variety of cropping systems, soil types, irrigation regimes, and climate conditions.

This diversity also creates difficulty in quantifying both carbon emissions and potential carbon sequestration benefits from implementing conservation tillage and cover crops in the myriad of California cropping systems. This potential needs to be verified through extensive research directly applied to California conditions. Thus, the potential climate change emission reductions for 2010 and 2020 remains to be determined.

Enteric Fermentation

Enteric fermentation is the process of feed digestion by ruminant animals (primarily dairy and beef cattle). This process results in methane emission from the animals. To reduce climate change emissions resulting from enteric fermentation, feed adjustments may be made that improve milk and meat productivity.

New measures would include establishing a research initiative to quantify emission changes from enteric fermentation resulting from changing feed regimens versus productivity impacts. Different animal populations would have differing abilities to manage feed rations. For example, grass-fed beef would have little to no ability to reduce enteric emissions. Dairy operators vary feed rations based on numerous factors. Feed rations are a complex system that not only provide nutrition to the animal, but also provide cost-effective and efficient use of other agricultural by-products including food processing residuals, fruit culls, almond hulls, cotton seed, and even rice straw.

This system would have to be carefully analyzed to determine overall climate change emission effects if the use of these other residuals is altered. This analysis would include both a technical analysis and a cost effectiveness analysis that would be initiated in 2006.

Pricing of food commodities to reflect embodied climate change emissions is not recommended for any action at this time. A "calcium crisis" currently exists in this country, where a significant portion of women and children are calcium deficient. Milk and dairy products are a major source of calcium that should be available to these at-risk populations, especially those of low and moderate income, at affordable prices.

Green Buildings Initiative

Governor Schwarzenegger's Green Building Executive Order, S-20-04, sets an ambitious goal of reducing energy use in public and private buildings by 20 percent by the year 2015, as compared with 2003 levels. The Executive Order and related action plan spell out specific actions state agencies are to take with state-owned and -leased buildings. The order and plan also discuss various strategies and incentives to encourage private building owners and operators to achieve the 20 percent target.

Preliminary estimates indicate that 6.5 million tons of CO_2 will be reduced annually by the year 2015 through building efficiency efforts in commercial and institutional buildings. This number is based on the average displaced power generation being an efficient natural gas combined cycle turbine. The 6.5 million-ton estimate has been adjusted in Table 5-2 to ensure against double counting amongst other strategies being recommended by the CAT.

5.5 Strategies the Public Utilities Commission will Implement Over the Next Two Years

Table 5-4 lists all of the strategies that the Public Utilities Commission will implement over the next two years. Working in cooperation with the Energy Commission, the Public Utilities Commission has implemented the most progressive Renewable Portfolio Standard in the nation. The Public Utilities Commission has also been progressive in energy efficiency and clean energy programs for investor-owned utilities. Many stakeholders indicated that these programs should apply to the publicly-owned utilities as well.

Table 5-4. Public Utilities Commission

Climate Change Emission Reductions (Million Metric Tons CO_2 Equivalent)	2010	2020
Accelerated Renewable Portfolio Std to33% by 2020 (includes load-serving entities)	5	11

California Solar Initiative	0.4	3
Investor Owned Utility Energy Efficiency Programs(including LSEs)	4	8.8
Investor-Owned Utility (IOU) Additional Energy Efficiency Programs/Demand Response	NA	6.3
IOU Combined Heat and Power Initiative	1.1	4.4
IOU Electricity Sector Carbon Policy	1.6	2.7

[1] These estimates are based on best available current information and will be updated as needed.

A summary description of each of the strategies in Table 5-4 is included below:

Accelerated Renewable Portfolio Standard (33 percent by 2020)

The Governor has set a goal of achieving 33 percent renewables in the State's resource mix by 2020. The joint PUC/Energy Commission September 2005 Energy Action Plan II (EAP II) adopts the 33 percent goal. The PUC and Energy Commission have already commenced review of the legal, regulatory, and infrastructure changes necessary to achieve the Governor's goal.

The Center for Resource Solutions has prepared a preliminary report for the CPUC entitled *Achieving a 33% Renewable Energy Target* (The Center for Resource Solutions, November 1, 2005), which concludes that the 33 percent target by 2020 is achievable and discusses the major hurdles and necessary implementation steps. The report is a starting point for further review by the CPUC on instituting a 33 percent goal.

California Solar Initiative

The solar initiative includes installation of 1 million solar roofs or an equivalent 3,000 MW by 2017 on homes and businesses, increased use of solar thermal systems to offset the increasing demand for natural gas, use of advanced metering in solar applications, and creation of a funding source that can provide rebates over 10 years through a declining incentive schedule.

Legislation to codify the Governor's initiative (SB 1) failed to pass the California Assembly in the fall of 2005. However, the PUC, in cooperation with the Energy Commission and the Governor's Office, will implement the California Solar Initiative under its existing statutory authority.

Investor-Owned Utility Energy Efficiency Programs

In September 2004, the PUC adopted aggressive savings targets for the investor-owned utility energy efficiency programs through 2013. The savings targets through 2013 are challenging goals to meet, and the PUC will reassess these targets and adopt more realistic goals during each three-year program cycle.

The PUC funds energy efficiency programs through the Public Goods Charge and the resource procurement budgets of the utilities. For the 2006–2008 program cycle, the total energy efficiency budget for all of the investor-owned

utilities is approximately $2 billion, for a total projected annual net savings of 7,371 gigawatt hours and 121,989 million therms. These projections exceed the savings targets by 108 percent and 109 percent respectively. By 2008 these programs will reduce annual carbon dioxide emissions by more than 3 million tons per year.

Investor Owned Utility Additional Energy Efficiency Programs/Demand Response

In September 2004, the PUC adopted aggressive savings targets for the IOUs' energy efficiency programs through 2013. The savings targets through 2013 are stretch goals and the PUC will reassess these targets and adopt the actual goals during each three-year program cycle. The PUC funds energy efficiency programs through the Public Goods Charge and the IOUs' resource procurement budgets. For the 2006–2008 program cycle, the total energy efficiency budget for all of the IOUs is approximately $2 billion, for a total projected annual net savings of 7,371 gigawatt hours and 121,989 million therms. These projections exceed the savings targets by 108 percent and 109 percent respectively. By 2008 these programs will reduce annual carbon dioxide emissions by more than 3 million tons per year.

Over the next year, the PUC will develop a risk/reward incentive mechanism for the IOUs and refine energy measurement and verification protocols. In 2008, the PUC will evaluate and adopt the 2009–2011 energy efficiency savings goals and programs of the IOUs.

Investor-Owned Utility Combined Heat and Power Initiative

This strategy encourages the installation of on-site power production to meet both heat and electricity loads, known as combined heat and power projects (CHP). The PUC's existing Self-Generation Incentive Program allocates $0.80 per watt to eligible CHP projects in the territories of the IOUs, up to a capacity size of 5 MW. Currently, all SGIP funds are reserved through 2007, although funding may become available if proposed projects do not materialize.

This strategy would seek to develop additional programs to further encourage the development of CHP. These additional programs are not yet underway, will require further consideration, and could likely require administrative, legislative, regulatory, and budget initiatives. To effectively implement this strategy, it is likely various policy instruments will be needed to attain the realistic market potential and subsequent CO_2 reductions.

These policy mechanisms may include regulatory incentives to encourage IOUs to promote customer and utility-owned CHP, changes to IOU rate design, market rules and regulations enabling easier access to wholesale markets, production tax credits for CHP, and other measures or incentives directed at key commercial and industrial activities in California. Statutory modifications are required in order to apply a similar strategy for CHP programs implemented by publicly-owned utilities.

Investor Owned Utility Electricity Sector Carbon Policy

The PUC is currently investigating various strategies and incentives to encourage the IOUs to make cost-effective procurement decisions that are based in part on reducing climate change emissions. These strategies include emissions targets or caps, incentives for preferred procurement options, and incentives for portfolio optimization and total cost minimization.

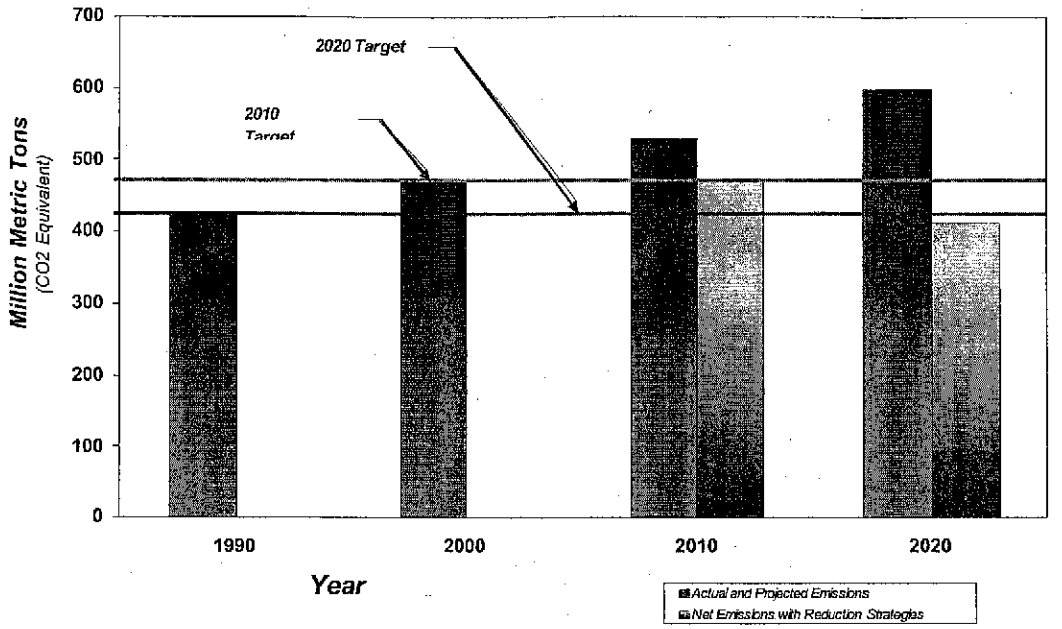
The PUC conducted workshops in March 2005 on the procurement incentive framework and issued a staff report in March 2005. The post-workshop comments were filed in April and May 2005. A final decision to include a carbon cap on emissions associated with all utility procurement activities was adopted in February of 2006. This strategy includes the following steps:

- Determine a methodology the IOUs will use to report their climate change emissions.
- Continue to work with the CEC to ensure that the IOUs and the municipal utilities use consistent methodologies to report their emissions.
- Begin work to establish emission baselines for IOUs.

5.6 The Governor's Targets Can Be Met

Based on the emission reduction potential demonstrated in the tables above and illustrated in Figure 2-1 below, it is clear the Governor's targets are achievable. However, continued top-down leadership as has been demonstrated by this Governor as well as a coordinated agency-level effort as has been achieved via the Climate Action Team will be essential to success.

Figure 5-1. California's Target Can Be Met



5.7 Emission Baseline Development

For the purposes of this report, it is necessary to use historical climate change emissions for the years 1990 and 2000 and projected climate change emissions for 2010 and 2020.

Table 5-5 illustrates the baseline data was that was used:

Table 5-5 Baseline Inventory Estimates*

Climate Change Emission Baseline (Million Metric Tons CO_2 Equivalent)				
Year	1990	2000	2010	2020
Baseline Emissions	426	473	532	600

* Not including international marine bunker fuels

The baseline climate change emissions used to compute reductions needed to meet Governor's targets were developed with the assistance of Tellus Institute working with the ARB and CEC. The CEC publishes climate change emission inventory updates on a regular basis and updates its Integrated Energy Policy Report in odd years. In 2007, the Energy Commission will update both reports and integrate these efforts to produce projected 2010 and 2020 climate change emissions.

5.8 Economic Assessment

The overall economic impact of implementing the strategies in Section 5.2 were estimated using a computable general equilibrium (CGE) model of the California economy. A CGE model simulates the functioning of a market economy in which different sectors interact with one another (one sector supplies inputs to another, or purchases the outputs of another) and where prices and production adjust in response to changes caused by government policies applied to specific sectors. The CGE simulates these relationships among California producers, California consumers, government, and the rest of the world. Because of the interconnection between sectors, an intervention in one sector has impacts on all others, which are captured by the CGE model analysis.

The results of a preliminary assessment of the macroeconomic impacts associated with the climate change emission reduction strategies show that the overall impacts of the climate change emission reduction strategies on the California economy are expected to be positive. Specifically, when the strategies already underway as well as new strategies being proposed are considered in total, the resulting impacts on the economy are expected to translate into job and income gains for Californians. For example, in 2020 the implementation of the strategies is expected to increase jobs and income by an additional 83,000 and $4 billion, respectively, above and beyond the substantial growth that will occur between today and 2020.

The favorable impacts on the economy are possible because of the reduced costs associated with many of the strategies. The additional job growth is expected to come from the net savings to consumers associated with the implementation of the strategies. The savings will in turn promote further business expansion and job creation.

A subsequent refined analysis is planned over the next year. The refined analysis will incorporate updated cost and savings estimates for the strategies. It will also assess the cost-effectiveness of the various individual strategies. Thus, the refined economic analysis will provide additional information to decision-makers as they proceed with implementation of the strategies.

6 MARKET-BASED OPTIONS FOR CALIFORNIA

Market-based programs can be integral to California's strategy for reducing climate change emissions. Options considered by the Climate Action Team would set an emissions cap that can be phased down over time but allow regulated sources flexibility to comply with the cap. Such flexibility would be designed to provide the greatest certainty of benefits at the least cost possible.

Because climate change emissions originate from diverse sources and are long-lived gases in the atmosphere, setting an overall emission cap and allowing flexibility through trading, allocation schemes such as auctioning credits, and/or offsets is recognized as a particularly effective strategy for reducing emissions from many (but not all) climate change emission sources. This approach is best applied to sources with emissions that can be measured or calculated reliably.

Emission sources that are diffuse, difficult to quantify, or small, are not good candidates for inclusion in market-based programs.

The European Union (EU) adopted a market-based approach to reduce climate change emissions from four energy-intensive sectors: (1) energy (electric power, oil refineries, and coke ovens); (2) metal ore, iron and steel production; (3) minerals (cement, lime, glass, and ceramics); and (4) pulp and paper. Initiated in 2005, the EU program is the largest market-based program in the world, involving 25 countries and more than 12,000 installations.

In the U.S., the Acid Rain Trading Program and the Northeast NO_x Program/NO_x SIP Call Program have successfully implemented a market-based programs to limit air emissions.[26] The ability to trade emission allowances has been credited with lowering significantly the cost of reducing emissions under these programs.[27] Additionally, compliance has been nearly 100 percent, so that emissions have been reduced as scheduled.[28]

The primary weakness associated with implementing a market-based program in California is that it will be vulnerable to emission "leakage." If the state implements the program without other states, there will be an incentive for activities that emit climate change emissions to shift to neighboring states to avoid the emission cap. If this occurs, emissions may decline in the state, only to increase in other states.

A coordinated national approach to capping climate change emissions within an international framework would be the best approach for addressing this leakage problem. In the absence of national action, leakage may be partially mitigated through the design of the program and ongoing efforts to coordinate with other states, such as the Northeast States or other Western states that are taking action to reduce climate change emissions.

As part of the implementation of a market-based program, data should be collected over time to assess the extent to which leakage occurs, and its impacts on businesses and on the effectiveness of the emissions cap.

6.1 Market-Based Program Design Options

Realizing the emissions certainty and the cost advantages of a market-based program leads to two overarching program design principles:

Broad Coverage is Preferred

- Broad coverage enables the program to have a direct impact on a large portion of total climate change emissions.
- By covering a broad range of emission sources, the program can capture the least-cost emission reduction opportunities.
- Broad coverage enlarges the set of emissions sources with an incentive to innovate to find ways to reduce emissions.

Flexibility is Preferred

- Compliance flexibility lowers the cost of reducing climate change emissions.
- Sources can meet their obligation under the cap using diverse methods.
- Sources can bank early emission reductions to reduce compliance costs in subsequent time periods.

The desire for broad coverage and flexibility must be tempered by administrative realities and source-specific considerations. For example, sources with emissions that are difficult to measure or calculate reliably may not be suitable for including under the cap. Similarly, sources that derive from numerous small emission points may be administratively burdensome to include.

There is no one best answer for how to design a market-based program to reduce climate change emissions. Rather, trade-offs are required to create a program that promotes real low-cost emission reductions in a framework that is equitable and administratively feasible.

The market-based program design options are described in terms of:

- *Scope:* The scope of the program defines the sectors, sources, or activities that are included under the cap.
- *Allowance distribution:* Emission allowances can be auctioned or given to regulated sources.
- *Emission offsets:* Offsets are verified emission reductions achieved by facilities. Offsets can replace or augment emissions trading.
- *Other Program Design Elements:* The climate change emissions included; whether to place restrictions on trading, offsets or auctioning of emission allowances; the manner in which allowances can be banked for future use or borrowed against future limits; and the manner in which compliance and enforcement will be performed must be defined.

Program Scope

The program scope defines the entities included in the market-based program. The market-based options subgroup examined three representative alternatives for defining the program scope: a sector-based emissions cap; an emissions cap on major stationary source combustion; and a fuels-based carbon cap.

A sector-based emissions cap could cover up to 30 percent of the state's climate change emissions by focusing on five key industries: electric power; oil refining; oil and gas extraction; landfills; and cement production (see Table 6-1). Reaching this level of coverage requires that the electric power sector be defined to capture all the emissions from electricity consumed in the state.

Approximately 10 percent of state climate change emissions come from in-state generation of electricity, and another 10 percent of emissions comes from out-of-state generation of electricity that is consumed in the state. To include the out-of-state emissions in a market-based program, the electric sector can be defined as Load Serving Entities (LSE) rather than electric generation facilities.

LSEs are responsible for procuring and delivering electric power to customers. In California there are three investor owned utilities (IOU) that are LSEs: Pacific Gas and Electric; Southern California Edison; and San Diego Gas and Electric. Municipal utilities, irrigation districts, the Department of Water Resources, and private electric service providers are also LSEs.

Under an LSE-based definition, each LSE would be required to hold emission allowances that cover the emissions associated with the power they deliver to their customers. To comply with its emission cap, each LSE would track or calculate the emissions associated with all the electricity it delivered, regardless of whether it was produced in California or out of state.

This LSE approach differs fundamentally from the option of focusing on in-state generators. Under the LSE approach, LSEs hold the emission allowances—not the generators. Each LSE would have the responsibility to obtain power from the set of generators that enables it to comply with its emission cap. LSEs could trade emission allowances: those with extra allowances could sell to those who need additional allowances, given their procurement decisions.

Table 6-1. Market-Based Scope Defined by Sectors

Sector	# Entities	Portion of State Climate Change Emissions
Electric Power Sector:		
Generation Based: In-state generators (≥25 MW)	≈313 facilities	≈10%
Load Serving Entity Based: All Load Serving Entities	≈47 LSEs	≈20%[a]
Other Sectors:		
Oil Refining	21 refineries	≈3%
Oil and Gas Extraction	429 facilities	≈3%
Landfills	≈300 landfills	≈2%
Cement Production	11 cement plants (various)	≈1.5%
Others		<1%
Mobile Sources:		
Motor Gasoline (light duty vehicles, on and off road)	(Not Applicable)	≈28%
Diesel—on road		≈7%
Domestic Aviation		≈6%
Other		<2%

a. Includes emissions from electricity imports.

Source: Climate change emissions estimates from Bemis, Gerry and Jennifer Allen, *Inventory of California Greenhouse Gas Emissions and Sinks: 1990 to 2002 Update*, California Energy Commission Staff Paper, Sacramento, California, Report CEC-600-2005-025, June 2005.

This LSE-based approach has several advantages.

The LSE-based approach captures a larger portion of climate change emissions than a generator-based definition of the electric power sector.

The LSE-based approach mitigates the emission leakage problem that arises under an in-state generator-based approach. Under the LSE-based option, in-state and out-of-state generation are treated equally, and the cap applies to total emissions associated with all electricity consumed in the state. Therefore, there is no opportunity to avoid the cap and there is no leakage.

The LSE-based approach motivates emission reduction opportunities that are not motivated by a generator-based system. To comply with its emission cap, an LSE could promote energy efficiency among its customers as a means of reducing the load itself. LSEs can also procure renewable-based power or shift to fossil-generated power sources with lower emissions. An LSE by its nature has a broader set of opportunities for achieving its emissions cap, as compared with an individual power plant owner/operator.

To implement the LSE-based option, the power sector must track emissions associated with all (or nearly all) power generation through the market to its eventual delivery. Such a tracking system does not currently exist, and developing it presents significant challenges. There are several workable approaches for solving this problem, and the effort is worthwhile to enable an LSE-based approach to be used.

The other industrial sectors with significant climate change emissions are oil refining, oil and gas extraction, landfills, and cement production. These industries have a manageable number of facilities that could be included in a market-based program (see Table 6-1).

The mobile source sector, the largest individual source of climate change emissions in California (42 percent), is not easily accommodated in a market-based program defined in terms of sectors. Diverse factors affect climate change emissions from mobile sources, including the demand for mobility; the cost, availability, and convenience of travel options, including private vehicles and mass transportation; and the emissions per passenger mile of the transportation mode used, which is driven by the technology employed and the fuel used.

A coordinated set of policies is needed to address the factors that influence mobile source climate change emissions: a sector-based cap is necessarily a partial solution. The main practical sector-based option would be to make vehicle manufacturers the point of regulation.

Based on the emission intensity of each vehicle (emissions per mile) and the expected annual miles driven by each vehicle type, the emissions "embedded" in new vehicle sales could be calculated. The manufacturers could be provided with an emission cap for their total new vehicle sales each year. Manufacturers would comply with their caps by reducing the emission intensity of their vehicles or by shifting the mix of vehicles sold toward those with lower emission intensity.

This vehicle manufacturer cap is similar to recently adopted vehicle climate change emission standards that limit average emissions per mile. The standards do not cap total emissions—emissions can increase or decrease as new vehicle sales increase or decrease. By putting a cap on total emissions, the manufacturer-based emission cap would constrain emissions even if new vehicle sales increase.

While the two regulatory policies do not necessarily conflict, it would be critical to coordinate the two policies if they were to be enacted simultaneously. However, such a cap is probably not needed in the short term, while the emission standards come into force for the first time. Emissions associated with the mobile sector could be monitored over time to assess whether a cap is needed.

An alternative to a sector-based program is an emissions cap on major stationary source combustion in the state. This approach would encompass all major stationary sources of carbon dioxide (CO_2) emissions, without reference to specific sectors as being either in or out of the cap. This scope would not capture mobile source emissions.

Based on preliminary analyses, CO_2 emissions from these sources appear to be concentrated in about 750 facilities statewide. These facilities account for more than 90 percent of CO_2 emissions from stationary fossil fuel combustion, or nearly 20 percent of total state climate change emissions. As discussed above, it may be preferred to define the electric power sector as LSEs to capture emissions associated with imported power and to address the potential for leakage.

The resulting program would be a hybrid approach: the electric sector would be defined to include all LSEs, and all remaining major stationary combustion sources (not including in-state generation) would be included under the stationary source definition.

A third approach to defining the scope of the program is to set a fuels-based carbon cap. This comprehensive fuels approach would reduce climate change emissions by placing a cap on the total carbon content of oil, gas, and coal consumed in the state. The primary advantage of this approach is that it encompasses all sectors that use fossil fuels. Consequently, all options for reducing fossil fuel combustion across all sectors can contribute to achieving the emissions cap.

To achieve climate change emission reductions via this cap, "carbon allowances" would be required to be held by entities at specific points in the distribution or use of fossil fuels in the state. The points at which allowances are required should be

selected to minimize administrative burden and maximize coverage and effectiveness. For fuel markets, these considerations favor an "upstream" approach to regulating the total carbon content of fossil fuel combustion: fuel producers and importers would be required to hold carbon allowances for the fuels they produce in the state or import into the state.[29]

For liquid fuels, carbon allowances could be required where liquid fuels enter into commerce at refineries, marine terminals, and storage facilities. An alternative is to track the carbon content of the crude oil and natural gas liquid inputs to refineries. This refinery input tracking may be simpler than tracking the carbon content of multiple products. Additionally, it has the advantage of incorporating in the cap the carbon emissions from refinery operations. The carbon content of imported refined products would need to be tracked under either option.

The upstream point for tracking natural gas flows would be at major pipeline transfer points and the natural gas utilities. Coal does not appear to have a convenient upstream point in the market for tracking carbon consumption. Because relatively small amounts of coal are used in the state, it may be easiest to track coal combustion downstream; for example, in major boilers.

The comprehensive fuel carbon cap covers about 75 percent of the state climate change emission inventory, including mobile sources. Limits on fossil fuel supply provide incentives for both: (1) improving the efficiency with which fossil fuels are used; and (2) developing non-fossil energy sources. Comprehensive mobile sector improvements are motivated, including shifting modes of transportation, improving vehicle efficiency, and adopting non-fossil based fuels.

This comprehensive fuel approach has several drawbacks. Non-fuel related emissions are, by definition, excluded from the scope of the program. To cover these emissions, a separate program component would be needed for the specific non-fuel related sources and processes. Alternatively, emission reductions from these sources could motivated by making them eligible to produce and sell emission offsets.

Perhaps most significantly, the comprehensive cap on fossil fuel carbon essentially creates an absolute limit on the availability of fossil fuels in the state. The supply constraint would lead to increases in the prices for fuels, which would be the primary motivation for improving fuel use efficiency and for developing alternative fuels. The size of the price increase will depend on the level of the carbon cap and the cost and availability of alternative fuels. During a transition period, prior to the widespread availability of alternative fuels, price increases could be substantial if the fossil fuel carbon cap is set too low.

The impacts of increased fuel prices would need to be mitigated in order to make this approach viable. If the impacts of increased fuel prices could be managed, California businesses could realize a competitive advantage through access to a more diverse fuel supply that is both less susceptible to price shocks and supply disruptions and more sustainable economically and environmentally. The key to realizing this outcome is to adopt a gradual phase-down of fossil-carbon based

fuels that allows improved efficiency and alternative fuels to constrain the rate of price increases.

One way to prevent unacceptably high fuel price increases is to put a maximum value on the carbon allowances, and to make additional carbon allowances available at that maximum value. This "safety valve" for the market sets an upper bound on the impact of the carbon cap on fuel prices. However, it also effectively removes the cap when the maximum value is reached. Nevertheless, a safety valve of this type may be needed to help ensure that unacceptable price increases are avoided during transition periods.

The implementation of this comprehensive fuel approach would need to address the vulnerability of the electricity sector to leakage: the cap on fossil-carbon based fuels would not cover electricity imports. This electric-sector leakage could be addressed by adopting the LSE-based approach discussed above.

The resulting program would be a hybrid: an emissions cap would be placed on the electric sector, defined to include all LSEs, and a cap on fossil-carbon based fuels would also be in place (any fuels used to produce electricity delivered by the LSEs would not count against the fuel cap). The two caps, one on LSE emissions and one on carbon in fuels, could be traded to allow emissions to flow to their most highly valued uses.

If California is the only state in the western U.S. to implement this comprehensive fuel approach, a "black market" for fuels may develop, particularly for liquid transportation fuels. Although marine terminals, storage facilities, and refineries could be tracked, gasoline is easily transported long distances in tanker trucks. Fuel from neighboring states could be trucked into California without the proper carbon allowances. Policing this activity could be difficult, and if significant fuel volumes move through a black market, the effectiveness of the cap will be eroded.

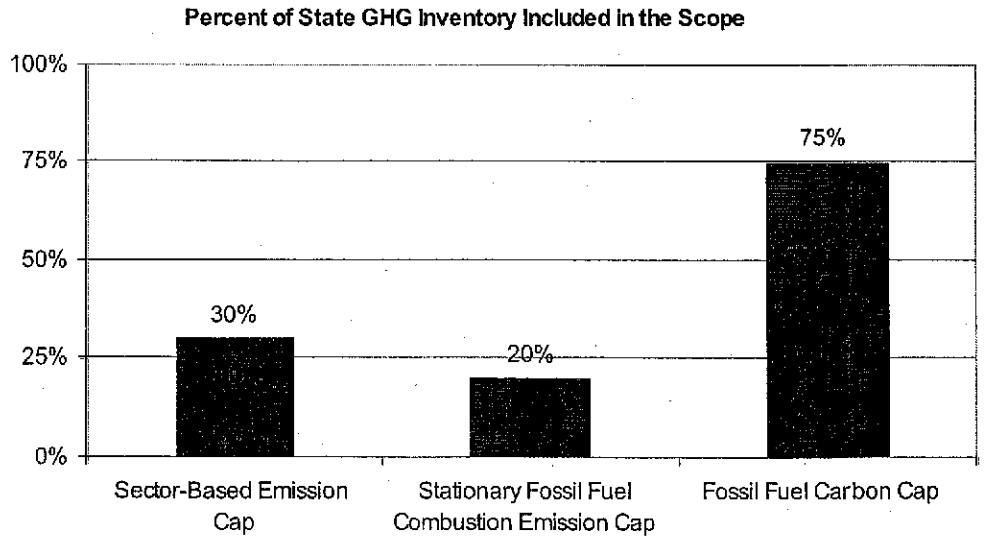
We can make several observations regarding the three representative approaches for defining the scope of a market-based program for reducing climate change emissions in California:

- The fuel-based carbon cap is the most comprehensive, encompassing the greatest diversity of emission reduction opportunities and motivating action across the broadest set of emission sources (see Figure 6-1).
- The sector-based approach focuses attention on the specific industries that contribute most to state climate change emissions. Stationary sources in the largest sectors cover about 30 percent of the state emission inventory. To significantly increase coverage beyond 30 percent, mobile sources, with about 42 percent of the emission inventory, would need to be included in the cap. However, mobile sources are not conducive to a sector-based approach.
- The stationary source definition of program scope encompasses all major stationary sources of CO_2 emissions from fossil fuel combustion, without reference to specific sectors as being either in or out of the cap.

Approximately 750 facilities could be included in the program to cover the overwhelming majority of emissions from these sources. This scope does not capture mobile source emissions, and consequently is limited to about 15 to 20 percent of the state inventory. An additional 10 percent of emissions can be covered if emissions associated with imported electricity are captured using a hybrid approach that includes a comprehensive definition of the electricity sector.

- All three methods for defining the scope of a market-based program are vulnerable to emissions leakage. A coordinated national approach to capping climate change emissions within an international framework would be the best approach for addressing this leakage problem. In the absence of national action, or even regional action, the leakage issues can be partially mitigated.
- All three methods appear to be administratively workable. Also, it may be preferred to cap emissions from the electric power sector under all three scope definitions using the LSE-based approach.
- All three approaches to defining the program scope could be leveraged into a regional or national climate change emission reduction program. An assessment of the relative likelihood of any of the three approaches being adopted nationally is beyond the scope of this assessment. However, it can be observed that the sector and stationary source approaches are more similar to past national and regional regulatory regional programs than the comprehensive fuel approach.

Figure 6-1: Climate Change Emissions Covered Under Three Definitions for Program Scope



Sector-Based Emission Cap for five sectors, not including mobile sources. See text.

Stationary Fossil Fuel Combustion Emission Cap covering approximately the 750 largest sources. See Text.

Allowance Distribution

A market-based program requires that each facility under the cap hold sufficient emission allowances to cover its emissions. Emission allowances can be auctioned (i.e., sold) or given away. If given away, the allocation algorithm can have a significant impact on the amount of allowances received by each facility. A hybrid approach can also be used, in which some allowances are given away and some are auctioned.

Much has been written regarding the pros and cons of giving allowances away versus auctioning them.[30] When allowances are given to entities covered by the cap, those entities receive something of value: the emission allowances. When the allowances are auctioned, the government collects a portion of the value of the allowances in the amounts paid in the auction. Both approaches can result in essentially the same cost of controlling emissions, and both approaches are expected to have the same impact on consumer prices in most cases.

If an auction is not used, the process for distributing the allowances typically considers facility-specific factors to promote equity among the regulated facilities. Although various factors can be considered, two primary factors are commonly discussed as bases for distributing emission allowances:

Baseline Emissions. Emission allowances can be distributed on the basis of recent emissions as defined in a baseline for each facility. This method has the potential to distribute fewer allowances to those entities that reduced their emissions prior to the baseline period, thereby penalizing them for taking early action.

Baseline Output. Emission allowances can be distributed using an average emission intensity for each industry and baselines of recent facility output. The average emission intensity for an industry would be equal to the total emission cap for the industry divided by the total baseline industry output. Each facility's allocation would be the product of the relevant industry average emission intensity and the individual facility's baseline output. By using this approach, past actions by a facility that reduced its emission intensity are rewarded.

Insofar as emission allowances are distributed on the basis of past emissions or output, new sources would not receive a share of the distribution of allowances. To address this issue, a portion of the emission cap can be set aside for new sources, so that they can be allocated a share of the cap. Alternatively, a share of the cap could be set aside to be auctioned off, so that all sources, new and existing, could bid for additional emission allowances over and above the allowances they receive through a distribution.

Facilities that have relatively high emissions will favor distributing allowances on the basis of recent emissions, because under this approach they will receive more allowances. Facilities that have relatively low emission intensities will favor

distributing allowances on the basis of an industry-average emission intensity. Facilities with growing levels of emissions or output would want to ensure that the method allows flexibility in the selection of the baseline year, so that recent periods of high emissions or output could be considered.

The specification of a distribution algorithm requires balancing divergent interests. One way to satisfy competing interests in this situation is to be overly-generous in the initial allocation of emission allowances. In doing so, all parties can receive a share of the emission cap that meets their current needs. In this case, care must be taken to reduce the cap over time, and to ensure that the extra allowances are not banked indefinitely in a manner that reduces the effectiveness of the emission cap over the long term.

Emission Offsets

Emission offsets are verified emission reductions achieved by entities that are outside the cap. The benefits of emission offsets are:

- Offsets help lower the cost of reducing emissions: facilities covered by the cap can purchase low-cost emission reductions from outside the cap as a means of complying with their emission limit.
- Offsets provide sources outside the cap with a financial incentive to develop low-cost emission reduction projects, thereby broadening the set of emission reduction opportunities that are motivated to be undertaken by the market-based program.

Although the forestry sector is not a strong candidate to include under an emission cap due to the diffuse nature of its emissions (and sinks), stakeholders and others have emphasized that forest management projects in California could be an important source of emission offsets. The funds received from selling the offsets could make forest management projects financially attractive. Of note is that the projects would generate multiple benefits beyond the sequestration of carbon.

To ensure that offsets do not compromise the emission reduction goal of the program, they must be real or additional, quantifiable, surplus to any regulatory requirement, enforceable, and permanent. Also, they cannot be counted toward any other climate change emission reduction targets.

Protocols for verifying offsets will be required for each of a variety of "prototype" emission reduction projects that are deemed eligible for producing emissions offsets under the state's market-based program. Each protocol would address the requirements specific to its prototype project. The California Climate Action Registry's Forest Project Protocol is an example of the type of protocol that would be needed.

A final issue to address regarding offsets is whether the market-based program should rely solely on the market to generate emission offsets, or whether an entity dedicated to producing offsets should be created. A dedicated organization could develop expertise and procedures that enable it to identify and execute emission reduction projects efficiently. The organization could specialize

in projects that are particularly relevant to California and qualify under the California program. Following initial funding for start-up, the organization could have the goal of becoming financially self-sustaining.

The primary benefit of creating an organization dedicated to creating offsets is that it can expand the availability of low-cost emission reductions. Initial experience under the primary international offset program (the Clean Development Mechanism) indicates that offset projects may be slow to materialize. The Climate Trust is an example of an organization that was formed to create emission offsets.

Other Program Design Elements

To define a market-based program fully, the following additional program design elements must be addressed:

Climate Change Emissions Included: To capture as many emission reduction opportunities as possible under the cap, all climate change emissions should be included. However, consideration should be given to limiting coverage, particularly during initial implementation, to those gases and sources that can be measured or calculated reliably.

Trading/Offsets/Auction: Flexibility is fundamental to a market-based program. However, unlimited trading, offsets, or availability of credits via auction may raise concerns about the potential concentration of emissions in impacted communities. Restrictions could be used to address this issue.

Emission Banking and Borrowing: Banking and borrowing are consistent with the use of a market-based program to achieve emission reductions at the lowest possible cost. Banking, in particular, can motivate early action and reduce overall compliance costs.

6.2 Compliance Tracking and Enforcement

Under all formulations of a market-based program, emissions and compliance must be tracked for all the entities covered by the cap, and appropriate action must be taken if entities fail to comply.

Emissions Tracking

Reporting procedures will be required to ensure that facilities produce consistent and reliable emission reports. The California Climate Action Registry has developed and adopted two levels of emission reporting protocols:

A General Reporting Protocol is used by sources that do not have unusual reporting or calculation needs. The GRP can be used by a wide variety of entities.

Industry-specific protocols are used to address data, measurement, calculation, or other issues that are specific to certain industries.

To date the registry has developed protocols specific to the forest sector and the power/utility sector, and work is well along in developing a protocol for the cement production industry. Additional industry-specific protocols will be

required if a multi-sector program is adopted, for oil refining, oil and gas extraction, and landfills. The registry's methods produce emission reports that are sufficiently precise to be used by the emissions sources likely to be included in a market-based program.

The registry currently requires that emission reports be verified by qualified third-party certifiers, with the cost of certification borne by the reporting entities. With mandatory reporting, we need to assess whether the current process should be continued, or whether a new approach should be used, such as the organization receiving the emission reports being responsible for verifying the emission reports. Both approaches can ensure consistency and maintain quality control of the emission reports. However, centralizing responsibility for verification of the emission reports in the entity that receives the reports may enable efficiencies to be realized.

Compliance Tracking

Compliance is tracked by comparing the emission reports to the official record of emission allowances and emission offsets. A system for tracking the ownership of emission allowances and emission offsets is needed, including "expiring" the allowances and offsets when they are used to cover emissions in a compliance period. The compliance tracking needs to be done in a timely manner, so that compliance can be evaluated shortly after the end of the compliance period.

Enforcement

Enforcement provides consequences in the event that an entity cannot surrender emission allowances in sufficient quantity to cover its actual emissions. The design and implementation of the enforcement requirements will determine the strength of the incentives that entities have to comply. Additionally, the enforcement scheme can have a significant impact on whether the desired emission reductions are achieved.

Options for the consequences of non-compliance include:

- Require the entity to acquire emission allowances or offsets to make up its shortfall. Including this requirement will ensure that emissions are reduced to the emission cap.
- Require the entity to pay a fee per ton for which they did not have sufficient allowances. Including this requirement provides a financial incentive to comply.
- Require that the entity implement controls to reduce emissions. This requirement would reduce compliance flexibility.

If the sole enforcement method is a fee per ton of excess emissions, this would provide a "safety valve" on compliance costs. The fee would become the upper bound for the price of emission allowances. The risk of this approach is that if the fee were set too low, the emission cap may become ineffective, as entities choose to pay the fee rather than reduce emissions.

To ensure that the emission cap remains effective, the non-complying entity may be required to acquire emission allowances or offsets to make up its shortfall. The risk of maintaining the cap in this way is that the cost of the additional allowances may become very high, particularly during a period of non-compliance by many entities.

Significant volatility in the cost of complying can adversely affect the program, and could lead to the cap being relaxed in response to unsustainably high compliance costs. This situation is not hypothetical: the RECLAIM Program in 2000 displayed these conditions.[31]

Specifying the enforcement penalties requires balancing these benefits and risks. Analyses can forecast likely compliance costs and allowance prices. Because there is no track record for a climate change emission market-based program in the United States, the forecasts will necessarily be uncertain.

6.3 Conclusions and Next Steps

- A market-based program can be integral to California's strategy for reducing climate change emissions. The primary benefits of a market-based program are its ability to establish a firm climate change emission limit and to reduce emissions at the least cost.
- A market-based program can be implemented as part of a comprehensive emission reduction effort that includes complementary programs and initiatives.
- A national program to cap climate change emissions within an international framework would be the most effective approach. In the absence of national action, or even regional action, California can lead by example by developing a workable market-based program as a model for national action. The added benefit and impact on the state of taking unilateral action must be assessed.
- There is no single, best solution for designing an effective market-based program. Trade-offs are required to create a program that promotes real low-cost emission reductions, in a framework that is equitable and administratively feasible. Divergent interests must be balanced in designing the program scope, emission allowance distribution, and other program elements.
- A carbon cap on all fossil fuels provides the broadest single opportunity to reduce emissions, covering about 75 percent of state climate change emissions, including both stationary and mobile fossil fuel combustion. As an alternative, an emission cap focused on five industrial sectors would cover about 30 percent of state emissions. Mobile source emissions, accounting for about 42 percent of state emissions, are not easily incorporated into a sector-based emission cap. However, alternative strategies can focus on mobile sources.
- New legislative authority is required to implement a market-based program to reduce climate change emissions.

The CAT finds that a market-based program should be considered an integral part of California's approach to reducing climate change emissions. The next steps in considering a market-based program include the following:

- Facility-level emission reporting is needed, not only to support the detailed design of a market-based program, but to better understand current emissions and options for reducing emissions. Consequently, facility-level emission reporting requirements should be adopted, along with the industry-specific reporting protocols needed to support the reporting.
- Several complete market-based programs should be defined in detail, representing the range of program design options. The program alternatives should be evaluated, including their impacts on climate change emissions; cost of reducing emissions; state competitiveness, business, and jobs; and impacted communities with environmental justice concerns.
- Administrative options for implementing a market-based program should be developed. The budget requirements to support the administration of the program should be assessed.
- The legislative authority required to implement a market-based program should be identified.

7 IMPLEMENTATION OPTIONS

This chapter discusses possible implementation options that can be used to reduce climate change emissions in the state as shown in Table 7-1. Some of these options, such as the programmatic and voluntary options, are already being implemented and will continue forward. Others, such as the public good charge for transportation fuels, cut across options and can be used to ensure success. A market-based approach is regarded as an attractive means of reducing emissions and was discussed in detail in Section 6. This section discusses fee-based options; however, such an approach would require more extensive examination of the environmental and economic consequences.

In general, the CAT supports the use of multiple implementation options designed to support one another and provide the greatest possible emission reductions for the least cost.

Table 7-1. Implementation Options for Meeting Statewide Climate Change Emission Reduction Targets

Implementation Options
Programmatic
Programs implemented by agencies. Examples of existing programs include ARB's motor vehicle regulations, energy efficiency standards, Renewable Portfolio Standard.
Market-Based Program
Climate change emission cap established for industrial sectors. Flexibility through trading, offsets and or auctioning of emission credits.
Public Goods Charge for Transportation
Transportation is by far the largest source of emissions in the state. A public goods charge on transportation could be used to reduce emissions from transportation sources. Specific emphasis would be placed on transportation fuel diversity that would both benefit the environment and stabilize the economy.
Fee-based Option
Fees could be assessed based on entity emissions, with an emphasis on largest emission sources; or they could be broadly based on energy sources at point of origin or as close to point of origin as possible. Proceeds could be used to provide incentives or otherwise fund emission reduction projects.
Offset Program
Allowing for the purchase of offsets can lower cost. However, it is essential to ensure that offsets are real, quantifiable, surplus, enforceable, and permanent.
Voluntary Emission Reduction Program
Participants work with the state to establish agreed-upon emission reduction activities in support of the Governor's statewide targets.
Mandatory Reporting
Necessity for all programs, tracking, and accountability.

A more detailed description of each of the implementation options in Table 7-1 is included in the subsections below. Mandatory reporting is included in this table because it is key to all of the options considered. Mandatory reporting is also discussed below.

7.1 Programmatic

The programmatic approach has been the mainstay of the agencies represented on the CAT and is reflected in Section 5. State agencies have long been implementing programs that have provided tremendous environmental and economic benefits to the state, including those based on regulations, education, and incentives. Such programs will continue and would be used in combination with other implementation options discussed in this section.

7.2 Market-Based Program

Market-based program options are discussed in detail in Section 6. Further analysis is needed to determine how best to design a market-based program for the state. However, a well-designed market-based program has the potential to significantly reduce emissions while also providing industry with flexibility and reduced compliance costs.

7.3 Public Goods Charge for Transportation Fuels

Transportation is the largest source of emissions in the state. Accounting for more than 40 percent of the statewide emissions, it dwarfs the next largest sources of emissions—the industrial and electricity sectors—at about 20 percent each. Although both the industrial and electricity sectors are somewhat diversified as to energy source, the same cannot be said of the transportation sector. Petroleum accounts for 99 percent of the fuel used in the transportation sector. The state's dependence on petroleum has been shown to be harmful to public health and the environment.

In further contrast, a relatively small public goods charge is applied to all other energy sources in the state. The public goods charge on electricity has contributed to the fact that Californians use 30 percent less electricity per capita than the average U.S. citizen. Californians benefit from building and appliance energy efficiency programs funded with the public goods charges on electricity and natural gas that provide a net saving of more than $1,000 per household annually.

Demand for petroleum in California and around the world has skyrocketed. Petroleum is a limited resource and much of the supply is located in politically volatile parts of the world. Even so, the demand for petroleum products continues to increase, despite the fact that increases in price have reached new peaks that are being sustained for longer periods of time.

The economic consequences of the state's dependence on petroleum can be measured in personal goods and services, and macro-economic terms. Consumers have less disposable income and those with little or no disposable income suffer disproportionately.

The costs of almost all goods and services increase when the cost of petroleum increases and many businesses cannot pass these costs on to consumers. This results in lower profits. In general, small businesses are at greatest risk. Finally, the price of crude oil is the single largest cost in the

production of transportation fuels, accounting for between 42 to 56 percent of the retail price of gasoline. California's demand for crude oil, like the U.S., is increasingly being met by international suppliers. Over the past two years, the price of crude oil has nearly doubled, which has resulted in an increasing percentage of California's consumer wealth being exported outside the state's economy.

The environmental consequences of petroleum are significant. As indicated above, climate change emissions from the transportation sector are large and growing. Using less petroleum also reduces smog-forming and toxic pollutants that occur at each point in the distribution system. Many alternative-fuel vehicles produce fewer emissions than their gasoline and diesel counterparts while also contributing to the need for fuel diversity in the transportation sector.

The Energy Commission in its 2005 Integrated Energy Policy Report32, which is the state's energy plan submitted to the Governor, has identified and recommended the concept of a public goods charge to finance programs that reduce petroleum demand and emissions for the transportation sector. A public goods charge on gasoline and diesel, if constructed appropriately, could be a very effective, fair, and efficient means to reduce climate change emissions from the transportation sector and mitigate these damaging consequences to our environment and our economy. Crucial questions about how the funds are administered and expended need to be addressed before a public goods charge for transportation fuels could be proposed.

7.4 Fee-Based Option

Fee-based options exist and merit further evaluation but have not been fully explored at this point. The primary attractiveness of such programs is that they can be centrally managed and can be targeted towards the largest sources or broadly targeted at energy sources at point of origin or as close to point of origin as possible. Proceeds could be used to provide incentives or otherwise fund emission reduction projects.

At this time the CAT would not recommend this option as it cannot guarantee emission reductions. The extensive consultation with industry and other stakeholders necessary also has not been completed.

7.5 Offset Program

Allowing for the purchase of offsets can lower cost. However, it is essential to ensure that offsets are real, quantifiable, surplus, enforceable, and permanent. A preliminary investigation into offset programs indicates that there are successful examples of such programs.

In Oregon and Washington, the Climate Trust program generates offsets for purchase by industry that take into consideration climate change emission reductions as well as reductions in other pollutants. The focus is to ensure high-quality, cost-effective offsets that provide a permanent and viable nexus between

those responsible for climate change emissions and the currently available solutions to reduce and eliminate those emissions over time.

A program similar to the Climate Trust program could be considered for California. Such a program could be designed to address the critical need to reduce pollution in low-income and minority communities and other priority issues in our state. Further analysis and review is needed for this implementation option, so the CAT has no specific recommendation regarding offsets at this juncture.

7.6 Voluntary Actions

There are many proactive industries that are taking actions to reduce climate change emissions. The Sustainable Silicon Valley group is made up of a number of large companies including Calpine, Hewlett-Packard Company, and Pacific Gas and Electric, who have pledged to voluntarily reduce their emissions to 20 percent below 1990 levels by 2010. The California Climate Action Registry allows companies to register their climate change emissions and assists these companies in tracking and reducing these emissions. British Petroleum, Eastman Kodak, Pacific Forest Trust and U.S. Borax are among the more than 50 companies that are currently members of the registry.

Such voluntary actions are instrumental in the effort to meet statewide targets. The CAT encourages such efforts as evidence that many in the business community as well as with local governments clearly believe action must be taken to reduce climate change emissions.

One of the overarching recommendations, which has been championed by industry and environmental groups alike, is recognition of early actions in any and all emission reduction programs implemented. Recognition of early action is also important as California joins its western state partners and the North East States in cooperative efforts to reduce emissions. State partnerships are expected to lead to national and international cooperative efforts.

7.7 Mandatory Emission Reporting

One of the overarching recommendations included in this report is the need for some level of mandatory reporting that builds upon the California Climate Action Registry. We simply don't have the basic information needed to track and account for emission reductions. The Energy Commission maintains a planning inventory that provides an overall picture of where emissions are coming from in the state. However, this inventory cannot be used for the purposes of determining baseline emissions from a source or for tracking emission reductions from a source.

The California Climate Action Registry does have emissions data that can be used for tracking emissions from a source and for accounting purposes. However, the Registry is voluntary, and many of the largest emitters in the state have not yet joined. There is no way to determine whether or when emission sources will join under the current provisions of law.

A preliminary estimate of the largest sources for which emissions data is needed in the state indicates that it would be prudent to begin with data collection from the electric power sector, oil refining and oil and gas extraction sector, landfills, and cement production. To the extent that industries have joined the registry voluntarily, the CAT believes this fulfills any reporting requirement for climate change emissions data.

As this state moves towards mandatory reporting of climate change emissions, the question as to where that data should be stored and managed arises. The CAT does not believe that such a program can be managed under a non-government organization such as the current Registry. However, some of the current duties and functions of the Registry could be placed within government for the purposes of mandatory data collection. The registry represents an excellent starting point for the process of mandatory reporting.

The role of Air Quality Management Districts, Local Enforcement Agencies, and other entities with within the state that have permit and enforcement authority will need to be determined. These entities already collect much of the data that would be needed under a mandatory reporting program and have existing enforcement and permit authority. This should be considered as a mandatory reporting program is developed.

8 ECONOMIC ASSESSMENT

This section discusses the results from a preliminary assessment of the macroeconomic impacts associated with the climate change emission reduction strategies presented in this report. The results show that the overall impacts of the climate change emission reduction strategies are expected to be positive. Specifically, when the strategies already underway as well as new strategies being proposed are considered in total, the resulting impacts on the economy are expected to translate into job and income gains for Californians.

In summary, the net impact of the strategies on jobs in year 2020, when the strategies are expected to be fully implemented, is expected to be a gain of 83,000 above what the California economy would gain without the climate change emission reduction strategies. The implementation of the strategies is also likely to add an additional income of about $4 billion to Californians in 2020, again, above what the economy is expected to produce without the strategies.

These favorable impacts on the economy are possible because of the reduced operating costs associated with many of the strategies. The additional job growth is expected to come from a net savings to consumers associated with the implementation of the strategies. The savings will in turn promote further business expansion and job creation.

The results presented in this section are considered preliminary because the cost and potential savings information associated with most of the individual strategies have not yet been fully developed. Therefore, when available, other sources have been drawn on to provide an initial assessment of the costs and

savings. Although this analysis needs refinement, we expect that the fundamental conclusion--that the suite of strategies discussed in this report has a net positive impact on California's economy--will stand.

The subsequent refined analysis will incorporate updated cost and savings estimates for the strategies. It will also assess the cost effectiveness of the various individual strategies. Thus, the refined economic analysis will provide additional information to decision-makers as they proceed with implementation of the strategies.

The remainder of this section discusses the model of the California economy used for the assessment, the analysis of the strategies in Section 5, a discussion, as well as a summary.

8.1 Economic Model

This economic assessment uses a computable general equilibrium (CGE) model of the California economy called E-DRAM, developed by the University of California, Berkeley. It has been used by the Department of Finance for the revenue impacts of tax and other State policies, by the California Energy Commission and ARB to assess impacts of reducing petroleum dependency (AB2076)[5], and by ARB for the Vehicle Climate Change Standards[6], the State Implementation Plan[7] analysis, and others. As a part of the application of the model to these analyses, it has been peer reviewed and calibrated to be representative of the California economy.

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[5] CEC 2004. Attachment to Appendix A (Revised): Impacts of Petroleum Reduction Strategies on the California Economy. At http://energy.ca.gov/fuels/petroleum_dependence/documents/2004-02-10_ATCHMNT_APNDX_A.PDF

[6] ARB 2005a. Regulations To Control Greenhouse Gas Emissions From Motor Vehicles: Final Statement Of Reasons. At http://www.arb.ca.gov/regact/grnhsgas/fsor.pdf

[7] ARB 2003, 2003 State and Federal Strategy for the California State Implementation Plan. At http://www.arb.ca.gov/planning/sip/stfed03/stfed03.htm

A CGE model simulates the functioning of a market economy in which different sectors interact with one another (one sector supplies inputs to another, or purchases the outputs of another) and where prices and production adjust in response to changes caused by government policies applied to specific sectors. The CGE simulates these relationships among California producers, California consumers, government, and the rest of the world. Because of the interconnection between sectors, an intervention in one sector has impacts on others, which are captured by the CGE model analysis.

The inner workings of the CGE model can be graphically illustrated. Figure 8-1 shows a simplified version of the sectors that interact and participate in goods, services, and labor flows that make up the economy. The diagram shows that the households sell factors of production (labor and capital) to the firms which use the factors to produce goods and services to sell to the households. It also shows the flow of payments that accompany the transactions between the firms and the households. The diagram includes the flow of transactions between the firms; this is, how the firms buy and sell intermediate goods amongst themselves to produce the final products sold to the households.

Figure 8-1 Circular Flow of Goods and Services in the Economy

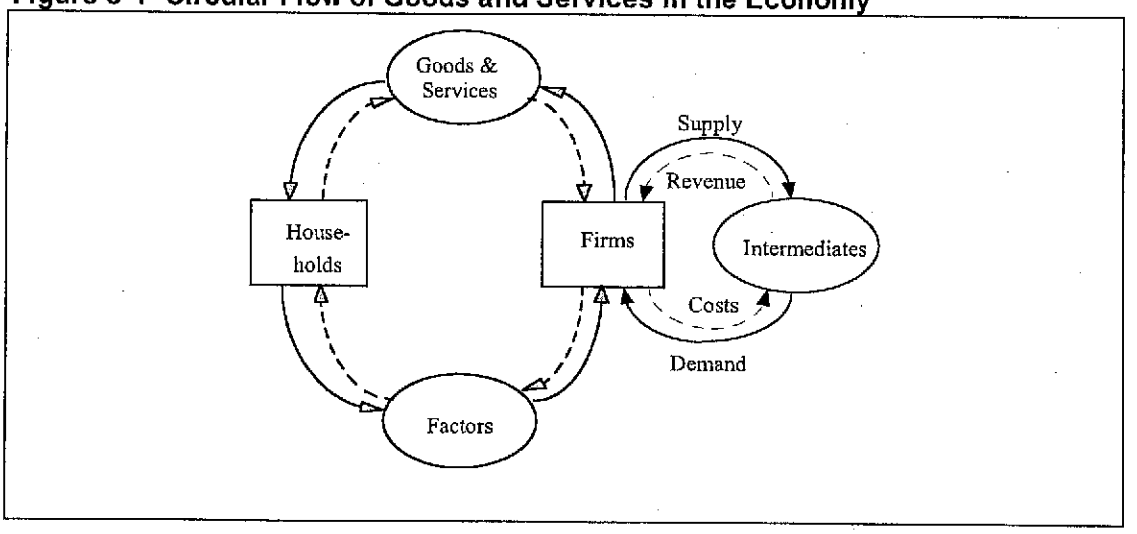
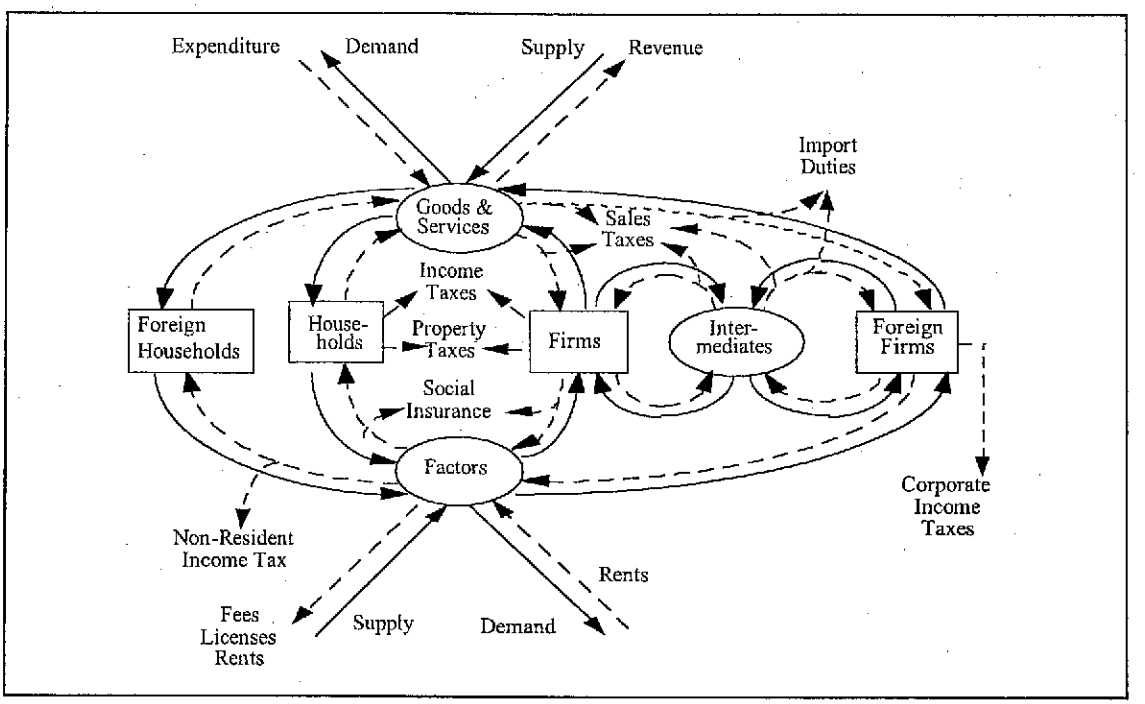


Figure 8-2 shows the complexity of the complete California economy and the many sectors involved in producing goods and services for final consumption by the households inside and outside of California.

Figure 8-2 Complete Circular Flow of Goods and Services in the Economy



The E-DRAM model accounts for all of the flows in the California economy using many equations. When a regulation or a policy is adopted that could affect costs of production in one part or sector of the economy, the rest of the economy has to adjust to the perturbation through price or employment changes. The CGE tracks the changes and produces results that show how much each sector has changed. The main economic indicators are number of jobs and income. It is believed that these two key indicators are particularly informative for characterizing the impact of potential policies on California's economy. Jobs are an important indicator for decision-making, and income closely follows the gross state product, which is an indicator of overall economic well-being in the State. This economic assessment presents the changes in these two indicators as the net economic impacts of the strategies.

8.2 Analysis of Climate Change Emission Reduction Strategies

The strategies evaluated in this analysis are taken from Section 5. The objective of the analysis is to draw on available cost and savings data to provide an overall assessment of the impact of the strategies on California's economy.

The E-DRAM model of the California economy was run with the strategy costs and savings as inputs into the model to assess the economic impacts for years 2010 and 2020. Two major economic indicators were selected to

demonstrate economic well-being. Job creation indicates a healthy economy providing opportunities to Californians. Income is an indicator of the output of goods and services and therefore gauges progress in economic activity. The impacts are shown as the difference between the predicted economic indicators with and without implementation of the strategies.

Table 8-1 shows the impacts of the strategies on income and employment in 2010. Many of the strategies have both costs and savings. Generally, the costs are incurred for technology and/or changes in behavior that reduces emissions, and savings are accrued from reduced operating costs. The costs of the strategies for the year 2010 are estimated at $1.3 billion, and the savings at $2.9 billion for a net savings of $1.6 billion. The net savings stimulate additional economic activity and generate about $2 billion of additional income (about a 0.13% increase in total income) and 19,000 new jobs (about 0.11% of the 2010 total employment). For context, Table 8-1and Table 8-2 also show the growth expected for the economy between 2004 and 2010 or 2020 irrespective of the strategies discussed in this report.

Table 8-1. Impacts of Achieving the Climate Change Emission Reduction Targets on California Economy in 2010*

Economic Indicator	In 2004	Without the Strategies**	With the Strategies	Impacts	Percentage of the Total
Income (Billions of 2005$)	1,317	1,527	1,529	2	0.13%
Employment (thousands)	16,460	17,969	17,988	19	0.11%

* We display several digits to make it clear how we calculated the difference associated with the strategies.

** This column indicates the income and employment forecast for 2010 without the implementation of the strategies presented in this report. Note that between 2004 and 2010, the economy is expected to realize substantial growth (e.g., income increases by about $200 billion while the number of jobs increase by about 1.5 million).

By 2020, additional savings from the strategies stimulates the economy further. The strategy costs are on the order of $7.9 billion, with a savings of $16.9 billion for a net savings of $9.0 billion. Table 8-2 shows the impacts of the strategies in 2020. The results also reflect the fact that the strategies that would be in effect by 2020 have a different mix of costs and savings than those in 2010.

The impact on income is about $4 billion, about a 0.19% increase, and the impact on jobs is creation of 83,000 new jobs, about a 0.40% increase, in the year 2020 for the California economy.

Table 8-2. Impacts of Achieving the Climate Change Emission Reduction Targets on California Economy in 2020*

Economic Indicator	In 2004	Without the Strategies**	With the Strategies	Impacts	Percentage of the Total
Income (Billions of 2005$)	1,317	2,128	2,132	4	0.19%
Employment (thousands)	16,460	20,704	20,787	83	0.40%

* We display several digits to make it clear how we calculated the difference associated with the strategies.

** This column indicates the income and employment forecast for 2020 without the implementation of the strategies presented in this report. Note that between 2004 and 2020, the economy is expected to realize substantial growth (e.g., income increases by about $800 billion while the number of jobs increase by about 4.3 million).

Although these of the economic impacts seem small when considered as a percentage of the total economy, the positive direction of the impacts indicate that the California economy is highly unlikely to suffer negative impacts from achieving the climate change emission reduction targets as directed by the Governor's Executive Order. Rather, implementation of the suite of strategies indicates a positive net impact on the economy. Refinement of the strategy cost and saving estimates, which is planned for the near future, will provide further details regarding the impacts of strategy implementation on the California economy.

With the exception of the Green Building Initiative and the strategies in Section 5 for which reductions are not reported, the economic impacts shown in Table 8-1 and Table 8-2 reflect the combined effect of all of the strategies (those underway and those proposed). The strategies not included in this analysis will be included in the subsequent refined analysis along with updated costs and savings information for the strategies analyzed thus far. However, the inclusion of these additional strategies is not expected to change the fundamental conclusions presented in this analysis because the additional strategies are, in total, expected to result in a net savings.

Discussion of the Economic Assessment of the Strategies Already Underway in California: One key observation on the strategies already underway is that almost all of them result in increased energy efficiency, which historically been shown to be highly cost effective. It is thus expected that the net effect of strategies underway, by themselves, will be to benefit the economy by providing additional jobs and income. As previously indicated, a subsequent economic

analysis will draw on refined cost and savings information for these strategies to support a more robust macroeconomic assessment of the individual strategies as well as their combined impact. Discussions of the strategies already underway are presented below. The cost and savings estimates are preliminary and are already being evaluated for refinement.

The Vehicle Climate Change Standards strategy was developed to support a regulation approved by the Air Resources Board in 2004. The staff report including the economic analysis is fully documented and was the subject of several public workshops. For example, the ARB economic analysis of the strategy concluded that by 2020, jobs increase by 53,000. The benefits result from operating cost savings by consumers which in turn are spent on other goods and services, generating additional jobs and income beyond what the economy normally would produce. Further, the Diesel Anti-idling strategy is expected to save several hundred million over its implementation by reducing diesel fuel consumption[8]. Because of the savings, its impact on the economy is expected to be positive.

In general, energy efficiency programs positively impact the economy. Most of the strategies already underway concern efficiency improvements. Although the State agencies developing these strategies may not have completed a refined assessment of the associated costs and savings, analyses of similar strategies by universities and institutes have shown net benefits for these strategies, and thus, positive impacts on the economy. Such strategies include Investor Owned Utility Energy Efficiency Programs, Building and Appliance Energy Efficiency Programs, Achieve 50% Statewide Recycling Goal, and Fuel-Efficient Replacement Tire and Inflation Programs. In total, these programs will almost certainly benefit the economy by producing additional jobs and income for California.

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[8] ARB 2005b. Notice Of Public Hearing To Consider Requirements To Reduce Idling Emissions From New And In-Use Trucks, Beginning In 2008. At http://www.arb.ca.gov/regact/hdvidle/isor.pdf

The Green Building Initiative is expected to produce net benefits and therefore positively impact the economy. Based on historical experience, every dollar spent on energy efficiency typically provides about $2 in benefits. As indicated, the Green Building Initiative will be folded into the subsequent refined analysis.

The California Public Utilities Commission (CPUC) is currently reviewing a statewide solar incentive program proposal. If adopted by the CPUC in January 2006, the proposed California Solar Initiative (CSI) will provide close to $2.9 billion in incentives between 2007 and 2017. The program is anticipated to bring on line or displace 3,000 MW of power. As costs and savings estimates are further developed they will be included in a refined economic impact analysis of the climate change emission reduction strategies.

In addition to the Solar Initiative, the CPUC commissioned a report entitled "Achieving a 33% Renewable Energy Target" to identify feasibility and next steps to accelerate and expand the current CPUC Renewable Portfolio Standard program. The report determines that after the initial infrastructure costs are borne, the resulting benefits to ratepayers in 2021 and beyond are net positive. Using the CEC's long-term forecast of natural gas prices, the report finds that ratepayers would likely realize a net benefit over a 20 year period.

Discussion of Economic Impacts of the Strategies Needed to Meet California's Targets: All of the strategies presented in Section 5 where estimated climate change emission reductions are available were included in the analysis that generated the results shown in Table 8-1 and Table 8-2. Several sources were drawn on to identify preliminary cost information including analyses done by UC Berkeley, and the Tellus Institute[33]. Many of the strategies have implementation costs. However, several strategies also have savings that may cover or exceed the costs.

8.3 Discussion

The economic impacts presented in this analysis are from the combined strategies listed in the tables in Section 5 for which preliminary cost information is available. Some of the strategies in Section 5 have net costs while others have net savings typically due to decreased operating costs. Those with net costs would be expected to adversely affect job growth if considered in isolation. However, those with savings will increase job growth and income. For example, the Air Resources Board's Heavy Duty Vehicle Emission Reduction Strategy would be expected to lower the operating costs of transporting goods.

Lower costs of producing a certain amount of goods or services lead to more economic activity and create more jobs and income as people spend savings from the lower costs.

The refined analysis would be expected to provide additional information to facilitate a focused consideration of each strategy with respect to several factors including cost effectiveness. Further, the refined analyses can include additional strategies that may be identified by stakeholders. Specifically,

stakeholders may identify additional cost-effective strategies that have the potential to provide additional emission reductions. However, as with the analysis presented here, a key product of the subsequent refined analysis will include the macroeconomic impacts of the suite of strategies rather than each strategy.

Subsequent analysis of the strategies may also be affected by overall program implementation methods that have the potential to promote further cost reductions or savings. For example, cap-and-trade policies can unleash internal innovative powers of the private sector to adopt and invest in processes and methods that lower energy use and increase efficiency. Like energy efficiency standards that have been shown to create jobs, the innovative efforts induced by cap-and-trade or other similar tools would likely further enhance the cost effectiveness of reaching the climate change emission reduction targets.

Many of the strategies that end up with net costs may have benefits that are not directly estimated or may not be the focus of the climate change emission reduction efforts. For example, the afforestation strategy has a net cost. However, planting forests may provide indirect benefits to the public or other sectors of the economy that are not captured in this analysis. Specifically, strategies currently believed to result in a net cost may actually provide a savings when both direct and indirect benefits are considered.

Further, the benefits of strategies that already indicate a net savings may not be fully recognized in a conventional economic analysis. For example, several of the energy efficiency strategies may also facilitate increased security through further energy independence. Such indirect benefits should at least be qualitatively identified and considered when evaluating the strategies.

Finally, it may not be appropriate to assign all of the costs of the strategies currently underway to the climate change emission reduction efforts given that there are typically other considerations that contributed to the policy. Specifically, many of the strategies that are underway are being pursued to achieve other objectives (e.g., the Diesel Anti-Idling Strategy from Section 5 focused on reducing the population's exposure and risk associated with diesel particulate emissions as well as reducing smog precursors) with the associated climate change emission reductions being an added benefit. Many of the proposed strategies in Section 5 have the potential to address other programmatic objectives beyond climate change.

8.4 Summary

Based on this preliminary analysis, it appears that the climate change emission reduction targets can be met without adversely affecting the California economy. It is possible to adopt a suite of strategies in a manner that continuously benefits the economy. The strategies that focus on increased energy efficiency and produce net savings can greatly contribute to economic activity while reducing climate change emissions. Further, technology

improvements and innovative implementation of strategies currently estimated to have net positive costs may, in the long-run, result in net savings.

As refined cost information is developed for the strategies, a subsequent analysis of the economic impacts will be performed. In addition to characterizing the overall impacts of the strategies on California's economy, the subsequent analysis will allow individual strategies to be evaluated. The analysis may also facilitate the identification and inclusion of new cost-effective strategies that are not currently presented in Section 5. The analysis will also further inform decision-makers on the approach to strategy implementation that maximizes both environmental benefits and the benefits to the economy.

8.5 Implementation Options Assessment

With the exception of the programmatic option, the implementation options shown in Table 7-1 have not yet been evaluated in terms of their economic impacts.

In the case of the market-based implementation option, an economic analysis will be needed once the state determines the design of such a program. By its nature the market-based option is designed to reduce the costs associated with achieving emission reductions relative to a command and control approach. Therefore, the primary concern with implementation of this option is typically not the economic impacts but rather the assurance of real emission reductions and the implications for low-income and minority communities.

In the case of the public goods charge for transportation, such a charge would be designed to provide economic security, risk reduction and cost savings to the paying public. In the case of the public goods charge on electricity, California consumers save approximately $1,000 per year as a direct result of conservation efforts.

The public goods charge for transportation would be designed to provide economic benefits as well. Given the current volatility in the price of petroleum, risk reduction for a diversified transportation fuels market and reduced dependence on petroleum will provide a significant benefit to both consumers and to the economy as a whole.

The CAT is not recommending the fee-based and offset program options at this time. Both would require an economic evaluation prior to implementation.

9 IMPACTS ON LOW INCOME AND MINORITY COMMUNITIES

Low-income and minority communities are disproportionately affected by pollution and other adverse environmental damages. Disproportionate access to health care and/or lack or resources have contributed to a situation in which residents of low-income and minority communities are more likely to be exposed to toxics and other pollutants and are less likely to have the resources to adequately respond. The environmental justice (EJ) movement was created as part of the larger social justice movement with the intent to ensure that residents

of low-income and minority communities were equally protected from exposure to toxic and other pollutants.

Environmental justice is an issue that has been embraced as a priority for the Governor and the Legislature. As this state moves forward in reducing climate change emissions, evaluating the impacts of climate change, and considering adaptation strategies, EJ concerns must be addressed.

9.1 Environmental Justice Programs

The Governor's Office of Planning and Research (OPR) is the coordinating agency for environmental justice programs for the state. In 2003, OPR incorporated environmental justice elements within the General Plan Guidelines. This effort marked a beginning to a number of other State agencies, such as California Department of Transportation and the California Resources Agency, in adopting environmental justice policies.

Cal/EPA is the model agency (1999 Statutes) for implementing EJ into its programs, policies, and activities. In 2004, under the Schwarzenegger administration, Cal/EPA established its Intra-agency EJ Strategy, model EJ mission statement, and EJ Action Plan to ensure fair treatment and equity for all Californians regardless of race, age, culture, income, or geographic location.

The EJ Strategy is a long-term planning process and marks an important step toward addressing disproportionate environmental impacts on low-income and minority populations. To compliment the EJ Strategy, Cal/EPA also initiated the EJ Action Plan, a three-year action-oriented process, to explore complex issues such as cumulative impacts and precautionary approaches within six pilot projects throughout various regions in California.

The goal of the action plan is to develop environmental risk reduction plans for children's health, develop guidance for precautionary approaches and cumulative impacts, and improve public participation in the decision-making process. Cal/EPA reports to the Legislature every three years on the status of the EJ Strategy and Action Plan.

9.2 Outreach to Minority and Low Income Communities

In order to solicit comment and promote dialogue with representatives from low-income and minority communities, the Climate Action Team made it a priority to attend local environmental justice community meetings. At these meetings, CAT representatives provided general background information on climate change and updated the groups on climate change activities and potential issues that might arise. Below is a list of meetings attended:

Date	Organization
September 30, 2005	California Environmental Rights (Los Angeles)
October 5, 2005	North Richmond Air Quality Committee (Richmond)

October 11, 2005	North Richmond Municipal Advisory Committee (Richmond)
December 10, 2005	California Coalition Against Toxics (Los Angeles)

9.3 Strategy Evaluation

As the efforts of the CAT agencies to implement strategies outlined in section 5 move forward, outreach to communities must continue. Each of the agencies on the CAT has committed to support this priority.

Implementation of climate change emission reduction strategies will most likely benefit communities. In many cases, such as electrification of ports, efforts to reduce climate change emissions will provide a direct benefit. In these instances, the support of the communities is essential, and the support of the larger EJ movement will be an asset. If implementation of a strategy would require concomitant measures to ensure against harmful consequences to communities, State agencies must work with communities. In all cases, an open public process that is accessible to community representatives will ensure that EJ concerns are addressed and the statewide targets are met equitably.

9.4 Scenario Analysis

When considering the impacts of climate change on California and adaptation measures necessary, the State must also consider impacts specific to communities and the degree to which low-income and minority residents are affected.

The impacts of global warming will have economic and social consequences for low-income and minority communities. The adaptive capacity of people in these communities is lower than for average Californians.

Specific examples of situations in which low-income and minority communities are likely to be more adversely affected include:

Increasing costs for food, water, and energy will disproportionately affect the low-income communities.

Increasing use of pesticides will have an economic and public health impact on the farm workers.

An increase in the number of days Californians are exposed to ozone will disproportionately affect the people who do not have insurance or access to health care resources.

9.5 Market-Based Options

Low-income and minority communities are particularly wary of market-based because of the general belief that emissions trading allows for increased emissions at a local level and those increases are believed more likely to occur in the communities. The principal concern is not with the climate change emissions themselves because, in most instances, these emissions do not directly cause

local air quality problems. Rather, the concern is with the emissions of other pollutants (CO, NO_x, SO_x, PM, toxics) which may be affected by efforts to reduce climate change emissions. Two types of impacts may be of particular concern:

- Options that reduce climate change emissions could increase emissions of pollutants that cause local air pollution. For example, shifting from a fossil fuel to a biomass fuel could increase emissions of smog-forming pollutants unless appropriate emission control technologies are installed as part of the switch.
- Efforts to reduce climate change emissions may result in facilities with lower climate change emissions per unit of output being operated more than would otherwise be the case. Under these conditions, emissions of local air pollutants may increase near the facility that increases its operations.

In both of these cases, a local community could be impacted by increased emissions, even though climate change emissions decline overall. Because a market-based program provides substantial flexibility for facilities to select their preferred methods for achieving the climate change emission cap, the design of the program does not automatically mitigate this concern. Rather, steps must be taken to address this issue through additional measures.

9.6 Implementation Options

For all of the implementation options shown in Table 7-1 it will be essential to involve community representatives as these options are developed. As indicated in Sections 9.5 and 9.6, both the programmatic and market-based program options will need to involve community representatives.

In the case of the Public Goods Charge for Transportation, the State must work with communities to ensure that costs are not unduly burdensome and benefits are equitable.

Although the CAT is not recommending Fee-Based and Offset Program options at this time, both would require an open public process that ensured participation from communities prior to implementation.

10 SUMMARY AND CLIMATE ACTION TEAM RECOMMENDATIONS

This report lays out a path forward to ensure that California's climate change emission reduction targets are met. Following the signing of Executive Order S-3-05, the Secretary of Cal/EPA created a Climate Action Team. The CAT has accomplished three main objectives: completion of a list of recommended strategies to reduce climate change emissions in the state; completion of a significant first step in what will be an ongoing scenario analysis that provides insight into the impacts of climate change on the state and presents adaptation plans; and evaluation of options for a market-based program in the state including next steps recommendations.

The CAT produced two categories of overarching recommendations. First and foremost, the overarching recommendations considered essential by the CAT in

meeting the statewide climate change emission reduction targets. The general recommendations listed in Section 10.2 are second tier recommendations that consist primarily of recommended next steps and indications of where further analysis is needed.

10.1 Climate Action Team Overarching Recommendations

This final report has been revised from the December 2005 draft to reflect the comments, recommendations and suggestions that have been submitted. The final report proposes a path to achieve the Governor's targets that will build on voluntary actions of California businesses, local government and community actions, and state incentive and regulatory programs. The Governor's climate change emission reduction targets are achievable with economic benefit for California.

The climate strategies set forth in this report are in various stages of development.Some of the strategies, such as the California Solar Initiative, are being implemented this year. Other strategies, such as those related to biofuels, may require stationary modification this year for implementation to proceed. Still others, such as Smart Land Use and Intelligent Transportation and Semiconductor Industry Targets, are sound but require further analysis and development and should be allowed to evolve over the next two years. The Climate Action Team preliminary economic assessment, which is based on the Environmental Dynamic Revenue Model, indicates that,
by 2020, implementation of these strategies will result in 83,000 new jobs and an increase in personal income of $4 billion.

The Climate Action Team process for developing this report has been successful and the Team should be charged with the next phase of activity. Since the signing of the Executive Order, under the leadership of Cal/EPA, the Climate Action Team has provided a forum for coordinating State agency actions, program development, and budget proposals in addition to this report. It allows for collaboration, reduced internal competition and conflict, and provides a single point of contact.

The Climate Action Team recognizes that reducing climate change emissions is challenging and will need to be addressed in a deliberative on-going manner. The Team also recognizes that many of the reductions will come from technological innovations that are not yet fully developed. We have identified key recommendations that will help ensure the Governor's targets are met:

- A multi-sector market-based system uses economic incentives to lower costs, protect economic growth and promote innovation. The Climate Action Team should proceed with the development of a multi-sector market-based program which considers trading, emissions credit auction and offsets. The Climate Action Team should develop a multi-sector market-based program and make a recommendation to the Governor on

the structure for such a program no later than January 1, 2008. The Governor's 2020 climate change emission reduction target to reach 1990 emission levels should be the basis for an emissions cap in the development of program. The Climate Action Team should consider working with other western states to develop a multi-state program to minimize emissions leakage.

- Mandatory emissions reporting from the largest sources oil and gas extraction, oil refining, electric power, cement manufacturing and solid waste landfills, that builds on the California Climate Action Registry is essential. Mandatory reporting will ensure an accurate inventory of emissions which is critical to ensure that decision-making is based on real emissions and emission reductions. Equally essential are provisions for early action credit and a mechanism to ensure that companies are not penalized for early action. Early action will be attributed to California businesses that have voluntarily joined the California Climate Action Registry and have reduced emissions. Although the voluntary Climate Action Registry is a foundation, the Climate Action Team believes mandatory reporting must occur through a state government agency.

- A multi-generational public education campaign should be implemented to ensure that the public is informed about the issue of climate change and what they can do to reduce emissions and adapt to adverse consequences. Such a program can build upon successful campaigns in place, such a Flex Your Power. The Education and the Environment Initiative mandates the development of a unified strategy to bring education about the environment into California's K-12 schools through California's Environmental Principles & Concepts and a standards-aligned, State Board of Education-approved model curriculum. It is essential that California's children understand the impacts and consequences of climate change on the State's resources as well as mitigation and adaptation strategies.

- The macroeconomic analysis should be updated to reflect refined data collected over the next year. A cost-effectiveness analysis of all the strategies recommended in this report should be developed. Both should be completed by July 2007 and should incorporate a peer review process.

- Transportation is the largest source of climate change emissions in California. The Air Resources Board's vehicle climate change standards address a significant portion of the transportation sector. However, an aggressive alternative fuels program will significantly reduce climate change emissions. The California Energy Commission working with Cal/EPA and its boards and departments, and the Department of Food and Agriculture is currently developing an aggressive biofuels program that will be available this Spring. This biofuels program should be

considered an essential component of the effort to reduce California's carbon footprint.

- The Governor's climate change emission reduction targets are based in part on the planning assumptions in the California Energy Commission's Integrated Energy Policy Report. Specifically the Integrated Energy Policy Report recommends that all long-term new electricity generated for use in the state must come from sources with climate change emissions equivalent to or less than a new combined cycle natural gas power plant. The Public Utilities Commission's recently adopted proposal for an electricity sector carbon policy is generally consistent with the Integrated Energy Policy Report and will set forth a regulatory scheme for enforcing such a policy applicable to investor-owned utilities. The Climate Action Team recommends the policy, including an accountability mechanism, in the Integrated Energy Policy Report be extended to apply to all load-serving entities in the State, including municipal utilities, electric service providers and community choice aggregators. The Public Utilities Commission will work with the Climate Action Team so that this effort is consistent with the development of a multi-sector market-based program.

- All utilities should meet the energy efficiency goals and the Renewable Portfolio Standard required of investor-owned utilities. The State has adopted energy efficiency goals and a Renewable Portfolio Standard for investor-owned utilities. Publicly-owned utilities should match this level of performance and account for their achievements in a manner consistent with that of investor-owned utilities. Because publicly-owned utilities provide 25% to 30% of the electricity used in California, these entities are essential to the state's overall goal to reduce electricity demand and increase the State's use of renewable resources. The Energy Commission should work with the publicly-owned utilities to develop an accurate accounting system that captures climate emission reduction efforts by publicly-owned utilities so that their performance can be evaluated comparatively to investor owned utilities.

- The California Climate Action Registry, in cooperation with the Energy Commission, should develop emission reporting protocols for local government. Local governments are already contributing to the effort to reduce climate change emissions and an accurate tracking system of their contributions is essential.

- Over time funding will be needed to implement the strategies set forth in this plan and to provide incentives for industry to develop emission reduction technologies for use in California and abroad. A coordinated investment strategy can leverage the talent of California's universities, community colleges, and other entities and to lead technology development and train the next generation of technicians that will be

needed to operate and service those technologies. A public goods charge for transportation that funds key strategies to reduce climate change emissions and to reduce dependence on petroleum should be considered. Overdependence on petroleum fosters undesirable geopolitical, economic, energy, and environmental consequences. Other possible funding could come from the PIER program at the Energy Commission, targeted dedication of other state funds, or philanthropic and corporate investment. The electricity sector and natural gas Public Goods charges should continue at projected levels. Any new funding concepts require additional study until the preliminary recommendations noted above can be more fully developed. Accordingly, the Governor's 2006-07 budget proposes $7.2 million across several state agencies to begin implementation of the recommendations in this report.

10.2 General Recommendations

General recommendations included in this report are listed below. These recommendations are broken down into broad categories according to their relation to the emission reduction strategies, economics analysis, climate change emission reduction inventory, or market-based program options.

Economic Analysis

The State needs to take the following actions by July 2007:

Complete an analysis of the individual strategies presented in Section 5 to determine the cost-effectiveness for each strategy.

Develop a revised macroeconomic impact assessment to include updated cost estimates for the individual strategies.

Determine preliminary costs associated with the impacts of climate change on public health, water, agriculture, coastlines, and forests in California.

Determine updated costs associated with adaptation.

Climate Change Emission Inventory

It is essential that the California Energy Commission continue to refine the planning inventory they currently keep.

Market-Based Program

A market-based program should be considered further as an integral part of California's approach to reducing climate change emissions. In the absence of national action, California can lead by example by developing a market-based program as a model for national action.

Market-based program alternatives should be defined in detail and evaluated in terms of impacts on emissions; costs of reducing emissions; state competitiveness, businesses, and jobs; impacted communities with environmental justice concerns; and administrative and budget requirements.

Legislative authority required to implement a market-based program should be identified.

Scenario Analysis

California should continue to support research relevant to policy on climate change, including support of the research activities of the California Climate Change Center. Some of the areas of research in need of attention include the study of ecological impacts, the development of probabilistic climate projections for the state, a geographically-detailed analysis of the impacts of sea level rise on the California coast and the San Francisco Bay and Delta, the impact of climate change on energy generation and demand and human health, and new methods for economic impact analyses.

Climate change may disproportionately impact the most vulnerable groups in our society, including children, the elderly and frail, and residents in low-income and minority communications. For this reason, future scenario analysis should strive to identify these potential impacts and suggest solutions.

Given the serious potential consequences of climate change on the State's resources, California should expand its support of climate change research to create the tools, methods, and information that will be needed to develop robust coping and adaptation strategies in the state.

11 LIST OF ACRONYMS AND ABBREVIATIONS

ARB California Air Resource Board

BT&H Business, Transportation and Housing Agency

CA H_2 Net California Hydrogen Highway Network

Cal/EPA California Environmental Protection Agency

CAT Climate Action Team

CCA Community Choice Aggregators

CDFA Department of Food and Agriculture

CEC California Energy Commission

Center California Climate Change Center

CEQA California Environmental Quality Act

CGE Computable General Equilibrium

CH_4 Methane

CHP Cooling, Heating and Power

CIWMB California Integrated Waste Management Board

CO Carbon Monoxide

CO_2 Carbon Dioxide

CO_2e climate change emissions expressed as CO_2 equivalent.

DHS Department of Health Services

DOE United States Department o Energy

DWR Department of Water Resources

EAP Energy Action Plan

E-DRAM Environmental Dynamic Revenue Model

EJ Environmental Justice

EO Executive Order

ESPs Energy Service Providers

EWMP Efficient Water Management Practices

GCMs Global Climate Models

GFDL Geophysical Fluid Dynamic Laboratory

GHGs Greenhouse Gases

GWP Global Warming Potential

HadCM3 Hadley Centre Climate Model, version 3

HFC Hydrofluorocarbons

IEPR Integrated Energy Policy Reports
IOU Investor Owned Utility
IPCC Integovernmental Panel on Climate Change
ITS Intelligent Transportation Systems
IWMA Integrated Waste Management Act
kWh kilowatt hour = 3.6 MJ = 3,412 Btu
LEAs Local Enforcement Agencies
MAF Million Acre Feet
MMt Million Metric Tons
MOU Memorandum of Understanding
N_2O Nitrous Oxide
NAST National Assessment Synthesis Team
NCAR National Center for Atmospheric Research
NMVOCs Nonmethane Volatile Organic Compounds
NO Nitrogen Oxides
NOAA National Oceanic & Atmospheric Administration
NPV Net Present Value
O_3 Tropospheric
°C Celsius
ODS Ozone Depleting Substances
°F Fahrenheit
PCM1 Parallel Climate Model
PFC Perfluorocarbons
PIER Public Interest Energy Research
PM Particulate Matter
PPM Parts per Million
PUC Public Utilities Commission
Registry California Climate Action Registrly
RPS Renewable Portfolio Standard
SF_6 Sulfur Hexafluoride
SO_2 Sulfur Dioxide
SRES Special Report on Emissions Scenarios
TRUs Transportation Refrigeration Units

U.S. EPA United States Environmental Protection Agency

UK United Kingdom

VMT Vehicle Miles Traveled

VOC Volatile Organic Compound

W/m_2 Watts per Square Meter

WUI Wildland-Urban Interface

12 ENDNOTES

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[10] This section summarizes the findings from:
Drechsler, Deborah M., Nehzat Motallebi, Michael Kleeman, Dan Cayan, Katharine Hayhoe, Laurence S. Kalkstein, Norman Miller, Scott Sheridan, Jiming Jin, and R. Tony VanCuren, "Public Health-related Impacts of Climate Change," 2006. Michael Kleeman and Dan Cayan. "Impact of Climate Change on Meteorology and Regional Air Quality In California." Interim Report to ARB. December 2005.
[11] This section summarize results from:
Brian Joyce et al., "Climate Change Impacts on Water for Agriculture in California: A case study in the Sacramento Valley," 2006; Jouse Medellin, Julien Harou, Marcelo Olivares, Jay Lund,

Richard Howitt, Stacy Tanaka, Marion Jenkins, and Tingju Zhu, "Climate Warming and Water Supply Management in California," 2006; Russell Yaworsky, U.S. Bureau of Reclamation, Sacramento, "Climate Change Impacts on the SWP and CVP," Progress on Incorporating Climate Change into Management of California's Water Resources. 1st Progress Report, in review; K. Hayhoe, D. Cayan, et al., "Emissions pathways, climate change, and impacts on California." PNAS 2004, Vol. 101, No. 34, pp. 12422–12427.

[12] This section summarizes reports prepared by:
T. Cavagnoro et al. 2006; D. Balducci et al. 2006; A.P. Gutierrez, C.K. Ellis, R. Ghezelbash, "Climatic Limits of Pink Bollworm in Arizona and California: Effects of Climate Warming," Acta Oecologica, forthcoming.

[13] This is the 1998 figure for the total sales of agricultural and processing products in California. N. V. Kuminoff, A. D. Sokolow, and D. A. Sumner, "Farmland Conversion: Perceptions and Realities," Agricultural Issues Center, Issues Brief, No 16. 2001.

[14] Gutierrez, "Climatic limits of pink bollworm."

[15] Dan Cayan et al., 2006.

[16] J.M. Lenihan, R. Drapek, R. Neilson, and D. Bachelet, "The response of vegetation distribution, ecosystem productivity, and fire in CA to future climate scenarios simulated by the MC1 DGVM," 2006.

[17] J.S. Freid et al., and Westerling et al. 2006

[18] Max Moritz and Scott Stephens, 2006.

[19] John Battles et al., 2006.

[20] Summarizes results from Battles et al. 2006

[21] This section summarizes work from the following sources:
Jouse Medellin, Julien Harou, Marcelo Olivares, Jay Lund, Richard Howitt, Stacy Tanaka, Marion Jenkins, and Tingju Zhu, "Climate Warming and Water Supply Management in California," 2006; Chung et al., "Progress on Incorporating Climate Change into Management of California's Water Resources," California Department of Water Resources, 2006; Guido Franco and A. Sanstad, "Electricity and Climate Change in California, California Energy Commission," 2006

[22] More discussion on the role of mitigation and adaptation can be found in A. Luers and S. Moser, "Preparing for the Impacts of Climate Change in California: Advancing the Debate on Adaptation," 2006.

[23] California Environmental Protection Agency Air Resources Board (ARB), Initial Statement of Reasons for Proposed Rulemaking, Public Hearing to Consider Adoption of Regulations to Control Greenhouse Gas Emissions from Motor Vehicles, August 6, 2004. <http://www.arb.ca.gov/regact/grnhsgas/isor.pdf>

[24] Adoption of the Proposed Airborne Toxic Control Measure to Limit Diesel-Fueled Commercial Motor Vehicle Idling, ARB, July 22, 2004. <http://www.arb.ca.gov/regact/idling/idling.htm>

[25] This figure is net of added electricity use at truck stops.

[26] The Acid Rain Trading Program caps total sulfur dioxide (SO2) emissions from all fossil-fueled electric generating units in the United States with capacity of 25 MW or more. The Northeast NOx Program caps total emissions of nitrogen oxides (NOx) from electric generating units and large industrial boilers in 19 states and the District of Columbia.

[27] Ellerman, A., Paul Joskow Denny, and David Harrison, Emission Trading in the U.S. Experience, Lessons, and Considerations for Greenhouse Gases, Pew Center on Global Climate Change, Washington, D.C., May 2003, pp.12–20 and pp. 29–31. U.S.EPA, Evaluating Ozone Control Programs in the Eastern United States: Focus on the NOx Budget Trading Program, 2004, U.S. EPA, Washington, D.C., EPA454-K-05-001, August 2005, pp. 27-30.

[28] A third cap and trade program in the U.S. is the Regional Clean Air Incentives Market (RECLAIM) program. The RECLAIM Program caps NOx and SOx emissions in the South Coast air basin from about 350 NOx sources and 40 SOx sources. In 2000, after seven years of operation, the emission trading market for the RECLAIM Program experienced volatile price swings that eventually led to the program being restructured to exclude electric generating units. Multiple factors contributed to the difficulties in the RECLAIM Program, including impacts from the deregulation of the electric power sector. U.S.EPA, An Evaluation of the South Coast Air Quality Management District's Regional Clean Air Incentive market—Lessons in Environmental Markets and Innovation, U.S. Environmental Protection Agency, Washington, D.C., 2002, p. 24.

[29] An upstream approach to carbon emission trading is discussed in Tim Hargrave, "U.S. Carbon Emissions Trading: Description of an Upstream Approach," Center for Clean Air Policy, Washington, D.C., 1998.

[30] See "Who Gains and Who Pays Under Carbon-Allowance Trading? The Distributional Effects of Alternative Policy Designs," Congressional Budget Office, The Congress of the United States, Washington, D.C., 2000.

[31] "An Evaluation of the South Coast Air Quality Management District's Regional Clean Air Incentive market—Lessons in Environmental Markets and Innovation," U.S. Environmental Protection Agency, Washington, D.C., 2002, pp. 15-16.

32 2005 Integrated Energy Policy Report, California Energy Commission, November 2005

33 Tellus Institute 2004. California Climate Leadership: Strategies to Reduce Global Warming Emissions. Draft

DRAFT

California Environmental Protection Agency
Air Resources Board

EXPANDED LIST OF EARLY ACTION MEASURES TO REDUCE GREENHOUSE GAS EMISSIONS IN CALIFORNIA RECOMMENDED FOR BOARD CONSIDERATION

Lyell Glacier, Yosemite National Park, California, USA circa 1903 (upper) and 2003 (lower)

SEPTEMBER 2007

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Comments on this report or its supporting appendices should be submitted to Michael Robert at (916) 327-0604, mrobert@arb.ca.gov and Dr. Tao Huai at (916) 324-2981, thuai@arb.ca.gov by September 24th, 2007.

The ARB staff is recommending that the Board expand the list of early action measures being pursued to reduce greenhouse gas emissions from 37 to 44 measures. Of these measures staff believes 9 merit consideration to be placed on the list of discrete early actions as defined by the California Global Warming Solutions Act of 2006 (AB 32), increasing the size of the current list of 3 by 6 items. Cumulatively, these 44 measures have the potential to deliver greenhouse gas emission reductions on the order of at least 42 million metric tons of CO_2-equivalents ($MMTCO_2E$) or a quarter of the 2020 emission reductions needed to meet AB 32 goal. Existing ARB regulations will contribute approximately an additional 30 $MMTCO_2E$ reductions. The Climate Action Team has also identified measures (external to the ARB) that account for a cumulative reduction of approximately 68 $MMTCO_2E$. The remaining reductions to meet the 2020 target will be identified by the Scoping Plan due in late 2008. These additional early action recommendations will be presented at a September 17, 2007 public workshop and following consideration of public input will be brought before the Board at its October 25-26, 2007 hearing.

EXECUTIVE SUMMARY

In June 2007 the Air Resources Board (ARB) directed staff to pursue 37 early actions for reducing greenhouse gas (GHG) emissions under the California Global Warming Solutions Act of 2006 (AB 32). The broad spectrum of strategies to be developed – including a Low Carbon Fuel Standard, regulations for refrigerants with high global warming potentials, guidance and protocols for local governments to facilitate GHG reductions, and green ports – reflects that the serious threat of climate change requires action as soon as possible. Three of these 37 identified strategies were also identified as discrete early action measures. These are measures that could be fully adopted as regulations and made effective no later than January 1, 2010, the date established by the Health and Safety Code (HSC) Section 38560.5(b) that requires ARB to adopt discrete early actions.

In addition to approving the 37 GHG reduction strategies, the Board directed staff to further evaluate early action recommendations made at the June 2007 meeting by the AB 32 Environmental Justice Advisory Committee (EJAC), the California Air Pollution Control Officers Association (CAPCOA), and the South Coast Air Quality Management District (SCAQMD), and to report back to the Board within six months. The general sentiment of the Board suggested a desire to try to pursue greater GHG emissions reductions in California in the near-term. This revised early actions report provides staff's analyses of additional emission reduction strategies, and provides recommendations to significantly expand the list of early actions as well as discrete early action measures as identified by HSC Section 38560.5(a).

Since the June 2007 Board hearing, ARB staff has evaluated all 48 recommendations submitted by the EJAC, CAPCOA, and SCAQMD, as well as several other stakeholder suggestions and several internally-generated staff ideas. Each of these measures has been carefully considered with respect to potential emissions reductions, technological feasibility, estimated costs, and economic impacts. This document reports staff's findings and makes further recommendations for a revised list of early actions and, specifically, discrete early action measures (See insert in next page for definitions). The report also provides much greater detail on the evaluation of measures that staff has conducted since the previous April 2007 early actions report[1] was released.

Based on its additional analysis, ARB staff is recommending the expansion of the early action list to a total of 44 measures. The additions to the list of the ARB's commitments also triple the number of measures that would be pursued on an accelerated timeline that meets the AB 32 timeframe for discrete early actions.

In total, as shown in Figure ES-1, the 44 recommended early actions have the potential to reduce GHG emissions by at least 42 million metric tons of carbon dioxide (CO_2) equivalent ($MMTCO_2E$) emissions by 2020, representing about 25% of the estimated reductions needed by 2020. ARB staff is working on 1990 and 2020 GHG emission inventories in order to refine the projected reductions needed by 2020 and expects to present its recommendations to the Board by the end of 2007. The 2020 target reductions are currently estimated to be 174 $MMTCO_2E$.

Efforts to develop several of the strategies are already underway with workshops planned for fall 2007 and early 2008. Further, the Climate Action Team (CAT) member agencies[2] are also moving forward with early actions with a targeted reduction of 68 $MMTCO_2E$ by 2020[3]. Both the ARB and CAT emission reduction projections are best estimates that are subject to revision as additional information on individual measures becomes available. The ARB staff will report on the early actions progress to its Board every six months. The CAT will also periodically update its efforts and progress on a similar schedule.

A list of all 44 early actions is presented in Table 1, with recommended additions as well as the discrete early action measures identified. In addition, the year and quarter in which the ARB Board hearing is anticipated is also indicated. Inclusion of a strategy, regardless of classification or whether it can be implemented before or after the January 1, 2010 enforceability date for discrete early action measures, represents a commitment by the Board to pursue and – for those strategies that meet all legal and technical requirements – bring the measure to the Board on the timeframe illustrated in the table.

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[1] Available at www.arb.ca.gov/cc/042307workshop/early_action_report.pdf.

[2] Includes the California Environmental Protection Agency, the Business, Transportation and Housing Agency, the Department of Food and Agriculture, the Resources Agency, the Air Resources Board, the Energy Commission, and the Public Utilities Commission.

[3] Those actions are described by the CAT in its companion report on early actions which can be found at www.climatechange.ca.gov/climate_action_team/reports/2007-04-20_CAT_REPORT.

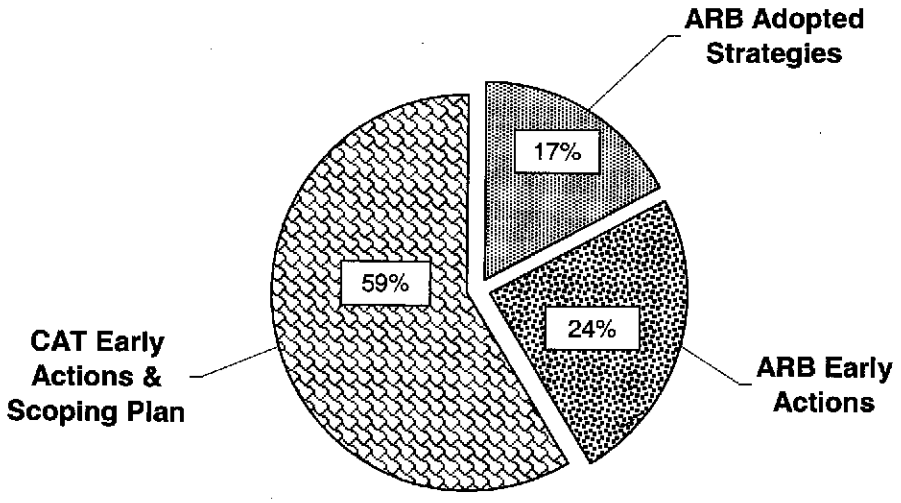

Figure ES-1. 2020 ARB GHG Reduction Estimates by Different Elements of the State's Climate Protection Action Plan.

BACKGROUND

The California Global Warming Solutions Act of 2006 (AB 32) creates a comprehensive, multi-year program to reduce GHG emissions in California, with the overall goal of restoring emissions to 1990 levels by the year 2020 (see Figure 1). AB 32 recognizes that such an ambitious effort requires careful planning and a comprehensive strategy. By January 1, 2009 the Board must design and adopt an overall Scoping Plan to identify how GHG emissions can be reduced back to 1990 levels by 2020. The Board has until January 1, 2011 to adopt the necessary regulations to implement that plan. Implementation begins no later than January 1, 2012 and the emissions reduction target is to be achieved by January 1, 2020. AB 32 also directs the Board to make recommendations on how to best achieve further reductions beyond 2020.

Discrete Early Action – Greenhouse gas reduction measure underway or to be initiated by ARB that meets the AB 32 legal definition as identified by the Health and Safety Code Section 38560.5. Discrete early actions are regulations to reduce greenhouse gas emissions adopted by the Board and enforceable by January 1, 2010.

Early Action – Greenhouse gas reduction measures underway or to be initiated by ARB in the 2007 – 2012 timeframe. These measures may be regulatory or non-regulatory in nature.

In April of 2007 ARB staff released a report entitled 'Proposed Early Actions to Mitigate Climate Change in California.' In that report staff proposed 37 early actions to reduce GHG emissions in California with a cumulative estimate in the range of 33-46 $MMTCO_2E$ by 2020. Existing ARB regulations contributing an additional 30+ $MMTCO_2E$ (principally the AB 1493 regulations on vehicle GHG emissions) were also discussed. Thus, ARB committed to pursue strategies with the potential to yield over 60 $MMTCO_2E$ by 2020, representing an important down payment towards the estimated 2020 reduction target. In its April 2007 report staff recommended that three of these strategies be developed on a schedule that met the AB 32 legal requirement for discrete early action measures – the Low Carbon Fuel Standard (LCFS), reduction of refrigerant losses from motor vehicle air conditioning maintenance, and increased methane capture from landfills.

At its June hearing the Board adopted a resolution which listed three discrete early action measures recommended by the staff and also committed ARB to pursue a total of 37 early actions. The Board also directed the staff to further evaluate recommendations for early actions made by the EJAC, CAPCOA, and the SCAQMD, and to report back to the Board within six months. The general sentiment of the Board suggested a desire to try to accomplish greater GHG emissions reductions in California in the near-term. The staff has completed these additional analyses requested by the Board and staff's conclusions and recommendations form the basis of this report. The updated recommendations documented herein will be presented at a September 17, 2007 public workshop at ARB headquarters in Sacramento, and following additional consideration of public input by the staff will be considered by the Board at its October 25-26, 2007 hearing.

Figure 1. Comprehensive Multiyear Program Established by AB 32

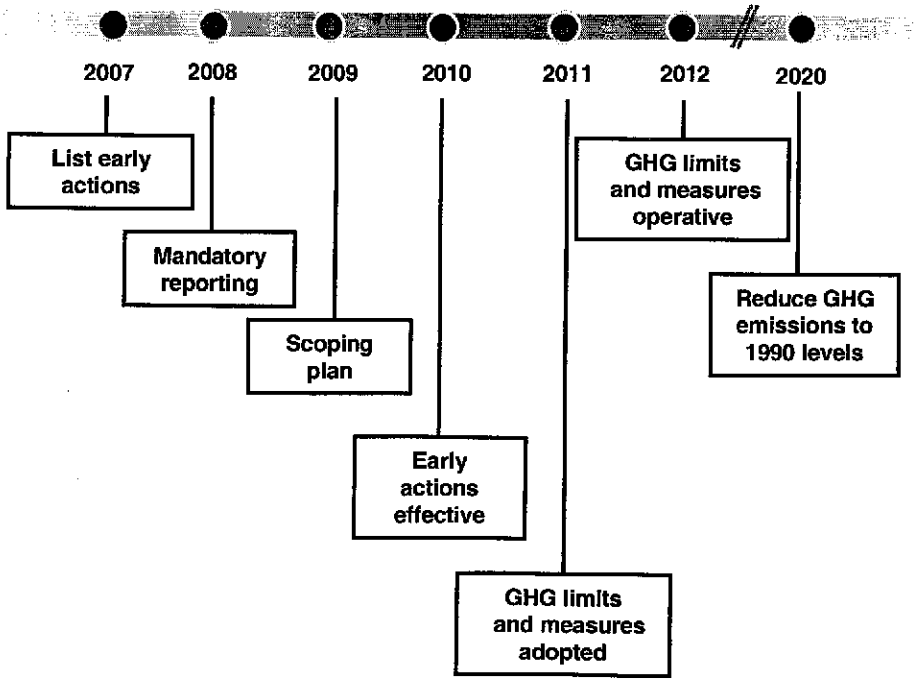

TABLE 1. GHG REDUCTION MEASURES UNDERWAY OR TO BE INITIATED BY ARB IN THE 2007-2012 PERIOD

EA ID	SECTOR	STRATEGY NAME	ARB BOARD HEARING DATE[1]																							
			2007				2008				2009				2010				2011				2012			
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1	Fuels	Above ground storage tanks[2]		■																						
2	Transportation	Diesel - Offroad equipment (non-agricultural)[2]			■																					
3	Forestry	Forestry protocol endorsement[2]				■																				
4	Transportation	Diesel - Port trucks[2]				■																				
5	Transportation	Diesel - Vessel main engine fuel specifications[2]				■																				
6	Transportation	Diesel - Commerical harbor craft[2]				■																				
7	Transportation	Green ports					■																			
8	Agriculture	Manure management (methane digester protocol)[2]							■																	
9	Education	Local government GHG reduction guidance / protocols[2]							■																	
10	Education	Business GHG reduction guidance / protocols[2]							■																	
11	Energy Efficiency	Cool communities program[2]							■																	
12	Commercial	Reduction of high GWP GHGs used in consumer products[3]								■																
13	Commercial	Reduction of PFCs from semiconductor industry								■																
14	Transportation	SmartWay truck efficiency								■																
15	Transportation	Low Carbon Fuel Standard (LCFS)								■																
16	Transportation	Reduction of HFC-134a from DIY MVAC servicing								■																
17	Waste	Improved landfill gas capture								■																
18	Fuels	Gasoline dispenser hose replacement[2]								■																
19	Fuels	Portable outboard marine tanks[2]								■																
20	Transportation	Standards for off-cycle driving conditions[2]								■																
21	Transportation	Diesel - Privately owned on-road trucks[2]								■																
22	Transportation	Anti-Idling enforcement[2,3]								■																
23	Commercial	SF_6 reductions from the non-electric sector									■															
24	Transportation	Tire inflation program									■															
25	Transportation	Cool automobile paints										■														
26	Cement	Cement (A): Blended cements[3]										■														
27	Cement	Cement (B): Energy efficiency of California cement facilities[3]																■								
28	Transportation	Ban of HFC release from MVAC service / dismantling												■												
29	Transportation	Diesel - offroad equipment (agricultural)[2]												■												
30	Transportation	Add AC leak tightness test and repair to Smog Check													■											
31	Agriculture	Collaborative research on GHG reductions from nitrogen land application[3]																■								
32	Commercial	Specifications for commercial refrigeration																■								
33	Oil and Gas	Reduction of venting / leaks from oil and gas systems																■								
34	Transportation	Requirement of low-GWP GHGs for new MVACs[4]																■								■
35	Transportation	Hybridization of medium and heavy-duty diesel vehicles																	■							
36	Electricity	Reduction of SF_6 in electricity generation																		■						
37	Commercial	High GWP refrigerant tracking, reporting, and recovery program[3]																				■				
38	Commercial	Foam recovery / destruction program																				■				
39	Fire Suppression	Alternative suppressants in fire protection systems																				■				
40	Transportation	Strengthen light-duty vehicle standards																								■
41	Transportation	Truck stop electrification with incentives for truckers																								
42	Transportation	Diesel - Vessel speed reductions[2,5]																								
43	Transportation	Transportation refrigeration - electric standby[2,5]																								
44	Agriculture	Electrification of stationary agricultural engines[5]																								

CUTOFF ADOPTION DATE FOR 01/01/2010 ENFORCEABILITY →

[shaded] = these items are expected to meet the AB 32 definition of discrete early actions in that they directly address GHG emission, are regulatory, and are enforceable by January 1, 2010

[1] Add 9-12 months to Board adoption date to determine the approximate date of Office of Administrative Law (OAL) approval, thereby making a regulation that the Board has adopted legally enforceable.

[2] There is a reasonable expectation that these measures will yield some reductions in emissions impacting climate (e.g., diesel particulate matter, hydrocarbons). However, they are not listed as discrete early actions because they do not directly address greenhouse gases for which the science is most robust (e.g., CO_2, SF_6, N_2O, CH_4, HFC, PFC), are non-regulatory, or are not enforceable by January 1, 2010. Some are regulations recently adopted by the Board.

[3] These are additional early actions that were not on the list approved by the Board at its June 2007 hearing.

[4] New requirements for HDVs and other classes not included in AB 1493 to be adopted in 2010. Additional requirements for LDVs to be adopted in conjuction with Pavley II (EA ID 40).

[5] Board hearing is not required or indicated - these measures may be ongiong voluntary efforts or under evaluation by staff with insufficient data to justify setting a Board hearing date at this time.

The ARB is one of many state agencies pursuing early actions. The CAT has identified and is refining additional GHG reduction strategies that can be accomplished or initiated in the 2007-2009 period. The CAT process continues to evolve and grow and its early actions will be indispensable for meeting the 2020 target.

The ARB is also in the process of developing a comprehensive Scoping Plan, due in late 2008, which will outline a multifaceted approach to meeting the 2020 emissions reduction target defined in AB 32. The Scoping Plan will evaluate opportunities for sector-specific reductions, integrate synergistically all ARB and CAT early actions and additional GHG reduction measures by both entities, identify additional measures to be pursued as regulations, and define the role of any potential market mechanisms such as a cap-and-trade program. The analyses of many potential GHG emission reduction strategies that are not recommended as early actions are currently underway and will continue as part of the Scoping Plan development. Recommendations regarding the form of these additional GHG reduction measures (e.g., regulatory, non-regulatory, market-based) will be included in the Scoping Plan.

AB 32 requires that all GHG reduction regulations adopted and implemented by the Board be technologically feasible and cost-effective. The law also requires that GHG measures be structured to prevent negative impacts on emissions of criteria pollutants (e.g., hydrocarbons, particulate matter) and to avoid any disproportionate socioeconomic effects (among other criteria). These are critical considerations for each of the recommended early actions. Staff must address these factors fully as detailed proposals are developed. While staff has advanced its understanding with respect to key requirements that must be addressed for most of the proposed strategies, the analyses have not progressed to the point where all impacts (e.g., technical feasibility, cost-effectiveness) can be defined conclusively at this time. Staff plans to develop this information for each of the early actions brought before the Board. If additional information or analysis reveals that a particular measure cannot meet one or more of these requirements, it will not be put into effect. The actual design or features of each measure will be crafted through an open public process that includes interaction with interested stakeholders through various means including workshops.

CONSIDERATION OF STAKEHOLDER INPUT

Sources of Additional Strategies

As directed by the Board, ARB staff further evaluated early action recommendations from the EJAC, CAPCOA, and SCAQMD as presented at the June 2007 Board Meeting. The original submissions from these entities are included in Appendix A to this report. A brief summary of recommendations from these three sources is as follows:

- The EJAC submitted 34 recommendations for early actions. Of these, 21 were approved by the Board at its June 2007 hearing. Thirteen strategies were not on the list approved by the Board at its June hearing. These are evaluated in Appendix B.

- The CAPCOA submitted five broad suggestions regarding early actions. These and a sixth suggestion are also addressed in the strategy evaluations presented in Appendix B.

- The SCAQMD submitted eight suggestions pertaining to early actions, each of which was further evaluated by ARB staff as documented in Appendix B.

In addition to the items from these three sources, ARB staff has also evaluated additional potential early actions since the June 2007 Board meeting. These measures were either stakeholder suggestions or were items generated internally. There were also several measures approved by the Board at its June 2007 hearing that have direct climate benefits but were not addressed via the EJAC, CAPCOA, SCAQMD, or additional stakeholder suggestions summarized above that are further evaluated in this report. A list of all 63 items considered from these various sources may be found in Table 2 of this document. The results of the staff analysis for each of the strategies evaluated are included in Appendices B and C as indicated in the 'Summary Number' column of Table 2. For those items in Table 2 that are included in the list of previously approved or newly recommended early actions in Table 1, their Early Action ID number from Table 1 is also provided as a cross-reference.

There were several early actions approved by the Board at its June 2007 hearing which were not evaluated further by the ARB (as the rationale for them was documented in the April 2007 report). These include the three discrete early action measures – specifically the LCFS, reduction of refrigerant losses from motor vehicle air conditioning maintenance, and increased methane capture from landfills – currently approved by the Board. Additionally, some air pollution control measures that have been approved by the Board with potential GHG reductions or other climate co-benefits (e.g., diesel control measures and hydrocarbon emission standards) have not been further evaluated by staff as their primary rationale was already established.

Staff Analysis of Strategies

Based on the direction from the Board, significant staff effort was expended to increase the depth and breadth of the analysis afforded to the strategies suggested by stakeholders. For each candidate early action measure analyzed, staff's recommendation concerning identification as an early action was based on a consideration of potential emissions reductions, estimated costs and economic impacts, the impacted sectors / entities, technological feasibility, and any additional information available. Completion of a full analysis for each of these factors was the goal for each strategy evaluated. However, as a comprehensive assessment will take at least several months for many strategies, much of the desired information is very preliminary or not currently available for a number of measures. Each staff evaluation sought to address:

TABLE 2. GHG REDUCTION STRATEGIES FURTHER EVALUATED BY THE ARB

SUMMARY NUMBER	TBL 1 EA ID	SOURCE	SECTOR	STRATEGY DESCRIPTION	DISPOSITION
NA	17	EJAC	Waste	Landfill methane gas recapture	No Change in Classification
Appendix B01	--	CAPCOA	Government	CAPCOA recommendations 1. Prioritize SIP reductions to maximize GHG reductions 2. Local rules / potential statewide measures to ID early actions 3. Existing permit programs for significant stationary sources 4. Develop guidance on review and mitigation of GHGs under CEQA 5. Local air district coordinated voluntary programs	Further Evaluation Required
Appendix B02	37	EJAC	Transportation	Refrigerant tracking, reporting and recovery program	Add as an EA
Appendix B03	8	EJAC	Agriculture	Manure digester protocol for calculating greenhouse gas mitigation	No Change in Classification
Appendix B04	33	EJAC	Oil and Gas	Reduce methane venting/leaks from oil and gas systems	No Change in Classification
		EJAC	Oil and Gas	Recycling of waste gases at oil production sites	
		EJAC	Oil and Gas	Eliminate methane exemptions granted to oil production sites	
		EJAC	Oil and Gas	Energy efficiency measures at oil production sites	
Appendix B05	14	EJAC STAKEHOLDER	Transportation	SmartWay truck efficiency	Re-classify as a Discrete EA Measure
Appendix B06	25	EJAC	Transportation	Cool paints for automobiles	No Change in Classification
Appendix B07	7	EJAC/SCAQMD	Commercial	Green ports	Re-classify as a Discrete EA Measure
		EJAC	Commercial	Shoreside generators / electrical hookup	
		SCAQMD	Transportation	Auxiliary ship engine cold ironing	
Appendix B08	43	EJAC	Transportation	Transport refrigeration units, electric standby	No Change in Classification
Appendix B09	41	EJAC	Transportation	Truck stop electrification with incentives for truckers	No Change in Classification
Appendix B10	24	EJAC	Transportation	Tire pressure program	Re-classify as a Discrete EA Measure
Appendix B11	34	EJAC	Transportation	Requirement of low-GWP GHGs for new MACS	No Change in Classification
Appendix B12	30	EJAC	Transportation	Addition of AC leak test and repair requirements to Smog Check	No Change in Classification
Appendix B13	--	EJAC	Cement	WAFFLEMAT Systems	Evaluating for Scoping Plan
Appendix B14	--	EJAC	Commercial	Green ship incentive program	Evaluating for Scoping Plan
Appendix B15	--	EJAC	Commercial	Anti-idling requirement for cargo handling equipment at ports	Evaluating for Scoping Plan
Appendix B16	--	EJAC	Transportation	Electrification of airport ground support equipment	Evaluating for Scoping Plan
Appendix B17	--	EJAC	Commercial	Electrification of construction equipment at urban sites	Addressed via recently adopted regulation
Appendix B18	35	EJAC	Transportation	Hybridization of medium and heavy-duty vehicles	No Change in Classification
Appendix B19	25	STAKEHOLDER EJAC	Cement	Cement (A): Energy efficiency of California cement facilities Relatively inexpensive energy savings measures with short pay back times for cement industry	Add as an EA
	--		Cement	Low carbon fuels for cement production	
Appendix B20	26	EJAC	Cement	Cement (B): Blended cements	Add as an EA
Appendix B21	--	EJAC	Oil and Gas	Relatively inexpensive energy savings measures with short pay back times for fossil fuel power plants built prior to 1990	Evaluating for Scoping Plan

TABLE 2. GHG REDUCTION STRATEGIES FURTHER EVALUATED BY THE ARB (continued)

SUMMARY NUMBER	TBL 1 EA ID	SOURCE	SECTOR	STRATEGY DESCRIPTION	DISPOSITION
Appendix B22	--	EJAC	Oil and Gas	Identify and implement energy efficiency measures at refiners that include, but are not limited to, conducting an energy audit	Evaluating for Scoping Plan
		EJAC	Oil and Gas	Recycle waste gases at refineries	
		EJAC	Oil and Gas	Energy efficiency measures at refineries	
Appendix B23	--	EJAC	Commercial	Accelerate the replacement of cargo handling equipment at ports	Evaluating for Scoping Plan
Appendix B24	--	EJAC	Agriculture	Evaluate enclosed dairy barns as an additional strategy for the capture and combustion of methane emissions at dairies	Evaluating for Scoping Plan
Appendix B25	--	EJAC	Commercial	Composting – adopt South Coast and San Joaquin rules statewide	Evaluating for Scoping Plan
Appendix B26	--	EJAC	Electricity	Phase out pre-1960 power plants generating at least 100 MW and provide incentives to replace them with clean energy	Evaluating for Scoping Plan
Appendix B27	--	EJAC	Electricity	Prohibit fuel oil burning in pre-1960 power plants generating at least 100 MW	Evaluating for Scoping Plan
Appendix B28	--	EJAC	Oil and Gas	Refinery methane emissions	Evaluating for Scoping Plan
Appendix B29	32	CAPCOA	Commercial	Specifications for commercial refrigeration	No Change in Classification
Appendix B30	--	SCAQMD	Transportation	Accelerate introduction and deployment of light-duty vehicle (passenger) hybrid technology	Evaluating for Scoping Plan
Appendix B31	--	SCAQMD	Oil and Gas	Natural Gas requirement of 1360 Wobbe Index	Further Evaluation Required
Appendix B32	11	SCAQMD	Energy Efficiency	Cool communities program	No Change in Classification
Appendix B33	40	SCAQMD	Transportation	Strengthen light-duty vehicle standards	No Change in Classification
Appendix B34	--	SCAQMD	Transportation	Off Highway Recreational Vehicle (OHRV) evaporative emissions control	Further Evaluation Required
Appendix B35	--	SCAQMD	Transportation	Determination of evaporative emissions from Pleasure Craft	Further Evaluation Required
Appendix B36	42	ARB	Transportation	Vessel speed reduction	No Change in Classification
Appendix B37	22	STAKEHOLDER	Transportation	Anti-Idling enforcement	Add as an EA
Appendix B38	23	ARB	Commercial	SF_6 reductions from the non-electric sector	Add as a Discrete EA Measure
Appendix B39	12	ARB	Commercial	Reduction of high GWP GHGs used in consumer products	Add as a Discrete EA Measure
Appendix B40	31	ARB	Agriculture	Collaborative research to understand how to reduce GHG emissions from nitrogen land application	Add as an EA
Appendix C01	44	ARB EA REPORT	Agriculture	Stationary agricultural engine electrification	No Change in Classification
Appendix C02	13	ARB EA REPORT	Commercial	Reduction of perfluorocarbons (PFCs) from the semiconductor industry	Re-classify as a Discrete EA Measure
Appendix C03	38	ARB EA REPORT	Commercial	Foam recovery / destruction program	No Change in Classification
Appendix C04	9	ARB EA REPORT	Government	Guidance and protocols for local governments to facilitate GHG emission reductions	No Change in Classification
Appendix C05	10	ARB EA REPORT	Business	Guidance/protocols for businesses to facilitate GHG emission reductions	No Change in Classification
Appendix C06	36	ARB EA REPORT	Commercial	Reduce sulfur hexafluoride (SF6) from electrical generation	No Change in Classification
Appendix C07	39	ARB EA REPORT	Commercial	Alternative suppressants in fire protection systems	No Change in Classification
Appendix C08	3	ARB EA REPORT	Forestry	Forestry protocol endorsement	No Change in Classification
Appendix C09	26	ARB EA REPORT	Transportation	Enforcement of federal ban on HFC release during service/dismantling of MVACs	No Change in Classification

- The potential emission reductions in 2010 (if any) and 2020 in terms of million metric tons of CO_2-equivalent per year, including any co-benefits (e.g., reduction in emissions of criteria pollutants) or disbenefits (e.g., fuel penalty).

- The costs per $MTCO_2E$ and the total cost of implementation in 2010 (if applicable) and 2020 and the sectors that will bear the costs including any potential disproportionate impacts on small businesses or environmental justice sectors of the community. This discussion includes businesses or individuals (e.g., environmental justice community) that may be adversely impacted by the proposed strategy.

- The likely technical feasibility of the technology by describing the degree to which it or a similar technology has already been proven. If not applicable, the research/pilot studies that suggest the technological feasibility is likely to be within the next few years are cited.

- Additional considerations that pertain to the measure, such as if any other jurisdiction (state, county) has taken the action, whether the item falls under ARB jurisdiction or is a CAT strategy, whether ARB has legal authority, whether the item would be regulatory, when the item could be taken before the Board, and coordination with affected entities, trade associations, and/or government agencies.

Current State of Understanding

Appendices B and C include a complete listing of staff's analysis for each of the 63 recommendations / potential early actions listed in Table 2, exclusive of the landfill methane capture suggestion by the EJAC, which is already a discrete early action. Each summary has a unique identification number that is also listed in Table 2 for each measure; note that multiple measures may be addressed by the same summary.

The summaries in Appendices B and C represent ARB staff's current understanding of the ideas evaluated. It is acknowledged that in many instances, additional time, effort, and information are still needed for a more thorough compilation of all relevant and necessary information to support development as a regulation or other approach such as guidance.

Based on its current state of understanding, staff has made one of six recommendations for each measure it evaluated which are described below. One of these six recommendations is indicated for each of the strategies evaluated (see disposition column in Table 2).

- Previously Approved – No Change – applies to measures which were approved by the Board as early actions at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this early action is recommended.

- Previously Approved – Reclassify as a Discrete Early Action – applies to measures which were approved by the Board as early actions at its June 2007 hearing. Based on further evaluation by staff, it is recommended that this early action be reclassified as a discrete early action measure.

- Proposed Measure – Add as a Discrete Early Action – applies to measures which are recommended for addition to the list of discrete early action measures.

- Proposed Measure – Add as an Early Action – applies to measures which are recommended for addition to the list of early actions.

- Proposed Measure – Continue to Evaluate in Scoping Plan – applies to measures proposed at the June 2007 Board meeting which are recommended for further evaluation in the Scoping Plan. A draft Scoping Plan is expected by mid-2008 and must be considered by the Board prior to January 1, 2009. Evaluation as part of the Scoping Plan provides the most effective approach for fully considering these recommendations.

- Proposed Measure – Further Evaluation Needed – applies to measures proposed that require further information and evaluation prior to recommending that they be pursued an early actions. As additional information becomes available staff will consider whether it supports recommending these strategies as additions to the Board's list of commitments for reducing greenhouse gas emissions.

RECOMMENDATIONS FOR ADDITIONAL EARLY ACTIONS

The ARB staff is recommending that a total of 44 early actions be developed and brought to the Board for future consideration. These measures are recommended because staff's evaluation concluded that they are expected to yield significant GHG emission reductions, are likely to be cost-effective and technologically feasible, and can be brought back to the Board as full proposals in the 2007-2012 timeframe. Specifically, staff is recommending that 6 more discrete early actions be added to the list previously approved by the Board, two of which are new recommendations to be added to the list of those actions meeting the narrow definition of discrete early actions in that they are regulatory and will be enforceable by January 1, 2010. Furthermore, staff is recommending that 4 previously adopted early actions be reclassified as discrete early action measures. Cumulatively, these 44 total recommendations are expected to yield at least 42 $MMTCO_2E$ reductions by 2020, representing about 25% of the 2020 target.

Summary of Items Reviewed

Table 2 lists each of the items evaluated as potential early actions. It consists of the recommendations made by the EJAC, CAPCOA and the SCAQMD as well as additional strategies that were identified by stakeholders or ARB staff. Each of the strategies has been evaluated with the results of the evaluation presented in

Appendices B and C. The 'Summary ID' column of Table 2 cross-references each of these items to its summary in the appendices; the final disposition of each item is listed in the 'Disposition' column.

Items Addressed by Recently Adopted Regulations

The ARB recently adopted an off-road diesel rule[4] at its July 2007 Board hearing. This regulatory measure was not listed as an early action in the April 2007 ARB staff report. The regulation requires a reduction in off-road diesel engine particulate matter emissions, and is applicable to off-road engines such as those used by urban construction equipment. A possible way to achieve such pollutant reductions is via the electrification of construction equipment at urban sites. This particular example was submitted by the EJAC [refer to summary number B17 in Appendix B]; this recommendation is therefore encapsulated within the intent of a recently adopted regulation and was not further evaluated as part of the early action effort.

Measures Recommended as Additional Discrete Early Actions

The ARB staff's recommendations concerning the addition of discrete early actions are summarized below. In addition to these measures staff closely evaluated many other measures as potential discrete early action measures. However, for reasons such as the non-regulatory nature of a measure, its implementation timeline, and others, they are not recommended for addition to the list of discrete early action measures. Additional information, including the specific rationale for the disposition of each strategy evaluated, may be found in Appendices B or C and is summarized in Table 2.

SF_6 Reductions in the Non-Electric Sector: This measure is recommended as an additional discrete early action measure. The strategy involves the potential ban of SF_6 in non-utility, non-semiconductor applications where safe, cost-effective alternatives are available. These applications may include magnesium production and casting operations, air quality tracer gas studies, and face velocity tests for laboratory hoods. The staff will investigate other possible uses of SF_6 during the development of the regulations.

Reduction of High GWP GHGs in Consumer Products: This measure is recommended as an additional discrete early action measure. The strategy involves the reduction of high-GWP GHGs used as propellants in aerosol products, tire inflators, electronics cleaning, dust removal, hand held sirens, hobby guns (compressed gas), party products (foam string), and other formulated consumer products when viable alternatives are available. Some data regarding emissions of greenhouse gases are available from a recent survey of consumer products, which may represent possible reductions within the discrete early action timeframe. Manufacturers are also currently being surveyed to determine the extent of usage of high GWP gases in several more categories of consumer products. These future survey results may lead to additional strategies with

[4] Staff report located at http://www.arb.ca.gov/regact/2007/ordiesl07/isor.pdf

emission reduction potential that can be pursued after the deadline for discrete early action items.

Measures Recommended for Reclassification as Discrete Early Actions

The ARB staff's recommendations concerning the reclassification of pre-existing early actions are summarized below. Additional information, including the specific rationale for the disposition of each strategy evaluated, may be found in Appendices B or C and is summarized in Table 2.

SmartWay Truck Efficiency: This measure is recommended to be re-classified as a discrete early action measure. The strategy involves requiring existing trucks/trailers to be retrofitted with the best available "SmartWay Transport"[5] and/or ARB approved technology. Technologies that reduce GHG emissions from trucks may include devices that reduce aerodynamic drag and rolling resistance. Aerodynamic drag may be reduced using devices such as cab roof fairings, cab side gap fairings, cab side skirts, and on the trailer side, trailer side skirts, gap fairings, and trailer tail. Rolling resistance may be reduced using single wide tires or low-rolling resistance tires and automatic tire inflation systems on both the tractor and the trailer.

Tire Inflation Program: This measure is recommended to be re-classified as a discrete early action measure. The strategy involves actions to ensure that vehicle tire pressure is maintained to manufacturer specifications. Specifically, the strategy seeks to ensure that tire pressure in older vehicles is monitored by requiring that tires be checked and inflated at regular service intervals. One potential approach would be to require all vehicle service facilities, such as dealerships, maintenance garages, and smog check stations, to check and properly inflate tires. It is also anticipated that signage at fueling stations clearly indicate the availability of compressed air at no charge. Staff also recommends that the feasibility of conducting an extensive outreach program be investigated.

Reduction of PFCs from the Semiconductor Industry: This measure is recommended to be re-classified as a discrete early action measure. The strategy involves establishing a PFC emissions reduction goal and determining measures to achieve that goal. There are several approaches the industry has either employed or committed to continue evaluating to reduce PFC emissions from semiconductor production, including process optimization (optimizing the use of PFCs, such as in the chamber cleaning process), alternative chemistry

[5] The United States Environmental Protection Agency (U.S. EPA) in collaboration with the freight industry has developed a voluntary program designed to increase energy efficiency while significantly reducing greenhouse gases and criteria pollutants. The program, known as the SmartWay Transport Partnership (SmartWay Transport), encourages trucking companies to use technologies that improve efficiency and reduce emissions. The SmartWay Transport also designates highly efficient and emission reduction technology packages as SmartWay Upgrade Kits which can be purchased at various SmartWay partner centers, dealerships, and service centers.
(http://www.epa.gov/otaq/smartway/documents/420f07027.htm)

development, emissions abatement; and recovery/recycling (separation of fluorinated compounds from other gases for further processing and reuse).

Green Ports: This measure is recommended as an additional discrete early action measure. The strategy involves providing an alternative source of power for ships while they are docked. For example, the ships can use cables to receive electricity from the shore, thereby allowing them to shut off their auxiliary engines, reducing emissions of air pollutants. Staff proposes to present the draft regulation to the Board as a measure to reduce nitrogen oxides (NO_x) and diesel particular (PM) emissions and to quantify the associated (carbon dioxide) CO_2 emission reductions. By focusing on NO_x and PM reductions, staff will address the local and regional health impacts of ships docked in California's ports, including any disproportionate impacts those emissions may have on surrounding communities.

Measures Recommended as Additional Early Actions

The ARB staff's recommendations concerning the addition of early actions are summarized below. In addition to these recommendations staff closely evaluated many other measures such as a green ship incentive program, and refinery methane emission reductions. However, for reasons such as a substantial lack of available information, technological barriers, implementation timeline, and others, they are not recommended for addition to the list of early actions. Additional information, including the specific rationale for the disposition of each strategy evaluated, may be found in Appendices B or C and is summarized in Table 2.

Refrigerant Tracking, Reporting, and Recovery Program: This measure is recommended as an additional early action. The strategy involves the reduction of emissions of high GWP GHGs through establishing requirements for enhanced monitoring, enforcement, reporting, and recovery. It may be determined that more than one strategy is required to effectively address the sources of interest and that the strategy or strategies are likely to include both regulatory and non-regulatory elements. Such strategies could include:

- Refrigerant Recovery from Decommissioned Refrigerated Shipping Containers: This consists of an assessment of the magnitude of the emissions from refrigerated shipping containers. Depending on results, the strategy may be similar to the one enforcing the federal ban on releasing refrigerants to the atmosphere from the servicing or dismantling of MVACS. After the recovery from a decommissioned container, it may be desirable to disable the refrigeration unit as well, which may require a regulation.

- Residential Refrigeration Program: This involves supporting existing voluntary programs to promote the upgrade of residential refrigeration equipment in need of repair, such as refrigerators and freezers. The program could potentially be expanded to include window unit air conditioners.

- High-GWP Refrigerant Tracking, Reporting, and Deposit Program: This strategy involves 1) expanding and enforcing the national ban on venting high-GWP GHGs (including fully emissive processes) during equipment/process lifetime; 2) requiring high-GWP GHG sales, use and energy use reporting as well as inspection and maintenance (I/M) and leak repair for equipment, cylinders, products, or systems with capacities above some CO_2E threshold; 3) requiring technician certification for sales, purchase, transport, recovery, reclamation, resale, I/M; and 4) establishing a high-GWP GHG deposit program and/or fines for emissive processes or leaky systems.

Cement (A): Energy Efficiency of California Cement Facilities: This measure is recommended as an additional early action. The strategy involves reducing CO_2 emissions from fuel combustion, calcination, and electricity use by converting to a low-carbon fuel-based production, decreasing fuel consumption, and improving energy efficiency practices and technologies in cement production.

Cement (B): Blended Cements: This measure is recommended as an additional early action. The strategy to reduce CO_2 emissions involves the addition of blending materials such as limestone, fly ash, natural pozzolan and/or slag to replace some of the clinker in the production of Portland Cement. Currently, ASTM cement specifications allow for replacement of up to 5% clinker with limestone. Most manufacturers could in fact replace up to 4% with limestone. Caltrans allows for 2.5% average limestone replacement until testing of the long term performance of the concrete is complete. Caltrans currently has over $1 million in task orders and is devoting considerable staff resources to the evaluation of limestone blending in cement. Caltrans also currently has standards for using flyash and slag in concrete. Other blending practices will be explored.

Anti-idling Enforcement: This measure is recommended as an additional early action. The strategy guarantees emission reductions as claimed by increasing compliance with anti-idling rules, thereby reducing the amount of fuel burned through unnecessary idling. Measures may include enhanced field enforcement of anti-idling regulations, increased penalties for violations of anti-idling regulations, and restriction on registrations of heavy-duty diesel vehicles with uncorrected idling violations.

Collaborative research to understand how to reduce GHG emissions from nitrogen land application: This measure is recommended as an additional early action. The strategy involves the identification of methodologies for better characterizing California's nitrogen cycle. An important first step to better characterizing the relationship between nitrogen land application and nitrous oxide formation in California agriculture, landscaping and other uses as well as opportunities for emission reductions is a collaborative research effort with stakeholders. The research is expected to focus on identifying optimal ways to reduce nitrous oxide emissions while increasing soil retention of nitrogen for plant uptake. As part of

the research the ARB will collaborate with the California Department of Food and Agriculture, Department of Pesticide Regulation, commodity groups, and other stakeholders. The research is expected to ultimately support the development of guidance to improve the characterization of nitrous oxide emissions from nitrogen land applications as well as identify effective strategies for emission reductions.

Process Forward for Regulatory Items

All discrete early action measures and the majority of the other early actions will enter into the conventional regulatory development process. This process involves public workshops and the consideration of stakeholder input, followed by the formal regulation development, which includes a public hearing where the Board considers the staff recommendation. If the Board adopts the regulation or an amended regulation, then it must be reviewed and approved by the Office of Administrative Law (OAL) before becoming law. Though the non-regulatory strategies such as guidelines will not become binding mandates, they will go through a similar process of public participation. This open process ensures that the regulatory development of each strategy that the staff recommends to the Board is informed by the best and most up-to-date information.

ADDITIONAL CONSIDERATIONS / CAT STRATEGIES

ARB has or will be adopting several strategies not discussed explicitly in this report that will yield significant GHG reductions by 2020. Most notably, the regulation that the Board adopted in response to AB 1493, which mandated the reduction of greenhouse gas emissions from passenger vehicles, is expected to account for 30 $MMTCO_2E$ by 2020. Other diesel PM, ozone-precursor, and State Implementation Plan (SIP) measures are also expected to have climate co-benefits whose magnitudes are yet to be determined.

In its April 2007 draft report entitled 'Climate Action Team Proposed Early Actions to Mitigate Climate Change in California', the CAT identified early actions external to the ARB that may yield up to 68 $MMTCO_2E$ reductions by 2020. In addition to ARB, members of the CAT have begun work on implementing many of the strategies outlined in the April 2007 draft report. Although not under statutory mandate to do so, the other CAT members expect to have several items implemented through regulations by January 1, 2010; these 13 strategies are expected to result in emission reductions of approximately 7 $MMTCO_2E$ with some reduction estimates still to be calculated. The same CAT members have also identified 41 additional measures for the post-2010 timeframe, which are expected to yield reductions in greenhouse gas emissions on the order of 61 $MMTCO_2E$ by 2020.

The ARB is in the process of developing a comprehensive Scoping Plan, due in late 2008, which will outline the multifaceted approach to meeting the 2020 emissions reduction target required by AB 32. The Scoping Plan will evaluate opportunities for sector-specific reductions, integrate synergistically all ARB and CAT early actions and additional GHG reduction measures, and define the role of any potential market mechanisms. The analyses of many potential GHG emission reduction strategies that

are not recommended as early actions are currently underway and will continue as part of the Scoping Plan development. Recommendations regarding the form of these additional GHG reduction measures (e.g. regulatory, non-regulatory, market-based) will be included in the Scoping Plan.

CONCLUSIONS / RECOMMENDATIONS

At its June 2007 hearing, the Board asked staff to conduct additional analyses of stakeholder suggestions for early actions. Staff has completed this task as well as the further evaluation of additional potential early action measures, and recommends that the list of early action measures be expanded to 44. Nine of these strategies meet the AB 32 definition of discrete early action measures, which is three times the number of original discrete early action measures currently approved by the Board. The ARB recognizes that California must act quickly and decisively now to begin the long road to mitigating the most serious impacts of global warming, and is committed to pursuing the full list of 44 early actions.

The revised list of early actions as recommended by ARB staff is a more ambitious plan than originally proposed and is a complement to the actions of the Climate Action Team members and many other entities in California, the U.S., and the world who are acting now for climate protection. Discrete early action measures that will be in place and enforceable by 2010 include the original list of 3 strategies, plus an additional 6 measures in the transportation and commercial sectors. In addition, 5 new measures as suggested by stakeholders or staff analysis will also be pursued as early actions, but will be implemented post-2010 or are not necessarily regulatory in nature. Cumulatively, all 44 early actions have the potential for reductions of 42 $MMTCO_2E$ by 2020.

The revised early action plan is a comprehensive framework of regulatory and non-regulatory elements that will result in significant and effective GHG emission reductions. The revised early action plan will receive public input at a September 17, 2007 workshop and will be considered by the Board at its October 25-26, 2007 hearing. If approved, each early action will be developed through an open public process.

GLOSSARY OF TERMS AND ACRONYMS

AB 32 – Assembly Bill 32, the Global Warming Solutions Act of 2006

ARB – Air Resources Board

CAPCOA – California Air Pollution Control Officers Association

CAT – Climate Action Team, a committee of multiple state agencies led by the Secretary of Cal/EPA

CO_2 – carbon dioxide; a byproduct of fossil fuel combustion, cement production, and other natural processes

Discrete Early Actions – Greenhouse gas reduction measure underway or to be initiated by ARB that meets the AB 32 legal definition as identified by the Health and Safety Code Section 38560.5. Discrete early actions are regulations to reduce greenhouse gas emissions adopted by the Board and enforceable by January 1, 2010.

Early Actions – Greenhouse gas reduction measures underway or to be initiated by ARB in the 2007 – 2012 timeframe. These measures may be regulatory or non-regulatory in nature.

EJAC – Environmental Justice Advisory Committee

GHG – greenhouse gas or gases; defined in AB 32 as including carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride; also known as "the Kyoto six"

GWP -- global warming potential, the relative warming of a greenhouse gas as compared to carbon dioxide which has a GWP of 1.0.

HFCs – Hydrofluorocarbons; a class of compounds whose molecules consist of carbon, hydrogen, and fluorine atoms typically used in air conditioning systems and as propellants

HSC – (the California) Health and Safety Code

LCFS – Low Carbon Fuel Standard

$MMTCO_2E$ – million metric tons (of) carbon dioxide equivalent (gases)

MVAC – motor vehicle air conditioning (systems)

OAL – California Office of Administrative Law

OHRV – Off Highway Recreational Vehicle

PFCs – perfluorocarbons, a class of compounds derived from hydrocarbons by replacement of hydrogen atoms by fluorine atoms. PFCs are made up of atoms of carbon, fluorine, and/or sulfur, and are mostly used in the semi-conductor industry

SCAQMD – South Coast Air Quality Management District

SF_6 – sulfur hexafluoride; a highly stable non-conducting chemical used for and emitted from various industrial processes and in the manufacturing of electrical circuitry

APPENDIX A – EJAC, CAPCOA, and SCAQMD Recommendations

ARB Discrete Early Action Measures
as proposed by
the Environmental Justice Advisory Committee on the Implementation of the Global Warming Solutions Act of 2006

Number	Description
1	Improved landfill methane capture
2	Require HFC-134a reductions through evaluation of refrigerants in de-commissioned or stored cargo containers, commercial and residential HVAC system leakage, auto dismantling/crushing facilities (i.e., requiring HFCs be removed from cars prior to scrappage)
3	Manure management[1]
4	Reduce venting/leaks from oil and gas systems
5	Heavy-duty vehicle emissions, efficiency improvements[2]
6	Cool automobile paints[3]
7	Port electrification
8	Transportation refrigeration, electric standby
9	Truck stop electrification with incentives for truckers
10	Tire inflation program
11	Require low GWP refrigerants for new MVACs[4]
12	Add AC leak tightness test and repair to Smog Check
13	Wafflemat system for concrete slab foundations
14	Demonstrate use of shoreside generators as bridge to electrical hook-up
15	Green ship incentive program
16	Anti-idling requirement for cargo handling equipment at ports
17	Require the electrification of airport ground support equipment
18	Require the electrification of construction equipment at urban sites
19	Adopt a regulation and or incentive program to take advantage of emerging hybrid technology for medium duty delivery trucks
20	Relatively inexpensive energy savings measures with short pay back times for cement industry
21	Explore a greenhouse gas and mercury emission performance standard for cement facilities equivalent to the level achievable through conversion from coal to natural gas
22	Relatively inexpensive energy savings measures with short pay back times for fossil fuel power plants built prior to 1980[5]
23	Relatively inexpensive energy savings measures with short pay back times for refineries[6]
24	Accelerate the replacement of cargo handling equipment at ports[7]
25	Enclose dairy barns to capture methane[8]
26	Adopt South Coast and San Joaquin rules on enclosed composting facilities statewide[9]
27	Establish necessary rules and or emissions thresholds for transmission to local Air Districts for the phase out, by 2010, of power plants built prior to 1980 that generate over 100 MW of electricity and provide incentives for clean energy production in their place[10]
28	Prohibit fuel oil burning for base load generation of electricity in facilities100 MW or greater and built prior 1980[11]
29	We recommend CARB undertake and adopt regulatory measures that require recycling of waste gases at refineries instead of dumping or incinerating them[12]
30	Adopt regulatory measures to eliminate the methane exemptions granted to refineries and require methane control measures at refineries[13]

31	Identify and implement energy efficiency measures at refineries that include, but are not limited to, conducting an energy audit. This audit shall consider and address, at least: a) Use of clean, renewable energy for refinery electricity consumption b) The impact of heavier crude oil modifications on GHG emission c) Other energy efficiency measures[14]
32	We recommend CARB undertake and adopt regulatory measures that require recycling of waste gases at oil production sites instead of dumping or incinerating them[15]
33	Adopt regulatory measures to eliminate the methane exemptions granted to oil production sites and require methane control measures at oil production sites[16]
34	Identify and implement energy efficiency measures that include, but are not limited to, conducting an energy audit at oil production sites. This audit shall consider and address, at least: a) Use of clean, renewable energy for oil production site electricity consumption b) Other energy efficiency measures.[17]

Early Action Measures to be Forwarded by ARB to the CAT Team

The Committee recommends that all CAT agencies with jurisdiction in the area of energy generation, procurement, siting, permitting, rate-setting and renewable energy deployment in both electricity and transportation sectors, conduct the following:

1) Quantify and publicly provide the air emission and cumulative impacts of new power plant construction in CA and report to CARB the implications for the achievement of the state's climate and air quality goals;
2) Require proponents of new power plant construction to conduct a thorough and robust renewable energy alternatives assessment. If a more carbon-beneficial combination of energy producing or saving sources is available, then the utility should be required to pursue that avenue. This process should begin with all currently approved and expected power plants;
3) Report to CARB on the progress of existing renewable energy deployment programs and identify obstacles to the achievement of the state's renewable energy goals;
4) Perform an audit, to be publicly available, of existing and planned low-income rate assistance, energy efficiency, solar, and green building programs and identify barriers that impede local community participation.

Note: The Committee supports electrification of engines when coupled with efforts to increase use of clean, renewable energy sources such as wind and solar.

[1] During the development of this measure ARB must identify methods that would eliminate the NOx emissions which result from this technology in order to comply with the prohibition in AB 32 against backsliding on criteria pollutants.
[2] Particularly promising avenues include requiring or incentivizing: Use of wide base tires, Use of automatic tire inflation systems, Use of low viscosity lubricants, Improving freight logistics, and Pursuit of hybrid truck technology. ARB should undertake a complete life cycle analysis before suggesting use of fuel additives.
[3] Any regulation developed would have to ensure that the new paint formulations did not cause backsliding on criteria pollutants.
[4] Any chosen replacements must first undergo a complete life cycle analysis and multi-media toxicity analysis.

[5] This measure was not included in the CARB report on Early Action Measures, but was received by CARB and the committee. The measure was evaluated and recommended as Early Action Measures because it met the criteria established by the committee.

[6] This measure was not included in the CARB report on Early Action Measures, but was received by CARB and the committee. The measure was evaluated and recommended as Early Action Measures because it met the criteria established by the committee.

[7] This measure was not included in the CARB report on Early Action Measures, but was received by CARB and the committee. The measure was evaluated and recommended as Early Action Measures because it met the criteria established by the committee.

[8] This measure was not included in the CARB report on Early Action Measures, but was received by CARB and the committee. The measure was evaluated and recommended as Early Action Measure because it met the criteria established by the committee.

[9] This measure was not included in the CARB report on Early Action Measures, but was received by CARB and the committee. The measure was evaluated and recommended as Early Action Measures because it met the criteria established by the committee.

[10] This measure was not included in the CARB report on Early Action Measures, but was received by CARB and the committee. The measure was evaluated and recommended as Early Action Measures because it met the criteria established by the committee.

[11] This measure was not included in the CARB report on Early Action Measures, but was received by CARB and the committee. The measure was evaluated and recommended as Early Action Measures because it met the criteria established by the committee.

[12] This measure was not included in the CARB report on Early Action Measures, but was received by CARB and the committee. The measure was evaluated and recommended as Early Action Measures because it met the criteria established by the committee.

[13] This measure was not included in the CARB report on Early Action Measures, but was received by CARB and the committee. The measure was evaluated and recommended as Early Action Measures because it met the criteria established by the committee.

[14] This measure was not included in the CARB report on Early Action Measures, but was received by CARB and the committee. The measure was evaluated and recommended as Early Action Measures because it met the criteria established by the committee.

[15] This measure had not been previously received by CARB and was added to the Early Action Measures list by the Committee. The measure was evaluated and recommended as Early Action Measures because it met the criteria established by the committee.

[16] This measure had not been previously received by CARB and was added to the Early Action Measures list by the Committee. The measure was evaluated and recommended as Early Action Measures because it met the criteria established by the committee.

[17] This measure had not been previously received by CARB and was added to the Early Action Measures list by the Committee. The measure was evaluated and recommended as Early Action Measures because it met the criteria established by the committee.

07-7-4

CAPCOA
CALIFORNIA AIR POLLUTION CONTROL OFFICERS ASSOCIATION

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Sacramento, CA 95814
(916) 449-9603 (916) 449-9604 FAX
www.capcoa.org

May 14, 2007

Ms. Catherine Witherspoon
Executive Officer
California Air Resources Board
1001 I Street
P.O. Box 2815
Sacramento, CA 95812

Re: Proposed Early Action Measures Under AB 32

Dear Ms. Witherspoon,

The California Air Pollution Control Officers Association is writing to support your efforts to identify discrete early action measures to help secure the earliest possible reductions in greenhouse gas emissions, and to urge you to include additional measures and timeframes in your final proposal. We also would like to offer the support and resources of local air districts in developing and implementing early action measures.

Local air districts recognize the critical importance of early reductions to delay the approach of a climate change "tipping point" and to effect a meaningful slowing of the process of climate change. We also recognize the extraordinary resource demands facing the ARB as you implement the requirements of AB 32. We believe that by relying on local air districts for specific tasks, the ARB will be able to reserve crucial resources for those activities that should be developed and implemented centrally.

CAPCOA supports the inclusion of the measures listed in the ARB's April 20, 2007 draft proposal. We believe additional measures can and should be identified as Group 1 measures. We also believe that more specific time frames should be included for measures in Group 2 and Group 3. Most importantly, we believe there are existing processes and programs that can be effectively leveraged for early reductions of greenhouse gases, and we urge you to include specific tasks and milestones for them in your final list of measures.

The local districts understand the difficulties identifying specific measures that can be adopted and implemented in the short time period called for in AB 32. We recommend actions in five key areas that ARB can take to secure these reductions quickly and without investing significant additional resources.

Recommendation 1: Prioritize SIP rulemaking. CAPCOA recommends that ARB review proposed SIP measures and rank them on the basis of criteria pollutant reductions, public health protection, and greenhouse gas reduction potential. Rules that rank high in all three areas should be given higher priority in the rulemaking calendar. This additional review will not add substantially to workload already planned, but will define GHG reductions that can be achieved in the near term without compromising progress towards clean air or undermining protection of public health.

Recommendation 2: Review Existing Rules. CAPCOA recommends that you perform a review of existing state and local rules, similar to an "All Feasible Measures" review that would identify existing rules that, whether expressly intended or not, result in significant reductions of GHGs. Rules that are so identified could be more quickly adapted for statewide implementation and adopted by the ARB. Some local districts have already adopted and implemented regulations intended to reduce GHG emissions; many others have regulations for criteria pollutants which, by virtue of the way the rules are structured, also secure significant collateral GHG reductions. We believe that with a modest investment of resources, perhaps relying on a contractor who could work with a CAPCOA committee, ARB could identify rules with potential for statewide GHG reductions. Because these rules have already been adopted and implemented, much of the preparatory work has been done and the feasibility and costs are well documented; this should shorten both the time and resources needed for state rulemaking. CAPCOA has already begun this review and we look to share initial results with you in the near future.

CAPCOA also recommends that ARB use a focused workgroup process (which you have already discussed with us) to tap district staff resources and expertise with specific source categories to identify discrete early reductions that could be achieved in each category. We believe this process could identify early reduction potential in the six categories ARB has identified for reporting and rulemaking, and could be used to accomplish some of the necessary steps to speed adoption by the ARB. The workgroup process could also be used to build on the review of local regulations (described above) and identify opportunities for additional reductions of greenhouse gases within the existing air pollution program structure. Some local districts have already begun this review and others plan to begin soon. CAPCOA believes such a coordinated workgroup process could identify potential GHG reductions and secure them in the near term through local rule amendments that implement a consistent statewide standard – similar to a suggested control measure. We recommend that this process be included in your final list, and would be happy to work with you in defining an appropriate schedule and associated emission reduction potential.

Recommendation 3: Minimize Impacts of New Stationary Sources. CAPCOA recommends that ARB work with the districts to develop a coordinated approach to reviewing greenhouse gas emissions from significant stationary sources in categories that also emit significant amounts of GHGs. As you know, the most environmentally effective and cost effective emission reductions are those implemented before a project is built. The challenge of reaching the 1990 baseline will be easier to meet if we ensure that economic growth occurs along the path of least climate impact. Local air districts already require permits and preconstruction review for such sources, which provides an efficient and effective platform to identify and address GHG emissions from new or modified sources in categories of concern. ARB could establish a general framework for including a review of GHG emissions in the local permitting process. The framework should also identify appropriate local, regional, or global mitigation strategies. This process would be analogous to the development of review programs for toxic air contaminants in the late 1980s and early 1990s. In fact, because of district obligations under CEQA, districts may be required to address GHG emissions associated with new permits regardless of any action by ARB. The outcome would be better coordinated with ARB participation at the outset to identify the scope of the review and the mitigations to be considered.

Recommendation 4: Leverage CEQA Mitigations. CAPCOA recommends that ARB work with local districts to coordinate approaches to the review of GHGs under CEQA and capture the reductions that result from mitigation. Local air districts routinely review the impacts of a variety of development projects under CEQA. Local governments are currently contacting air districts with questions about how to incorporate climate change and address GHG emissions of projects, and are seeking specific guidance on GHG significance thresholds for projects. CAPCOA's Climate Protection Committee and Planning Managers Committee are working on this now, and we would like to include ARB staff in this effort. We believe that a focused effort to identify thresholds and mitigation measures could result in practical reductions in the near term through the CEQA process. We recommend that ARB include timelines and commitments to such a process on the early action measures list, and we would be happy to work with you on an appropriate schedule and associated emission reduction potential.

Recommendation 5: Capture Voluntary Reductions. CAPCOA recommends ARB work with local districts to establish mechanisms to promote, track, verify, and capture voluntary reductions in GHGs. As you are well aware, there is tremendous interest in voluntary reductions on the part of business, local government, and the general public. CAPCOA believes this interest should be aggressively pursued. Many local air districts are already working with local stakeholders to identify and organize voluntary reduction efforts. CAPCOA also has a Climate Protection Committee that is tasked, among other things, with compiling voluntary reduction strategies and other materials to support individual districts in this area. We suggest ARB work with us to compile information, and that ARB rely on local districts to help form your reporting, verification, and tracking structure for early reduction efforts. We believe ARB should include milestones for implementing this in your final list of measures, and will work with you to identify associated emission reduction targets.

Summary

In closing, CAPCOA applauds ARB's efforts to identify and secure early reductions of greenhouse gases under AB 32. We urge you to include additional Group 1 early action measures on your final list, and to establish time frames for the measures in Group 2 and Group 3. We specifically recommend that ARB 1) prioritize SIP reductions to maximize collateral GHG reductions, 2) review existing local rules to identify potential statewide measures or local enhancements, and use district resources in workgroup efforts on specific source categories with significant GHG emissions, 3) coordinate with districts on a strategy to use existing permit programs to review and mitigate greenhouse gases from significant stationary sources, 4) coordinate with districts on review and mitigation of GHGs under CEQA, and 5) rely on local air district resources to implement early reductions through coordinated voluntary programs.

Thank your for your consideration of our recommendations.

Sincerely,

Larry R. Allen
President

South Coast
Air Quality Management District
21865 Copley Drive, Diamond Bar, CA 91765-4178
(909) 396-2000 · www.aqmd.gov

May 7, 2007

Via email

Mr. Bart Croes
Division Chief
California Air Resources Board
1001 I Street
Sacramento CA 95812

Re: Proposed Early Actions to Mitigate Climate Change in California

Dear Mr. Croes:

Thank you for the opportunity to comment on the State's Proposed Early Actions to Mitigate Climate Change in California. This effort will contribute significantly to the overall strategy to reduce greenhouse gases in the state. The following comments are offered for your consideration.

The report includes 3 tables: Table 1, Group 1 – Early Action Measures; Table 2, Group 2 – Additional GHG Reduction Measures Underway or Initiated by ARB in 2007 – 2009 Period; and Table 3, Group 3 – ARB Air Pollution Controls for 2007 – 2009 Adoption with Potential GHG Reductions or Other Climate Co-Benefits. Relative to the measures in Group 1, which will be adopted and implemented by January 1, 2010, SCAQMD staff recommends including a measure to accelerate hybrid penetration, as this technology is already well developed and readily available. At a minimum, this measure should be added to Group 3 if it is not added to Group 1. In addition, the measure on Low Carbon Fuel Standard (1-1) needs to be evaluated in light of the recent Stanford study regarding potential negative implications of E-85.

For Group 2, it would be very helpful for CARB staff to identify years for adoption and implementation for each measure to enable a better sense of priority. Providing preliminary information for potential reductions would also help to understand these measures and their relative benefits. Measure 2-16, Port Electrification should be moved to Group 3 as part of the port measures. There are also several measures that SCAQMD staff would like to see adopted by 2009, not just underway or to be initiated. These are measures 2-9 - Energy Efficiency, 2-13 – Transportation (light-duty vehicle standards), and 2-14 – Transportation (heavy-duty vehicle emission reductions and efficiency improvements.

For Group 3, there are SIP measures in the SCAQMD 2007 Air Quality Management Plan that should be added:

- Evaporative Emission Standards for Recreational Boats and Off-Road Recreational Vehicles; and
- Auxiliary Ship Engine Cold Ironing.

In addition, CARB staff should consider adding one of the SCAQMD measures in the 2007 Air Quality Management Plan – Accelerated Use of Plug-In Hybrids for Light- and Medium-Duty Vehicles, if it is not added to Group 1.

The report also includes tables in Attachment A with the status of assignment to Groups 1, 2, or 3, or deferred to the Scoping Plan. Sixteen of the 24 items in the table are deferred to the Scoping Plan, which is not due for another 18 months. SCAQMD staff recommends that work on these concepts be initiated right away so emission reductions can be realized as soon as possible.

SCAQMD staff also concurs with comments made at the April 30th Environmental Justice Advisory Committee meeting that the report could be improved by adding information on the more than 70 proposals received and the reasons why many ideas were not included in this report.

Thank you again for the opportunity to contribute to this important policy document. If you have any questions or would like to discuss this further, please call me at (909) 396-3104 or Elaine Chang at (909) 396-3186.

Sincerely,

Jill Whynot

Jill Whynot
Planning and Rules Manager

EC:JW
cc: Alberto Ayala, CARB
M. Robert, CARB

South Coast
Air Quality Management District
21865 Copley Drive, Diamond Bar, CA 91765-4178
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May 9, 2007

Via email

Mr. Bart Croes
Division Chief
California Air Resources Board
1001 I Street
Sacramento CA 95812

Re: Additional SCAQMD Comment - Proposed Early Actions to Mitigate Climate Change in California

Dear Mr. Croes:

South Coast Air Quality Management (SCAQMD) staff sent comments on May 7, 2007 regarding the Proposed Early Actions to Mitigate Climate Change in California. We have an additional comment that CARB staff should consider for inclusion.

An early action measure should be added to require that natural gas supplies for the state be at a Wobbe index of 1360 or lower. As you know, higher carbon content will result in increased carbon dioxide emissions. It is possible to achieve this level by securing natural gas sources with low Btu content, removing heavier hydrocarbon components by a condensing process, injection of inert gas such nitrogen, and blending high Btu gas with low Btu gas. This would have concurrent nitrogen oxides benefits, as well. Please see control measure #2007CMB-04 in the draft 2007 Air Quality Management Plan for additional information.

Thank you for considering this addition to the early action list. If you have any questions or would like to discuss this further, please call me at (909) 396-3104 or Elaine Chang at (909) 396-3186.

Sincerely,

Jill Whynot

Jill Whynot
Planning and Rules Manager

EC:JW
cc: Alberto Ayala, CARB
M. Robert, CARB

Cleaning the air that we breathe...

Jill Whynot
07-7-4

Suggested Changes to Early Action Measures by SCAQMD Staff June 21, 2007

Add New Group 1 (Early Action Measures)

- Accelerate hybrid penetration
- Wobbe index $\leq$ 1360 for natural gas

Group 2 Measures (underway or to be started in 2007 – 2009)

- Add specific adoption and implementation dates
- 2-9 Energy Efficiency adopt by 2009
- 2-13 Transportation (LD) adopt by 2009
- 2-14 Transportation (HD) adopt by 2009
- 2-16 Port Electrification adopt by 2009

Add to Group 3 Measures (adopt 2007 – 2009)

- Evaporative Emission Standards for Recreational Boats and Off-Road Recreational Vehicles
- Auxiliary Ship Engine Cold Ironing
- Accelerated Use of Plug-In Hybrids (if not added to Group 1)

Consider Other Measures Suggested by CARB Environmental Justice Advisory Group

APPENDIX B – Staff Evaluation of Stakeholder Recommendations / Additional Strategies

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY # *B01*
ID NUMBER: *N/A*
TITLE: *CAPCOA RECOMMENDATIONS*
PROPONENT: *CALIFORNIA AIR POLLUTION CONTROL OFFICERS ASSOCIATION (CAPCOA)*

2. Staff Recommendation

Work with CAPCOA to pursue its recommendations. The proposed CAPCOA working group can provide input into the development of the scoping plan for AB 32. Other recommendations could help in quantifying greenhouse gases reductions.

3. Action Description

CAPCOA makes five recommendations. These recommendations can support identification and quantification of greenhouse gas reductions as we proceed on AB 32 implementation.

PRIORITIZE SIP RULEMAKING

CAPCOA recommends that ARB's SIP rulemaking be ranked taking into consideration greenhouse gas emissions. The requirements of the federal Clean Air Act dictate that we proceed expeditiously with the measures needed to meet ozone and PM2.5 standards. The most critical near-term SIP rulemakings are already underway and all must be considered top priorities in order to meet federal deadlines. However, as we develop new longer-term SIP measures we will look for opportunities to reduce both criteria pollutants and greenhouse gases.

REVIEW EXISTING RULES

CAPCOA recommends a workgroup process that taps district resources and expertise to identify potential greenhouse gas reductions that could be achieved consistently statewide through local rulemaking. This would be similar to the "suggested control measure" approach that has been used for criteria pollutants. We propose to work with CAPCOA to initiate this process to support development of the AB 32 scoping plan.

MINIMIZE GHG IMPACTS OF NEW STATIONARY SOURCES

CAPCOA recommends that ARB work with local air districts to minimize impacts of new stationary sources. It suggests a coordinated approach to reviewing significant stationary sources in categories that also emit significant amounts of greenhouse gases.

The local permitting process and the environmental review (CEQA) process are suggested as possible mechanisms for achieving GHG emissions mitigation.

Staff suggests a joint effort to identify stationary source technologies for new sources that would reduce both criteria pollutant and greenhouse gases. This could include promoting development of new technologies that achieve multiple benefits.

LEVERAGE CEQA MITIGATIONS AND CAPTURE VOLUNTARY REDUCTIONS

CAPCOA recommends that ARB work with local air districts on approaches to the review of greenhouse gas impacts under the California Environmental Quality Act (CEQA) process, including GHG significance thresholds for projects, and to develop a process for the capturing of reductions that result from CEQA mitigations.

The Governor's Office of Planning and Research is charged with providing statewide guidance on CEQA implementation. With respect to quantifying any reductions that result from project level mitigation of greenhouse gas emissions, we would like to see air districts take a lead role in tracking such reductions in their regions.

4. Potential Emission Reductions

To be estimated during scoping plan development or rulemaking process.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

To be assessed during scoping plan development or rulemaking process.

6. Technical Feasibility

To be assessed during scoping plan development or rulemaking process.

8. Division: Planning and Technical Support Division
Staff Lead: Jeff Weir
Section Manager: Ravi Ramalingam
Branch Chief: Kurt Karperos

9. References:

Air Resources Board's Proposed State Strategy for California's 2007 State Implementation Plan, April 26, 2007.

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #	*B02*
ID NUMBER:	*NA*
TITLE:	*REFRIGERANT TRACKING, REPORTING AND RECOVERY PROGRAM (REFRIGERANT RECOVERY FROM DECOMMISSIONED REFRIGERATED SHIPPING CONTAINERS, RESIDENTIAL REFRIGERATION PROGRAM, HIGH-GWP TRACKING/REPORTING/REPAIR/DEPOSIT PROGRAM)*
PROPONENT:	*STAKEHOLDER SUGGESTION- ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE, ARB STAFF*

2. Staff Recommendation

This combination of measures is recommended for addition to the list of early actions. The Board date for consideration of these items is anticipated in 4th quarter of 2011. It is presented as one strategy given the interrelated objective, which is to reduce emissions of high-GWP GHGs through establishing requirements for enhanced monitoring, enforcement, reporting, and recovery. It may be determined that more than one strategy is required to effectively address the sources of interest and that the strategy or strategies are likely to include both regulatory and non-regulatory elements.

3. Early Action Description

Below is a brief description of potential approaches for addressing each of the source categories considered. Staff will explore the most efficient opportunities for achieving the largest reductions from the below categories which may translate into a single or multiple strategies.

Refrigerant Recovery from Decommissioned Shipping Containers: This action consists of an assessment of the magnitude of the emissions from refrigerated shipping containers. Depending on results, the strategy may be similar in scope to the measure aimed at enforcing the federal restrictions on refrigerant venting during servicing or dismantling of motor vehicle air conditioning systems (MVACS). After the recovery from a decommissioned container, it may be desirable to disable the refrigeration unit, which may require a regulation. Enforcement personnel and federal and local air management district assistance would be needed.

Residential Refrigeration Program: This involves supporting existing voluntary programs to promote the upgrade of pre-2000 residential refrigeration equipment in need of repair, such as refrigerators and freezers. The program could potentially be expanded to include window unit air conditioners (A/Cs); upgraded HVAC units are not

recommended, as the costs are likely significant and would disproportionately impact lower-income people.

A statewide effort to support programs for expanding the upgrading of old appliances to Energy Star efficiencies or better should be coordinated with various local utilities' voluntary programs and the US EPA's RAD program[1]. Given the utilities lead role in such programs, the ARB's role would be expected to consisting of enhancing its outreach efforts to underscore the benefits of participating in such programs. This program could also be coordinated with a foam recovery program, especially if automated recovery of refrigerant, foam, and scrap metal is implemented.

This program will likely result in an increased number of refrigerators entering the waste stream that will need to be properly recycled to achieve GHG emission avoidance. However, if all waste refrigerant, foam, and other materials are properly recycled/destroyed, direct GHG emissions avoidance benefits may be significant, as well as indirect GHG emissions avoidance due to energy efficiency gains[2].

Part of the residential refrigeration program includes a strategy to be developed in collaboration with the US EPA to enhance the enforcement of end-of-life (EOL) recovery of refrigerant[3].

Insulation foam contained in residential appliances will be addressed in another strategy, but there may be some overlap between refrigerant and foam recovery for appliances if the entities involved in manual refrigerant removal (which requires US EPA technician certification) are also able/willing to perform manual foam removal on appliances at end-of life (EOL).

The proposed measure will be voluntary, and ARB's role will be to promote replacement through coordination/outreach efforts with the utilities, the US EPA, and the California Energy Commission (CEC), which will enhance public awareness of energy savings and GHG benefits associated with the program.

For maximum effectiveness, this program will also have to be coordinated with ARB's planned end-of-life enforcement and foam recovery measures to ensure that old residential appliances are properly disposed of and high global warming potential (GWP) refrigerants/foams are properly recovered/recycled or destroyed.

High-GWP Tracking/Reporting/Repair/Deposit Program: This strategy involves the following: 1) expanding and enforcing the national ban on venting high-GWP GHGs (including fully emissive processes) during equipment/process lifetime; 2) requiring high-

[1] http://www.epa.gov/ozone/snap/emissions/radp.html
[2] Dave Godwin, USEPA, personal communication, 7/06.
[3] The CFC-12 refrigerant/CFC-11 foam blowing agent combination was used for many years in residential refrigerators and freezers, and phaseout of HCFC-141b from appliance foam has only been occurring in the past four years. New refrigerators and freezers generally contain HFC-134a as the refrigerant and HFC-245fa as the foam blowing agent. Currently, ODS recovery is mandated by federal law, and venting HFCs is forbidden, but enforcement is weak and venting is not well-defined. Additionally, EOL technician certification for recovery/reclamation is only required for ODSs and is subject to little oversight/enforcement; the EOL recovery regulation would extend the certification requirement to other high-GWP GHGs and would call for additional oversight/enforcement at transfer stations, landfills, and other disposal facilities.

GWP GHG sales, use and energy use reporting as well as inspection and maintenance (I/M) and leak repair for equipment, cylinders, products, or systems with capacities above some CO_2E threshold; 3) requiring technician certification for sales, purchase, transport, recovery, reclamation, resale, I/M; and 4) establishing a high-GWP GHG deposit program and/or fines for emissive processes or leaky systems.

Currently, Section 608 of the CAAA limits intentional venting of ODSs and HFCs, requires record keeping for systems employing more than 50 lbs of an ODS, and requires technician certification for ODS systems (I/M, repair, recovery, reclamation). High-GWP GHG sales are only restricted to ODSs in cylinders (not pre-charged equipment); the sales restriction does not apply to HFCs.

Reporting, in addition to record-keeping for ODS systems > 50 lbs, is required in SCAQMD (Rule 1415), and it is proposed that ARB implements a high-GWP GHG reporting requirement rather than record-keeping only. Reporting would be for any high-GWP GHG above a specified CO_2E threshold (extending beyond ODSs). The permanent reporting protocol could apply to any high-GWP GHG bought, sold, or used, by any manufacturer, retailer, distributor, repair person/technician, auditor, facility/corporate parent. Production plus imports into California (gas in cylinders or as an equipment charge) can be checked against use and exports out of California for mass balance purposes.

High-GWP GHG sales will be restricted to certified technicians (i.e., consumers cannot not buy cans or cylinders of high-GWP GHGs over some threshold value), which differs from current federal law which only limits sales of ODSs to certified technicians (except for ODS refrigerants contained in air conditioners and refrigerators).

The deposit program could apply to cylinders (raw chemical) or pre-charged equipment (such as refrigerators, A/Cs, vending machines, etc.)[4]. Furthermore, fines could be assessed based on annual use reporting and auditing for systems above some CO_2E threshold. Reporting will have little to no impact on leaking/emissive equipment if there are not financial disincentives in excess of refrigerant costs (i.e., the deposit or fine should cost more than refrigerant needed to recharge a leaky system, so that leaks are promptly fixed).

Deposit/return and/or fine programs would encourage leak-tightness and recovery of high GWP GHGs, as well as encourage upgrading of old, leaky equipment. A similar program has been adopted in Australia, and industry groups are voluntarily considering a deposit/return program in the US.

Adoption of this measure will require a blend of regulatory/non-regulatory approaches, as it will extend current regulations and also require a collaborative effort with the US EPA to enforce what is already established by law.

4. Potential Emission Reductions

[4] Consumer goods would be more difficult to subject to deposit and return since they are intended to be fully emissive, but it is believed that purchases over a given CO2E limited to certified technicians will inhibit consumers from buying more than small numbers of product.

Refrigerant Recovery from Decommissioned Shipping Containers: There is insufficient data on the emissions from this source. For the decommissioned shipping containers, it is estimated that the HFC-134a refrigerant bank at end-of-life could be approximately 15,000 $MTCO_2E$ per year in the area surrounding the Ports of Long Beach and Los Angeles. This is based on the estimated Los Angeles-Long Beach fraction of world shipping container activity of approximately 8 percent and 30 percent of the total container population consists of refrigerated shipping containers. The percent of refrigerated containers that a ship may carry varies between 10 to 50 percent of the total container capacity. The estimated Los Angeles-Long Beach fraction of world refrigerated shipping container activity applied to the estimated annual turnover rate of refrigerated shipping containers has been estimated to be 100,000. The refrigerant charge in modern shipping containers ranges from 13 to 16 pounds. If these containers are allowed to accumulate, the bank could become on the order of 0.1 MMTCO2E in a 5 to 10 year period assuming a 10 pound refrigerant charge at decommissioning. Thus, the reduction potential of a mitigation strategy for this source would be less than 0.1 MMTCO2E in 2020. In addition, given that these shipping containers may last from 20 to 30 years, there may be a significant number of older CFC-based systems. Finally, it is important to determine what happens to the shipping containers as they approach end-of-life.

Residential Refrigeration Program: Estimated annual emission reductions of 0.8 $MMTCO_2E$ are possible for refrigerant recovery[5]. Of the 0.8 $MMTCO_2E$ of annual emissions avoided for refrigerant recovery, about 0.7 is due to recovery of R-12 refrigerant. This estimate does not include the benefits from deploying more efficient systems sooner (see energy efficiency calculations, below).

Although refrigerant recovery is currently supposed to occur at the time of disposal, destruction of refrigerant is not required, and it is generally assumed that recovered/reused refrigerant will eventually be emitted.

The CO_2E emissions avoidance was calculated for 2005, and only refrigerators and freezers going to landfills were considered; numbers of pre-2000 appliances in need of repair were not available. Inclusion of portable A/C units could increase emissions benefits, but numbers of portable units that are repaired or landfilled each year are unknown. Without knowledge of the numbers and age distributions of appliances in California, 2020 emissions reductions based on sector growth and transitional refrigerant/blowing agent use estimates were not possible. However, it is reasonable to assume that approximately 0.8 $MMTCO_2E$ reductions will be possible every year until refrigerators and freezers containing R-12 are gone, which will happen in large part by 2020.

Energy efficiency emissions avoidance in 2020 resulting from appliance retirement could not be calculated due to lack of data regarding age distribution of California appliances,

[5] The following assumptions were used: 1) 20 year lifetimes for refrigerators, 2) R-12 use in refrigerators stopped in 1995; from 1995 – 2005 HFC-134a was used, 3) in 2005, half of disposed refrigerators contain R-12 as the refrigerant and the other half contain HFC-134a as the refrigerant, 4) 13,000,000 refrigerator/freezers are disposed of annually in the US and 60% go to landfills or transfer stations, 5) the California population fraction was roughly 13% in 2005, 6) 100-year direct GWPs of 8100 and 1300 were used for R-12 and HFC-134a, respectively, 7) refrigerant masses of 0.23 kg/appliance and 0.16 kg/appliance for R-12 and HFC-134a, respectively, were obtained from USEPA (Dave Godwin, personal conversation, 2/07).

but again it is reasonable to assume that an additional 0.45 $MMTCO_2$ reduction is possible annually[6].

To summarize, by 2020, annual emission reductions of roughly 1.25 $MMTCO_2E$ are possible by recovering refrigerant from pre-2000 refrigerators and freezers, and by requiring upgrading to Energy Star or better appliances.

High-GWP Tracking/Reporting/Repair/Deposit Program: Staff believes that significant emission reductions may be realized through the proposed strategy; however, emission reductions cannot be estimated for this strategy, as there are no data to support emission avoidance calculations.

Total Reductions: The combined annual reductions possible with this group of strategies is 1.25 $MMTCO_2E$, which is a lower-bound estimate that does not include CFC-containing shipping containers, appliances that are upgraded rather than repaired, and the impacts of requiring reporting/repair/deposits for systems over a given CO2E threshold.

5. Estimated Costs/Economic Impacts and the Impacted Sectors/Entities

Refrigerant Recovery from Decommissioned Shipping Containers: Very little specific information on costs and economic impacts is known today. Per the federal regulation (40 CFR 82), refrigerant cannot be released to the atmosphere. Specialized equipment and certified technicians are required to properly carry out this measure. Equipment to recover the refrigerant may cost $5,000. The training cost for servicing certification is minimal. Both the equipment and the certified technicians are something that businesses should already have if they are in compliance with the existing federal regulation. It is possible that existing businesses in the air conditioning and refrigeration servicing industry may be able to handle recovering the refrigerant from the decommissioned refrigerated shipping containers. There will also be a requirement to remove or disable the decommissioned refrigeration unit, which should be a minimal cost. It is believed that as these shipping containers age, they get sold to smaller shipping businesses and these may bear the brunt of the measure for decommissioned containers. In addition, some of these units may be sold to restaurants and other businesses for increased refrigeration capacity. If the federal regulation is applied to in-use containers, then all segments of the business would be affected.

Residential Refrigeration Program: The US EPA states that because of reduced energy demand, appliance incentive/disposal programs cost about $0.04 on average to reduce each kWh of demand. This translates into about $63/$MTCO_2$, which includes the incentives and credits given to upgrade older appliances[7].

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[6] USEPA estimates that 700 kWh/year savings are possible by replacement of a 20 yr old refrigerator with a current energy star appliance; an emission factor of approximately 1.4 lbs CO2/kWh for gas-generated electricity was obtained from Carbon Dioxide Emissions from the Generation of Electric Power in the United States, DOE, 7/2000: http://tonto.eia.doe.gov/FTPROOT/environment/co2emiss00.pdf

[7] See above footnote.

The impacted sectors and entities would mostly be appliance salvagers/recyclers and individuals disposing pre-2000 appliances; however, with incentives and rebates, the cost associated with disposal and some of the cost of a new appliance is avoided.

The US EPA RAD program was started in 2006 and the success of the program has not been gauged yet, although it is anticipated that a mandatory program would be more effective.

High-GWP Tracking/Reporting/Repair/Deposit Program: Record-keeping, I/M and repair is already required for systems containing > 50 lbs of an ODS refrigerant; in SCAQMD, reporting is required for these systems in addition to record-keeping. Even those entities who are not yet keeping records for reporting purposes must still have some records of refrigerant/product purchases for resale and income tax purposes. Therefore, the costs associated with record-keeping and reporting are believed to be negligible.

I/M costs are not believed to be significant[8], but leak repair and/or high GWP GHG recovery for some processes may be expensive. The costs associated with I/M and leak repair cannot be estimated due to the large variety in numbers and types of equipment covered by this strategy. Costs associated with a deposit and return program are unknown, but will presumably be passed on to the consumer at the time of purchase.

6. Technical Feasibility

The technology required to remove refrigerants from shipping containers and appliances is feasible and commercially available. Automated refrigerant and foam removal from appliances is also technically feasible, and can be performed during scrap metal processing and recovery[9].

There are no anticipated technical feasibility issues for the tracking/reporting/repair/deposit program other than recovery of high-GWP GHGs for certain unknown, emissive processes.

7. Additional Considerations

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[8] Presently, owners or operators of large RAC systems should maintain and repair their systems for optimal performance and reduced energy costs, so the incremental cost of the new rule is not expected to be significantly higher than current costs, unless leaks are going undetected and unrepaired. The costs to pay for yearly inspection and maintenance by certified technicians is not expected to be more than about $200 (based on one 8-hour workday by a HVAC technician at a rate of $22/hour in California:
http://www.payscale.com/research/US/Job=HVAC_Service_Technician/Hourly_Rate/by_State).

The incremental costs per system associated with an owner, operator, or HVAC technician/auditor filling out several short reporting forms is also expected to be less than $200 (see above).

[9]Guidance on the Recovery and Disposal of Controlled Substances Contained in Refrigerators and Freezers, SEPA, 2002:
http://www.sepa.org.uk/pdf/consultation/closed/2003/fridge/fridge_consultation.pdf

All Strategies: Ozone depleting substances (ODSs) were used in the past as refrigerants and foam-blowing agents; each of the strategies described above include ODSs as they exist in older refrigeration systems, appliances, and foams. Recovering and destroying ODSs from containers and appliances is a cost-effective way to reduce high-GWP gas emissions, and also reduces negative impacts on stratospheric ozone.

An enforcement component for the decommiossioned container and tracking/reporting/repair/deposit measures is anticipated, since these are regulatory measures rather than voluntary measures.

Refrigerant Recovery from Shipping Containers: Staff will perform a needs assessment to improve the current understanding of overall refrigerant leakage emissions and refrigerant banks for both active and decommissioned refrigerated shipping containers. This is particularly important for the major port areas of Los Angeles, Long Beach, and Oakland. If mitigation action is supported by the analysis, the measure should involve a program enforcing the existing provisions of the existing federal regulation, 40 CFR 82. A basic inventory is needed to determine the extent that refrigerant emissions are unaccounted for. In addition, end-of-life accounting for these different types of refrigerated containers needs to be explored.

Residential Refrigeration Program: The impacted sectors and entities would mostly be appliance salvagers/recyclers and possibly individuals disposing of foam-containing appliances, as recovery costs are expected to be passed along to the user.

California trade associations associated with Certified Appliance Recyclers and recyclers of scrap metals are unknown.

Coordination with the US EPA with respect to this regulation is ongoing. Further coordination with utilities participating in appliance trade-in programs is anticipated.

High-GWP Tracking/Reporting/Repair/Deposit Program: The affected entities will be owners/operators/purchasers/sellers of high-GWP GHGs and systems containing those chemicals, as well as contractors/technicians who install/repair such systems.

A partial list of trade associations possibly impacted, either positively or negatively, by the regulation follows: ARAP (described previously), the Air-Conditioning and Refrigeration Institute (ARI), American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), North American Technician Excellence (NATE), and many others unknown to staff (equipment trade associations, building trade associations, industrial chemical and consumer trade groups, semiconductor and other industrial process trade groups, etc.).

Coordination with the US EPA and SCAQMD with respect to this strategy would be ongoing.

8. **Division:** Research Division
Staff Lead: Whitney Leeman/Winston Potts
Section Manager: Michael Robert/Tao Huai
Branch Chief: Vacant/Alberto Ayala

9. References

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Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #	*B03*
ID NUMBER:	*ARB 2-1 / EJAC-2*
TITLE:	*MANURE DIGESTER PROTOCOL FOR CALCULATING GREENHOUSE GAS MITIGATION*
PROPONENT:	*ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE*

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in 3rd quarter of 2008.

Specifically, staff recommends Board endorsement of the California Climate Action Registry (CCAR) manure digester protocol in order to promote voluntary greenhouse gas emissions reductions.

3. Early Action Description

Description of Protocol – The manure digester protocol provides methodologies for calculating reductions in the emissions of greenhouse gases resulting from the installation of a manure digester at an animal agricultural facility.

Technology Description – Manure digesters (also called biogas control systems) are systems which trap gaseous emissions from manure (primarily methane) and combust the gas. The trapping process is achieved by enclosing the manure, which often involves covering a manure lagoon with plastic or otherwise isolating the manure from the ambient environment. The combustion process occurs either by combusting the trapped methane biogas in an engine in order to generate electricity, or by venting and flaring the gases.

CCAR Protocol Development Process – CCAR began developing a protocol for calculating manure greenhouse gas emission back in April 2006. The protocol development process began with a first scoping meeting, included multiple working group meetings and document reviews, and included representatives from nearly every stakeholder group, including industry, government, academia, and the general public.

Need for Digester Protocol Endorsement – Although this protocol was adopted by CCAR, endorsement by the Board would send a clear signal that the ARB considers the protocols to be accurate and acceptable for voluntary GHG emissions reductions. To achieve this end, the ARB is initiating a process to continue discussions on the protocol by holding workshops to solicit comments on the protocol and to identify potential improvements. The ultimate goal is to present the protocol to our Board for endorsement as a voluntary greenhouse gas reduction measure.

Establishing a voluntary protocol can help incentivize the installation of manure digesters by legitimizing the technology and offering a pathway to quantify and verify the greenhouse gas benefits. Keeping this protocol a voluntary measure helps avoid premature technology mandates which could have significant cost and environmental drawbacks due to digesters currently being a costly, combustion-oriented technology.

4. Potential Emission Reductions

Digesters have the potential to provide a 50 percent reduction in GHG emissions resulting from manure storage (0.006 MMT CO2E per digester) as well provide electrical energy, offsetting the production of additional GHGs.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

Cost per digester can range from the low hundreds of thousands of dollars to over a million dollars, depending on the digester type (covered lagoon, plug flow, etc.) and the amount of manure and biogas being processed. The captured biogas can be valuable if used for heating (water, animal housing) or combusted in an engine/ generator to produce electricity. Thus, the digester can reduce farm costs and may provide income if the gas or electricity is sold to other entities or back to the grid.

6. Technical Feasibility

Manure digesters are currently installed and operating at a limited number of farms in California.

7. Additional Considerations

Affected Entities: Farmers, energy companies, and any companies involved in the business of mitigating greenhouse gases (AgCert, CEERT, etc.)

Trade Associations: California Farm Bureau, Western United Dairymen, California Dairy Campaign.

Government Agencies Coordination: State Water Resources Control Board, local Air Pollution Control Districts, California Department of Food and Agriculture, California Climate Action Registry and others.

Proposed Board Hearing Date: September 2008

8. Division: Planning and Technical Support Division
Staff Lead: Kevin Eslinger
Section Manager: Dale Shimp
Branch Chief: Richard Bode

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #	*B04*
ID NUMBER:	*EJAC-3/ARB 2-12*
TITLE :	*REDUCE METHANE VENTING/LEAKS FROM OIL AND GAS SYSTEMS*
PROPONENT:	*ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE AND CALIFORNIA AIR POLLUTION CONTROL OFFICERS ASSOCIATION*

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in 4th quarter of 2010.

Staff recommends an evaluation of the effectiveness of the existing district rules. Most likely these rules can be amended and readily adopted by the ARB for statewide implementation. Staff also proposes to investigate the feasibility of deploying innovative technologies and to improve management practices, including the stakeholder's proposal to implement energy efficiency measures that will further promote recycling of otherwise vented gases. These combined actions could potentially reduce methane emissions from both gas and oil systems by approximately 1.0 $MMTCO_2E$ in 2020[1].

3. Early Action Description

Emissions from natural gas systems are primarily methane gas. There are four major sources of methane emissions from the systems: production, processing, transmission, and distribution of natural gas. These emissions are process related, mostly stemming from normal operations, routine maintenance, and system upsets. Also, a relatively smaller amount of methane emissions results from oil systems.

Several air districts have adopted and implemented rules to reduce volatile organic compound (VOC) emissions from natural gas and crude oil production and processing facilities. These existing rules may also reduce methane emissions. In addition, there are several proven cost-effective technologies and management practices that would result in a significant reduction of methane emissions.

Staff will take the following approach to achieve the GHG reduction goal from oil and gas systems as stated in the 2006 CAT report:

- Amend existing rules[2,3]
  Form a working group that consists of ARB, district, and interested stakeholders to review the existing rules to identify potential methane emissions reduction measures.

- Improve management practices[4]
  Encourage districts with oil and gas systems under their jurisdiction to practice directed and more frequent inspections of compressor stations, gate stations, surface and storage facilities, transmission pipelines, and off-shore platforms.

- Require the installation of cost-effective technologies[4]
  Numerous technologies have been identified and proven in the U.S. EPA Natural Gas STAR program[5], a voluntary program partnership with the oil and natural gas industries, that will pay back investments in a short period of time through saleable gas savings. These technologies include replacement of high- with low-bleed pneumatic devices, installation of a flash tank on glycol dehydrators, retrofitting compressors to capture vented gas, and using an infrared aerial imaging camera to detect leaks, etc.

4. Potential Emission Reductions

Among the above identified strategies, staff estimated installation of new technologies will provide the greatest potential GHG emissions reduction, about 70 percent of the targeted goal of 1.0 MMTCO$_2$E in 2020, while the rest will come from the existing rule amendments (~10 percent) and enforcement (~20 percent). Collectively, these strategies will provide a medium potential of GHG emissions reduction. They will also provide further emissions reduction of VOCs and toxics, with no incurred fuel penalty.

5. Estimated Costs / Economic Impacts and the Impacted Sectors/ Entities

ARB will develop this measure in partnership with CAPCOA. ARB will need additional resources to develop and enforce the new rule. CAPCOA may also require additional resources for complementary rulemaking to ensure that the rules are consistent.

As for the oil and gas industries, investment in new technologies will likely pay for itself through net fuel savings to offset the costs. As a result, staff believes that none of the proposed strategies will cause any potential disproportionate economic impacts on small businesses or environmental justice communities from increased utility rates.

6. Technical Feasibility

Natural Gas STAR partner companies have implemented most of the new technologies identified through a voluntary program established by the U.S. EPA when the natural gas prices were relatively low. These technologies were proven to be reliable and cost-effective. With the higher gas prices today, these technologies are even more cost-effective and attractive to the industry.

7. Additional Considerations

Staff has reviewed several districts' rules, addressing VOC emissions, that may have reduced methane emissions, and will work together with the districts to identify if any oil and gas industries have implemented fuel saving technologies. The ARB has legal

authority to develop regulations and outreach programs to speed up the deployment of these technologies. However, staff believes a comprehensive and uniform regulation for this CAT strategy cannot be achieved in 18 months.

Affected Entities:

Oil and gas industries, pipeline operators, gas processing and storage facilities, utility companies

Trade Associations:

American Gas Association (AGA), Gas Processors Association (GPA), Interstate Natural Gas Association of America (INGAA), Kinder Morgan, Natural Gas Supply Association (NGSA), Pacific Gas and Electric Company (PG&E), Southern California Gas Company (SoCalGas), San Diego Gas & Electric (SDG&E), Western States Petroleum Association (WSPA)

Government Agencies to coordinate with:

Air Districts, California Air Pollution Control Officers Association (CAPCOA), California Energy Commission (CEC), California Public Utility Commission (CPUC), California State Land Commission (CSLC), Federal Energy Regulatory Commission (FERC), United States Environmental Protection Agency (U.S. EPA)

8. Division: Stationary Source Division
Staff Lead: Win Setiawan
Section Manager: Terrel Ferreira
Branch Chief: Barbara Fry

9. References:

[1]*California Climate Leadership: Strategies to Reduce Global Warming Emissions* July 2005, Tellus Institute.

[2]Stakeholders' comments to the ARB Proposed Early Action Measures to Reduce Greenhouse Gases, June 2007 Board Hearing, Los Angeles:
http://www.arb.ca.gov/lists/ab32eam07/67-ab32eam07-ws-5.pdf
http://www.arb.ca.gov/cc/ejac/ghg_eams_finalcommitteerec.pdf
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[3]*Various Air Districts Rules.*

[4]*U.S. Methane Emissions 1990-2020: Inventories, Projections, and Opportunities for Reductions,* EPA 430-R-99-013, September 1999, U.S. EPA.

[5]*The EPA Natural Gas STAR Program:*
http://www.epa.gov/gasstar/

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #	*B05*
ID NUMBER:	*EJAC-4/ARB 2-14*
TITLE:	*SMARTWAY TRUCK EFFICIENCY*
PROPONENT:	*2006 CAT REPORT AND STAKEHOLDER SUGGESTION*

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, it is recommended that this measure be reclassified as a discrete early action. The Board date for consideration of this item is anticipated in 4th quarter of 2008.

The rationale for staff's recommendation is based on the commercial availability of a wide variety of technologies that improve fuel efficiency of heavy-duty vehicles that pay for themselves from fuel savings in a very short time. Although these technologies are commercially available, the trucking industry has been reluctant in using them due to the high initial capital investment and logistic issues related to using some of the technology at loading docks and other locations. However, staff believes these issues can be resolved. Therefore, staff recommends developing a regulatory program and evaluate whether financial assistance would be needed to help small businesses comply with the proposed regulation.

3. Early Action Description

The strategy would require existing trucks/trailers to be retrofitted with the best available fuel efficiency "SmartWay Transport"[1] and/or ARB approved technology. Technologies that improve fuel efficiency of trucks may include devices that reduce aerodynamic drag and rolling resistance. Aerodynamic drag may be reduced using devices such as cab roof fairings, cab side gap fairings, cab side skirts, and on the trailer side, trailer side skirts, gap fairings, and trailer tail. Rolling resistance may be reduced using single wide tires or low-rolling resistance tires and automatic tire inflation systems on both the tractor and the trailer.

[1] The United States Environmental Protection Agency (U.S. EPA) in collaboration with the freight industry has developed a voluntary program designed to increase energy efficiency while significantly reducing greenhouse gases and criteria pollutants. The program, known as the SmartWay Transport Partnership (SmartWay Transport), encourages trucking companies to use technologies that improve fuel economy and reduce emissions. The SmartWay Transport also designates highly fuel efficient and emission reduction technology packages as SmartWay Upgrade Kits which can be purchased at various SmartWay partner centers, dealerships, and service centers. (http://www.epa.gov/otaq/smartway/documents/420f07027.htm)

The requirements would apply to California and out-of-state registered Class 8 trucks (gross vehicle weight rating greater than 33,000 pounds) that travel to California. Most of the newer Class 8 combination trucks are long haul trucks for which technologies that reduce both aerodynamic drag and rolling resistance would be appropriate. The older model combination trucks are typically considered short haul trucks and thus spend considerably less time at highway speeds, reducing significantly any benefits associated with aerodynamic improvements since drag varies with the square of the vehicle speed. Thus, it would be most appropriate to require only rolling resistance improvements for these trucks. Straight trucks (trucks with an integrated cargo area) would likely be required to be equipped with devices that reduce aerodynamic drag as well as rolling resistance.

Staff's preliminary thinking is that the rule could be implemented through a phase-in schedule with 10 percent of the trucks and trailers meeting the requirements in 2010, 25 percent in 2011, 60 percent in 2012, and 100 percent in 2013. This rule should also require that new 2010 and subsequent trucks and trailers that are sold in or service California be "SmartWay" certified tractors and trailers[2].

Although the cost of retrofitting the trucks and trailers would eventually be recovered through fuel savings, the upfront investment capital needed to comply with the requirements may become a financial burden to businesses, especially small businesses and those that own multiple trailers per tractor. Therefore, staff recommends that an evaluation be conducted to determine whether a financial assistance program would be needed to help small businesses comply with the requirements.

4. Potential Emission Reductions

Potential GHG emission reductions were estimated for calendar years 2010 and 2020. For 2010, the scenario assumes that 10 percent of the existing 2009 and older model year (MY) trucks and tractor-trailer combinations and all 2010 MY trucks and tractor trailer combinations comply with the requirements. MYs 2006 to 2010 trucks were assumed to be long haul, MYs 2000 to 2005 medium haul, and MYs 1990 to 1999 short haul. Based on these assumptions and considering the total vehicle miles traveled both inside and outside of California, in 2010, the estimated GHG reductions could be up to 6 $MMTCO_2E$ of which about 7% would occur within California. Similarly in 2020, MYs 2016 to 2020 were assumed to be long haul, MYs 2010 to 2015 medium haul and MYs 2000 to 2009 as short haul trucks. Thus, the 2020 estimated GHG reductions could be up to 20 $MMTCO_2E$ of which about 11% would occur within California. Requiring compliance by California registered trucks and trailers would significantly reduce the

[2] U.S. EPA Certified SmartWay tractors and trailers are long haul tractors and trailers equipped with components that significantly reduce fuel consumption and emissions. The specifications for a U.S. EPA Certified SmartWay tractor include a model year 2007 and later engine, integrated cab-high roof fairings, cab side fairing gap reducers, tractor fuel-tank side fairings, aerodynamic bumper and mirrors, options for reducing extended engine idling, and options for low-rolling resistance tires. The specifications for a U.S. EPA Certified SmartWay trailer are side skirts, weight-saving technologies, gap reducers on the front of the trailer or trailer tail, and options for low resistance tires. For further information refer to:
http://www.epa.gov/smartway/documents/420f07033.htm .

GHG benefits of this rule to 0.2 and 1.3 MMT CO_2e in 2010 and 2020, respectively. The strategy is also expected to reduce emissions of criteria pollutants and especially emissions of oxides of nitrogen (NOx) since NOx is directly related to the tractive power requirements. Staff has not yet precisely quantified the reductions in emissions of criteria pollutants that may result from this strategy, but expect them to be on the order of 10 percent reduction for pollutants such as NOx, which are closely related to fuel use.

5. Estimated Costs/ Economic Impacts and the Impacted Sectors / Entities

Entities that may be affected by this strategy include the freight industry, trailer manufacturers, truck manufacturers, tire manufactures, businesses that own trailers to haul their freight into and out of California, and cab and trailer aerodynamic device manufacturers. The strategy is expected to provide cost savings to trucking businesses over the useful life of the tractor trailer combination by reducing fuel consumption. Assuming that add-on devices result in 13.9 percent fuel economy gain, the savings are approximately $5,400 per year for a truck with a baseline fuel economy of 6.1 miles per gallon and an average mileage accrual rate of approximately 90,000 miles per year, and a fuel cost of $3.00 per gallon. The cost of the add-on devices for a tractor trailer combination, which staff estimates to be approximately $12,000[3], can therefore be recovered within 2 to 2.5 years for a trailer-to-tractor-ratio of 1 and within 8 to 10 years for a trailer-to-tractor ratio of three[4]. Businesses that own only trailers and no tractors may not be able to recover the cost of retrofitting their trailers through fuel savings, and therefore, they may need to recover their investment either by paying less to haulers or by passing it to customers by increasing the cost of their merchandise.

6. Technical Feasibility

As indicated above, technologies that improve fuel economy of trucks are currently commercially available. Most of the tractors currently on the road are equipped with cab roof fairings and cab side fairing gap reducers. Trailer side skirts, trailer side fairing gap reducers, single wide tires and automatic tire inflation systems are also commercially available as SmartWay Upgrade Kits. However, there are some minor technical issues with these technologies that will need to be resolved. Retrofit of cab aerodynamics may or may not be possible depending on whether the tractor has factory installed reinforcements or not. Trailer side skirts may be problematic on some trailers where the side skirt interferes with access to equipment. Also, some fleets have expressed concern on trailer side skirts getting damaged when driving over road dips or bumps. The use of trailer tails is currently very limited due to functionality problems at loading docks. Currently, manufacturers of SmartWay devices are working on solutions to these problems and staff believes that these minor technical problems will be resolved by the time the rule is implemented or can be addressed in the development of this rule.

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[3] The $12,000 estimate includes the cost for trailer aerodynamics (side skirts, gap fairings, and trailer tail), single wide tires and wheels for the tractor and trailer, automatic tire inflation system, and installation cost.

[4] The industry average trailer-to-tractor ratio is not exactly known. However, the most commonly cited numbers range between 2 to 3 trailers-per-tractor. The higher the number of trailers per tractor, the longer it takes to recover the cost from fuel savings.

7. Additional Considerations

This regulatory strategy is motivated primarily by its potential to reduce GHGs. All portions of this strategy can be accomplished under the authority granted by the California Global Warming Solutions Act of 2006, Assembly Bill 32 (AB 32). AB 32 provides the Air Resources Board (Board) with the authority to regulate sources of GHGs to achieve the maximum and cost-effective GHG emission reductions from these sources. The item can be taken to the Board by the 4th quarter of 2008 but requires additional resources.

Affected Entities:	Truck carriers, shipper carriers, trailer manufacturers, truck manufactures, truck and trailer aerodynamic device manufacturers, tire manufacturers, businesses that own trailers to haul their freight into and out of California
Trade Associations:	American Trucking Association, California Trucking Association, Truck Manufacturers Association, Truck Trailer Manufacturers Association, California Chamber of Commerce.

Government Agencies to coordinate with: None.

8. Division:	Mobile Source Control Division
Staff Lead:	Daniel Hawelti
Section Manager:	Stephan Lemieux
Branch Chief:	Michael Carter

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #	*B06*
ID NUMBER:	*EA 2-15*
TITLE:	*COOL PAINTS FOR AUTOMOBILES*
PROPONENT:	*EARLY ACTION REPORT OF APRIL 21, 2007 AND STAKEHOLDER SUGGESTION*

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in 2nd quarter of 2009.

3. Early Action Description

Cool paints are highly solar energy reflective coatings formulated with pigments that have low absorption (high reflectance) of sunlight. White is considered to reflect more sunlight than any other color. But while white paints reflect the visible light, they may or may not reflect the balance of the sunlight. The majority of solar energy is not in the visible range, therefore careful formulation of pigments can allow the reflectance of near-infrared (NIR) sunlight which contains about 52 percent of the solar energy, while maintaining visible light reflectance (i.e., perceived color). For vehicles, the more solar energy is reflected, the less the vehicle's interior will heat up when it is parked in the sun.

Cool paints have been demonstrated by the Society of Automotive Engineers as part of the Improved Mobile Air Conditioning Cooperative Research Program. They are technically feasible in the near-term for new vehicles. Researchers at Lawrence Berkeley National Laboratory (LBNL) tested various automotive paints formulated for use between 1992 and 2002[1]. Using a solar spectrometer, they determined the reflectance of both visible and NIR light wavelengths. Table 1 presents the reflectance of light (higher reflectance equals cooler paint). As expected, the dark colors tended to reflect less light; more light energy is absorbed. The potential of cool paints can be readily seen when examining the results for red paints, shown in **bold** on the table. The red paints ranged from a reflectance of 0.13, not much better than the black paint tested, to a high of 0.37. While that does not approach the 0.70 seen for the white vehicle, it is nearly three times more reflective than the worst performing red paint.

[1] These paints were all tested with a white primer.

Table 1. Reflectance of Vehicle Paints

Vehicle Paint Color	Visible light	NIR	Total
Black, 1998 Ford	0.04	0.04	0.04
Dark Grey, 1998 Dodge Intrepid	0.06	0.05	0.06
Grey Metallic, 1992 GM Buick	0.21	0.25	0.22
Silver, 1992 Ford Escort	0.49	0.54	0.50
Gold Metallic, 1998 Ford Taurus	0.46	0.56	0.49
Light Blue Metallic, 1994 Honda Accord	0.33	0.44	0.39
Blue Metallic, 2001 GM	0.06	0.13	0.10
Green, 1995 Chevy Camero	0.07	0.08	0.08
Red, Chevy	0.08	0.18	**0.13**
Red, 2000 Ford Escort	0.14	0.50	**0.33**
Red, 2002 Chevy Avalanche	0.15	0.35	**0.25**
Red, 1993 Chevy S10 Blazer	0.15	0.57	**0.37**
White, 1997 GM Park Avenue	0.70	0.77	0.70

4. Potential Emission Reductions

The concept behind this proposed action item is that the use of cool paints would reduce the solar heat gain in a vehicle parked in the sun. A cooler interior would provide drivers with less need to activate the air conditioner (A/C).

LBNL researchers have investigated the CO_2 reduction that would result from a 5°F reduction in vehicle temperature at start up.[2] LBNL's Dr. Hashem Akbari estimates that such a reduction in temperatures, applied to the light duty vehicle fleet in California, would reduce CO_2 emissions from A/C use by about 25 percent, reducing current CO_2 estimates of A/C related emissions of 10.2 million metric tons per year (MT/yr) to 7.8 MT/yr, a 2.4 MT/yr reduction.[3]

Staff also requested input from Dr. John Rugh, National Renewable Energy Laboratory, on the probability of A/C use for a given reduction in temperatures. Dr. Rugh is currently involved in a global effort led by the Society of Automotive Engineers (SAE) to come up with an agreed upon method to determine life cycle climate performance. This effort is known as SAE's Improved Mobile Air Conditioning Cooperative Research Program. Dr. Rugh provided a draft analysis from Phoenix, showing the percent of time the A/C is in use for given ambient temperature ranges. As would be expected, at low ambient

[2] A 5°F reduction in interior temperature has been measured by Toyota when changing from a metallic blue paint with a solar reflectivity of 10 percent to one with a reflectivity of 20 percent. Table 1 shows NIR reflectivity of 0.77 for white paint. This could be applicable to all paints, and could probably be improved to reach values closer to 100 percent reflectivity. Therefore, even the metallic blue paint should be able to achieve a reflectivity of at least 50 percent. Thus, the anticipated CO_2 reduction should be conservative.

[3] Literature on cool paints and window glazings typically model the potential for downsizing the A/C unit that exists due to measured reductions in soak temperature. Statements of the amount of downsizing feasible for equivalent cooling times are typically followed by an associated reduction in CO2 emissions. Dr. Akbari presumes improvements in emissions would result whether the A/C unit was downsized or the existing unit was simply used less frequently.

temperatures, very little A/C is used: As temperatures increase to around 18°C, A/C use begins to increase. Use continues to increase steadily until the A/C is in use nearly 100 percent of the time, around 38°C. During the rising portion of the curve, A/C use increases about 5 percent per °C. If it is presumed that increased ambient temperatures are associated with increased soak temperatures, it would be logical to correlate a reduction in soak temperature in the midsection of the graph with a reduction in A/C use. Thus, a reduction in temperature of about 2.7°C (5°F), as seen in the Toyota test, would be expected to result in 14 percent less A/C use when ambient temperatures are in the rising portion of the curve. Staff applied that figure to the methodology developed by Dr. Akbari, and found a predicted reduction in CO_2 emission from a 2.7°C reduction in temperature of 2.1 MT/yr, which is comparable to the estimate presented by Dr. Akbari.

The following bullets summarize the issue:

- Slightly over half of all solar energy is in the form of NIR radiation, which is not visible to the naked eye. Cool paints use pigments that have low absorptance of NIR while maintaining a variety of visible colors.
- The benefits of cool paints include:
  - Lower external surface temperatures, reducing burn hazard and the transfer of heat to the interior of the vehicle.
  - Lower interior temperatures, resulting in greater driver comfort and potentially reduced A/C demand.
  - Potential to reduce size of air conditioner. According to LBNL staff, a vehicle's A/C is currently designed to cool a black vehicle parked for 4 hours in the summer sun in Phoenix within a set time period. If that vehicle is painted with cool black paint, the soak temperature would be reduced and the A/C load reduced. Downsizing the A/C would allow it to operate at more efficient loads while maintaining desired interior temperatures.
  - Reduced use of and/or downsizing of an A/C would result in reduced GHG emissions. Analyses indicate a reduction of 2.1 to 2.4 MT/yr CO_2e could be achieved for the light duty fleet with a relatively small improvement in solar reflectivity. Additional reductions for the medium and heavy duty fleets would likely increase this figure.
  - Possible increased lifespan of exterior paint, interior plastics and other materials

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

There are few disbenefits to this technology beyond a slight increase in coating cost. This may be more than offset by reduced A/C use or A/C downsizing, if this occurs. Cool paints currently cost about $10 more per vehicle than traditional paints. Literature indicates these paints are applied with standard equipment and methods. The small increased cost could be more than offset by a downsized A/C unit, and would be offset by improvements in operational costs due to reduced A/C use. In addition, the increased comfort should be of value to many consumers.

These paints would have the most benefit if used in conjunction with other technologies (e.g., window glazing, passive ventilation) to reduce a vehicle's interior temperatures. Therefore with the development of this rulemaking, staff will also evaluate other

technologies that will reduce the heat load on the vehicle's A/C and determine if it would be appropriate to include these technologies in the "cool paints" proposal.

6. Other Considerations:

Cool paints can be formulated with existing paint formulations such that supply should not be an issue. BASF, DuPont, Sherwin Williams, many other paint manufacturers do have cool versions of at least some paints developed. Cool paints do not limit consumer choice of color. Cool paints use pigments that have low absorbance of the non-visible spectrum while maintaining the same variety of visible colors that consumers demand. Presently, cost and car maker acceptance appear to be the only show-stoppers for the use of cool paints and other complimentary cool car technologies.

An evaluation should be done to determine if the reformulated "cool paint" will result in an increased toxic exposure risk during the paint application process and disposal. Staff believes this exposure risk should be minimal due to the fact that research thus far, shows that "cool paints" can be formulated using existing pigments; however it is an issue that needs to addressed during the formal rulemaking process.

7. Division:

Staff Lead:	Marijke Bekken
Section Manager:	Sharon Lemieux
Branch Chief:	Michael Carter

8. References:

Akbari, Hashem, "Coatings for Cool Vehicles" Presentation, March 16, 2007

Lawrence Berkeley National Laboratory, Heat Island Group, http://CoolColors.LBL.gov

Rugh, J., "Assessing the Vehicle Level and National A/C Fuel Use Impact of Advanced Climate Control Technologies," International Energy Agency Workshop – Cooling Cars with Less Fuel, Paris, France, Oct. 23, 2006.

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #	*B07*
ID NUMBER:	*EJAC-14/SCAQMD-6/EA 2-16/ARB A-14*
TITLE:	*GREEN PORTS*
PROPONENT:	*2006 CAT REPORT AND STAKEHOLDER SUGGESTION*

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, it is recommended that this measure be reclassified as a discrete early action. The Board date for consideration of this item is anticipated in 1st quarter of 2008.

Staff proposes to present the draft regulation to the Board as a measure to reduce nitrogen oxides (NO_x) and diesel particular (PM) emissions and to quantify the associated (carbon dioxide) CO_2 emission reductions. By focusing on NO_x and PM reductions, staff will address the local and regional health impacts of ships docked in California's ports, including any disproportionate impacts those emissions may have on surrounding communities.

3. Early Action Description

This early action allows docked ships to shut off their auxiliary engines by plugging into shoreside electrical outlets or other technologies. The Air Resources Board identified port electrification as a strategy to reduce the emissions of nitrogen oxides (NO_x) and diesel particulate matter (PM) when the Board approved the Goods Movement Emission Reduction Plan in April 2006. Furthermore, the Climate Action Team (CAT) recommended port electrification as a greenhouse gas (GHG) emission reduction strategy in 2006.

While a ship is docked at a berth, or "hotelled," it continuously runs at least one auxiliary engine to power lighting, ventilation, pumps, communication, and other onboard equipment. Ships can hotel for several hours or several days.

Port electrification provides an alternative source of power for these ships while they are docked. The ships can use cables to receive electricity from the shore, thereby allowing them to shut off their auxiliary engines, reducing emissions of air pollutants. Although the generation of electricity creates emissions—typically from power plants located elsewhere—these emissions are much less than those from the auxiliary engines located on the ships. Port electrification of a ship can reduce its emissions of NO_x and diesel PM by more than 90 percent. Greenhouse gas (GHG) emissions, as carbon dioxide (CO_2), are also reduced, depending on the source of electricity provided to the berth.

To be an attractive candidate for shore electrification, a ship must visit a California port frequently, spend a sufficient number of hours in berth, and have an ample power demand while docked. The ship categories that typically meet these criteria are container ships, passenger ships, and refrigerated cargo ships. (Passenger ships, although in port for only about 10 hours, visit frequently and have tremendous power needs.) Ship categories that are not attractive candidates include bulk cargo ships, vehicle carriers, and most tankers. The ports that receive numerous calls by container ships, passenger ships, and refrigerated cargo ships—and therefore the ports most likely to employ port electrification—are Los Angeles, Long Beach, San Diego, Oakland, San Francisco, and Hueneme.

ARB staff is currently working with ports, ship operators, utility companies, local air districts, and other interested stakeholders to develop a regulation to reduce emissions from ships while docked. Although the proposed regulation will allow alternative technologies to reduce emissions, the key component of the regulation will be port electrification. Staff expects to take the proposed regulation to the Board for its consideration by the end of 2007.

4. Potential Emission Reductions

ARB staff is pursuing the port electrification strategy as a measure to reduce NO_x and diesel PM emissions. This strategy was identified in the Goods Movement Emissions Reduction Plan (GMERP), approved by the Board in April 2006. The reduction of these pollutants is essential for protecting public health near California's ports and for the South Coast Air Basin to eventually achieve and maintain health-based ambient air quality standards for ozone and fine particulate matter. The reduction of CO_2 is a co-benefit of the proposed at-berth emission reduction regulation.

Although the proposed regulation is not yet fully developed, staff estimates that the regulation may result in the following emission reductions:

Pollutant	2015	2020
NO_x (Tons)	15,000	19,000
Diesel PM (Tons)	400	500
CO_2 (Million Metric Tons)	0.3	0.5

Staff expects port electrification to achieve emission reductions in 2010—largely due to the commitments of the Port of Los Angeles and the Port of Long Beach through their Clean Air Action Plan—however, the emission reductions from the proposed regulation will not be substantial until after 2010.

The potential CO_2 emission reductions of port electrification are dependent on the source of the electricity provided to the port. If the electricity portfolio of the utility company has a significant portion of renewable sources, such as wind, solar, or biomass, then the CO_2 reductions may be substantial. Similarly, if the portfolio contains sources of electricity that generate considerable amounts of CO_2—say, out-of-state coal-fired plants—then the potential CO_2 emissions would be diminished.

For the purpose of this analysis, ARB staff used a CO_2 emission factor of 0.25 MMT CO_2/MW-hr for the electrical grid and 0.69 MMT CO_2/MW-hr for the auxiliary engines. Staff will consider utility-specific CO_2 emissions and marginal electricity generation CO_2 emissions (typically combined-cycle gas turbines) as the development of the regulation proceeds.

As mentioned earlier, the proposed regulation will allow alternative technologies to achieve required emission reductions. These alternatives may include ship-side technologies, such as post-combustion devices, alternative fuels, or cleaner engines, or shore-side technologies, including distributed generation or emission-capture-and treatment devices. These technologies will probably be less effective in reducing GHG emissions when compared to port electrification; however, their overall deployment and impact are uncertain.

As a GHG emission reduction strategy, port electrification has the potential to reduce CO2 emissions on the order of 0.3 to 0.5 MMTCO_2 per year. This estimate does not consider the climate benefit associated with reduction of black carbon, a component of diesel PM.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

Staff estimates that port electrification, as currently proposed, will cost more than $1.2 billion, roughly one-third of that cost borne by the ports and terminals, two-thirds by the ship operators.

The growth in port activity—especially the substantial increase in containers expected to be handled by the ports and the projected surge in cruise-ship vacations—will have a significant impact on the number of ships that must be built or retrofitted to accommodate port electrification. ARB staff estimates the number of ships to be affected by the proposed regulation as:

Ships Affected	**2015**	**2020**
Container	500	1,200
Passenger	76	110
Refrigerated Cargo	10	25

In addition to the recovery of that capital expenditure, annual operating expenses will include labor costs necessary to connect and disconnect the ships to shore power and the cost of the electricity itself. Fuel savings realized by shutting down the auxiliary engines will help offset the electricity costs.

Staff estimates that the annual costs of port electrification are as follows:

Annual Costs	**2015**	**2020**
Capital Costs	$148 million	$250 million
Operating Costs	$42 million	$ 75 million
Total	**$190 million**	**$325 million**

As mentioned above, port electrification is considered foremost a measure to reduce NO_x and diesel PM emissions with GHG emission reductions being a co-benefit. The cost effectiveness of port electrification for 2020 is estimated at $17,000/ ton for NO_x or $640,000/ ton for PM. These values represent the cost of the regulation completely allocated to either NOx or diesel PM; a sharing of the total costs between these two pollutants would further enhance their cost effectiveness.

If NO_x and diesel PM emission reductions were not considered, and port electrification were considered solely as a GHG emission reduction measure, the cost effectiveness in 2020 would be $650/MT CO_2.

Staff proposes to present the draft regulation to the Board as a measure to reduce NO_x and diesel PM and to quantify the associated co-benefit of CO_2 emission reductions. By focusing on NO_x and PM reductions, staff will address the local and regional health impacts of ships docked in California's ports, including any disproportionate impacts those emissions may have on surrounding communities.

6. Technical Feasibility

Port electrification is a proven technology. The U.S. Navy has been employing it worldwide for decades. Princess Cruise Lines currently uses port electrification in Juneau, AK and Seattle, WA, as does China Shipping at the Port of Los Angeles (POLA). The NYK Atlas has recently plugged in at POLA, and British Petroleum is expected to utilize port electrification by the end of the year at the Port of Long Beach for two of its diesel-electric tankers.

Although technically feasible, port electrification is not without its challenges, including the availability of electricity, the standardization of electrical hookups, and sufficient visits to electrified berths by retrofitted ships to make the emissions reductions cost-effective. Staff has been discussing the necessary electrical infrastructure and supply with the major ports and utility companies. The International Maritime Organization (IMO) is considering standard electrical connections for port electrification, and several California ports and other organizations are participating in that effort.

7. Additional Considerations

California will be the first state to require port electrification, or its equivalent, if the Board adopts a proposed regulation within the next six months. Current port electrification projects within California and the United States have been required on a case-by-case basis.

The requirement to reduce emissions from ships while docked at California ports is clearly within the jurisdiction of the Air Resources Board. Port electrification has been identified as a strategy to reduce NO_x and diesel PM in the Goods Movement Emission Reduction Plan and as a GHG emission reduction strategy by the CAT. Staff will bring a proposed regulation to the Board within the next six months.

8. Division: Stationary Source Division
Staff Lead: Grant Chin

Section Manager: Mike Waugh
Branch Chief: Mike Tollstrup

9. References:

Draft Evaluation of Cold-Ironing Ocean-Going Vessels at California Ports (ARB, March 2006)

Documentation to Climate Action Team, December 2006

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Action Strategy Name and Proponent

SUMMARY #	*B08*
ID NUMBER:	*EJAC-7/ARB 2-17*
TITLE:	*TRANSPORT REFRIGERATION UNITS, ELECTRIC STANDBY*
PROPONENT:	*2006 CAT REPORT AND ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE*

2. Staff Recommendation

This strategy was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this strategy is recommended. Costs for this strategy are high and new information indicates costs may be 30 to 50 percent higher than originally estimated. An extensive amount of coordination with industry remains to be completed before any regulatory action can proceed. This is due to a variety of factors, including the lack of industry standards for electric power use on transport refrigeration units (TRUs). For example, more than four optional voltages are used, along with both single phase and 3-phase frequencies, and many electric power plug configurations are in use (see Part 7 for more information). Therefore, a Board hearing date is not indicated.

3. Description

Transport refrigeration units are refrigeration systems powered by integral internal combustion engines designed to control the environment of temperature sensitive products that are transported in trucks, trailers, shipping containers, and railcars. In 2004, the TRU Airborne Toxic Control Measure (ATCM) was adopted to reduce diesel particulate matter (PM) emissions from TRU engines. ARB staff is currently implementing this ATCM. As conceived, this strategy would go beyond current ATCM requirements with a regulatory action to require that no TRU-equipped trucks, trailers, shipping containers, or railcars that are used at a large distribution center for outbound loads would be allowed to be powered by internal combustion engines for more than 30 minutes in a 24-hour period.

An optional component of this strategy would prohibit the use of internal-combustion engine-powered TRUs on trucks, trailers, shipping containers, and railcars from being used for extended cold storage at California distribution centers, grocery stores, and elsewhere. This practice occurs during the 4-to-6 week period before all of the major holidays because distribution center cold storage warehouse capacity is exceeded at about 30 percent of the distribution facilities and at an unknown number of grocery stores.

4. Potential Emission Reductions

For this strategy, staff estimates a reduction of 3.4 to 4.3 million gallons of diesel fuel used per year (with 51 to 64 GWh of new electricity use); the optional component (extended cold storage prohibition) would result in an additional reduction of 1.7 million gallons of diesel fuel used per year (with 26 GWh new electricity use). This strategy would also provide emission reduction co-benefits due to reduced diesel engine operating times; therefore, emissions of ozone precursors and diesel PM particulates would also be reduced. However, ARB staff estimates only about 0.04 million metric tons per year of CO_2 reductions could be achieved (0.45 million metric tons total by 2020).

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

Capital costs are estimated to be $105 million for the first year and $3.1 to $3.6 million per year thereafter. The optional component would require an additional one-time capital cost of $44 million. New information indicates capital costs may be 30 to 50 percent higher than these early estimates. Without including these potential increases, inflation or discount factors, ARB staff estimates rough annual costs at $16.7 million per year (total accrued costs, with savings, would be approximately $167 million in 2020). Staff is still working on refining cost and is not able to provide a cost-effectiveness estimate at this time.

6. Technical Feasibility

Compliance is a critical issue which will most likely require the use of various technologies in order to ensure that adequate enforcement of the regulation occurs. Technologies exist that could be applied toward automated compliance assurance and reporting systems, but it may take several years to develop and test the reliability of such systems such that they could be used for this application. Additional regulatory action may also be necessary to ensure these compliance assurance systems provide an enforceable reporting mechanism.

7. Additional Considerations

Industry standards need to be developed and adopted to address compatibility issues, plug types, and configurations. Although electric standby (E/S) technology is available for some TRU models, less than one percent of trailer TRUs are currently equipped with E/S and retrofitting with E/S is extremely expensive and has never been attempted. Extensive design and development work is needed before E/S use could be required. Most existing TRU models will need to be redesigned to use smaller, more efficient refrigeration compressors or to use larger, more powerful electric motors to provide enough capacity for quick initial trailer cool-down prior to loading perishable goods. Current E/S designs use under-powered electric motors that are intended only to maintain a temperature set point after the diesel engine completes the initial chill down. Additionally, further investigation on the feasibility of prohibiting the use of diesel-powered TRUs for extended cold storage is needed as it may require a significant change in business practices and have unforeseen economic impacts.

8. **Division:** Stationary Source Division
Staff Lead: Rod Hill
Section Manager: Richard Boyd
Branch Chief: Dan Donohoue

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #	*B09*
ID NUMBER:	*EJAC-9/ARB 2-19*
TITLE:	*TRUCK STOP ELECTRIFICATION WITH INCENTIVES FOR TRUCKERS*
PROPONENT:	*ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE*

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is waiting to be determinate.

Staff recommends that ARB considers an incentive-based strategy to expedite a comprehensive deployment of on-shore electric power infrastructure to eliminate idling emissions from heavy-duty trucks. This incentive program must consider the existing requirements of the idling regulations in order to design an approach that would yield surplus emissions through the use of financial incentives. The incentives could be structured to pay a portion of the plug-in usage fee either to the truckers or to the technology vendors. The advantage of this strategy would be the elimination (exclusive of power plant emissions) of greenhouse gas and criteria pollutant emissions resulting from truck idling activities. This approach would also provide an alternative for the trucking industry to not just comply with the idling requirements, but would allow them to go beyond those requirements to achieve zero emission through the use of financial incentives. The disadvantage of this strategy would be the high costs to obtain relatively small incremental benefits since existing regulations have already established very low emission thresholds for this source category.

3. Early Action Description

This strategy would require truck stops to install electrical power infrastructure (i.e., on-shore electrical power) to reduce heavy-duty trucks idling emissions, perhaps through the use of financial incentives. On-shore electric power involves the electrification of truck parking spaces to provide power for heating, cooling and on-board truck accessories. Affected entities of this strategy include owners and/or operators of heavy-duty trucks, truck stops owners and technology vendors.

Heavy-duty trucks idle their engines an estimated 6 hours per day, resulting in emissions of criteria pollutants and greenhouse gases. These emissions could be eliminated with the proposed electrification strategy as a result of eliminating the combustion of diesel fuel from either the truck engine or the auxiliary power unit (APU) engine. The ARB has already adopted regulations limiting the idling time of heavy-duty trucks unless the truck

is installed with appropriate low-emission technology. Starting in 2008, all trucks must comply with a 5-minute idling limit unless it has a certified APU coupled with a PM trap. Engine manufacturers also have the option of certifying model year 2008 and newer main truck engines to a low idling NOx emission level of 30 grams per hour (ARB, 2005). Since the existing regulations have already set limits and requirements on truck idling activities, this proposed strategy would provide additional emission reductions beyond those regulations by eliminating the emissions resulting from operation of the APU, or from low-idling emission engines.

Currently, there are already two on-shore power technologies that have been commercially established and have been used to eliminate truck idling emissions. The two technologies are commonly referred to as on-board power infrastructure and off-board infrastructure technologies.

On-board power infrastructure provides trucks with 110-volt AC electrical power at truck stops to run the air conditioning, heating and on-board accessories. This would require truck stops to be equipped with electrical outlets throughout the parking spaces and trucks need to be equipped or retrofitted with inverter/chargers, electrical power connections and electrically driven heating and air conditioning units. The drawbacks of this approach include the high initial infrastructure cost, cost for equipment add-ons to trucks, and its availability, which is limited to where the infrastructure is installed. The aftermarket cost for add-ons and installation is about $4,000 per truck and power infrastructure installation is about $3,500 to $6,000 per truck parking space depending on the number of power pedestals installed (Perrot, et al, 2004).

Off-board power infrastructure provides 110-volt AC electrical power through an externally installed heating and air conditioning unit, as well as hook-ups for basic telephone, internet and television services at each truck parking space. The unit is connected to the truck through a console installed to the truck window using a template insert. The console contains all the necessary connections and controls, including a card reader for the billing system. Currently the usage fee for basic services range from $1.25 to $1.50 per hour. The off-board power infrastructure installation cost is approximately $12,000 to $20,000 per parking space depending on the number of parking spaces installed (Antares, 2005). The advantage of this system is that the truck does not need to be modified with any alternative cab comfort technology, resulting in immediate benefits to the truck owner using the service through reduced fuel consumption and maintenance savings.

This strategy could be crafted as a regulation requiring all truck stops to install electric infrastructure that could be used by truckers to eliminate truck engine idling. To be effective, that regulation would also need to require the truckers to use the electric infrastructure for their idling needs instead of idling the truck engine or using the APU. However, since ARB already has existing idling regulations, one of which has already been implemented and the other will become effective in January 2008, it will be challenging to develop another regulation on top of the existing idling regulation. A less contentious approach would be through an incentive-based program to spur the installation of the appropriate electric infrastructure that would allow truckers the option to "plug in" when they park at these truck stops.

ARB has already had direct experience in implementing an incentive-based on-shore power infrastructure program. ARB executed a grant with IdleAire, a company that

developed an off-board power infrastructure technology, to assist in the installation and operation of off-board power infrastructure at various truck stops located in the San Joaquin Valley. The grant, totaling $1,334,536, was used to pay for usage ($1.50 per hour) of the IdleAire device at the 415 parking spaces at six truck stops that are spread throughout the San Joaquin Valley. The South Coast Air Quality Management District (SCAQMD) has also funded IdleAire projects in the South Coast with funding from the Carl Moyer Program and the U.S. EPA. In addition to paying for usage, at a rate of $3.94 per hour, the SCAQMD program also pays for a portion of the installation cost ($8,726 per unit) of the IdleAire power unit.

4. Potential Emission Reductions

The existing truck idling regulation limits idling time from heavy-duty trucks to 5 minutes unless the truck is equipped with an APU coupled with a particulate trap or, alternately, unless the truck is a 2008 and later model year that is certified to the low idling NOx emission standard of 30 grams per hour. Because of this requirement, the NOx idling emission rate of 30 grams per hour was used as the baseline emission level. Since existing idling regulations do not specify optional idling emission rates for pollutants other than NOx emissions, the truck baseline idling emission levels for other pollutants such as HC, PM, and CO2 were established using EMFAC2002 idling emission rates. The surplus emission reductions are calculated as going from these baseline levels to a zero emission level for each truck stop parking space that is electrified.

Based on data from Report to Congress of Adequacy of Parking Facilities, there is currently about 7,500 spaces at truck stops and 1,300 spaces in Caltrans public rest areas. Currently, about 900 parking spaces at truck stops are installed with electric power infrastructure, resulting in an estimated 2010 annual reduction of about 55,000 tons of CO2 per year (0.055 MMTCO2E). If the remaining truck stop parking spaces are electrified, an additional annual reduction of about 405,000 tons of CO2 (0.4 MMTCO2E) would result. Depending on the expected growth of available parking spaces at truck stops, the 2020 emission benefits could be adjusted accordingly. The expected CO2 emission reduction from this strategy, if fully implemented, could be on the order of >0.1 to 1.0 MMTCO2E. Emission reductions of criteria pollutants (HC, NOx, and PM) are estimated to be about 530, 1,300, and 120 tons per year, respectively, in 2010.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

Given the cost of the existing on-shore electric power infrastructure technology and the expected baseline emission rates, it is estimated that the cost to reduce CO2 emissions to range from a low of about $135 per metric ton to a high of about $359 per metric ton. There are about 6,600 parking spaces at truck stops and about 1,300 parking spaces in Caltrans public rest areas that are currently do not have electric power infrastructure, for a total of about 7,900 truck non-electrified parking spaces. Assuming the cost of on-shore power infrastructure to range from $7,500 to $20,000, including the cost of on-truck equipment in the case of the on-board power infrastructure technology, the total cost to electrify all 6,600 parking spaces at truck stops would be about $49,500,000 to $132,000,000. If the 1,300 parking spaces at Caltrans public rest areas are also to be installed with on-shore electric power infrastructure, it would cost an additional $9,750,000 to $26,000,000.

A requirement for an on-shore electric power infrastructure would impact truck stop owners, truck drivers, and technology vendors. The economic burden on truck stop owners would depend on how they structured their approach towards establishing the required infrastructure. They could purchase the equipment and have it installed at their facilities, or they could opt to lease the parking spaces to technology vendors for them to install the equipment. The cost to truckers could range from the cost to install the necessary equipment on their trucks in the case of an on-board technology to simply just paying for the hourly cost of plugging in when they use the facility. The cost to technology vendors would be the cost to manufacture, install, and operate the power infrastructure.

6. Technical Feasibility

On-shore electric power infrastructure is an established, proven commercial technology. This technology is currently being deployed at various truck stops throughout the country. In California, approximately 900 truck stop parking spaces already have on-shore electric power infrastructure. The main obstacle to more widespread deployment of this technology appears to be the relatively high initial cost of installing the necessary infrastructure.

7. Additional Considerations

Additional analysis is needed before deciding on an implementation path. It is possible that other jurisdictions have taken this action as an incentive program. Also, this strategy clearly falls under ARB jurisdiction and authority as idling limits have been adopted. Although an incentive program appears to be the best option, a regulation could be developed in the next 18 months, making the strategy a discrete early action.

Affected Entities: Truck stop owners, truck drivers, technology vendors

Trade Associations: Trucking associations, utilities companies

Government Agencies to coordinate with: Local air districts, local governments regarding permitting requirements

8. Division: Mobile Source Control Division
Staff Lead: Bob Nguyen
Section Manager: John Kato
Branch Chief: Jack Kitowski

9. References:

ARB, Notice of Public Hearing to Consider Requirements to Reduce Idling Emissions from New and In-Use Trucks, Beginning in 2008, Sacramento, September 1, 2005

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY # *B10*
ID NUMBER: *EA 2-20*
TITLE: *TIRE PRESSURE PROGRAM*
PROPONENT: *AIR RESOURCES BOARD STAFF*

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, it is recommended that this measure be reclassified as a discrete early action. The Board date for consideration of this item is anticipated in 1st quarter of 2009.

Maintaining a vehicle's tire pressure to the manufacturer's recommended specifications is a practical strategy to achieving early greenhouse gas (GHG) emission reductions. Current Federal law requires auto manufacturers to install tire pressure monitoring systems in all new vehicles beginning September 1, 2007. Staff recommends that the ARB investigate strategies to ensure that the tire pressures in older vehicles are also monitored, as well as requiring the tires to be checked and inflated at regular service intervals. One potential strategy would be to require all vehicle service facilities, such as, dealerships, maintenance garages, and smog check stations, to check and inflate tires.

Staff also recommends that the feasibility of conducting an extensive outreach program be investigated. The outreach program could entail placards being placed above each fueling dispenser to encourage drivers to properly maintain their tires each month. The placards would highlight the amount of money consumers could save as a result of lower fuel consumption, as well as, how each consumer is doing their part to help prevent climate change.

3. Early Action Description

According to the National Highway Traffic Safety Administration (NHTSA), 74% of all vehicles have at least one significantly under inflated tire[1]. The U.S. Department of Energy (DOE), California Energy Commission (CEC), and NHTSA, state that every 1 pound per square inch (PSI) drop in tire pressure equals an approximate 0.4% drop in a vehicle's gas mileage. Establishing a program to monitor and correct vehicle tire pressure could save Californians a minimum of 61 million gallons of fuel, which equates to 0.54 MMT of CO_2 emissions in 2010 (first year of implementation) and 22.5 million gallons of fuel and 0.20 MMT of CO_2 emissions in 2020. Potential savings from a program that was 100 percent effective in ensuring proper tire inflation are on the order of 96 millions gallons of fuel saved in 2010.

4. Potential Emission Reductions

The GHG emission benefit of this program is associated with the reduction in gallons of fuel consumed by California drivers. The reduction in gallons of fuel consumed is based upon 10 million vehicles visiting a repair facility at least once a year and having their tires checked and inflated to the manufacturer's recommended pressure[2]. Approximately 74 percent of vehicles in California have under inflated tires, of which, 27 percent have at least one tire severely under inflated (25 percent or more of the manufacturer's recommended pressure)[1]. On average, a vehicle tire loses approximately 1 PSI per month[2]. For every loss of 1 PSI in tire pressure, a corresponding loss in fuel economy of 0.4% can be expected[2].

It is estimated that Californians will consume approximately 14.1 billion gallons of gasoline in 2010 and 16.2 billion gallons in 2020[3]. In 2010 (first year of implementation), the predicted reduction in the consumption of fuel is 61 million gallons which equates to 0.54 MMT of CO_2. This is based on 27 percent of vehicles having at least one tire severely under-inflated, 47 percent having tires under inflated by 1 PSI, and 26 percent having the correct pressure[1]. In 2020, emissions reductions are expected to be lower due to the recommended strategy and outreach programs and the federal requirement for tire pressure monitoring systems in all new vehicles. The reduction in gallons of fuel consumed will be approximately 22.5 million gallons which equals 0.20 MMT of CO_2.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

Costs associated with this program include public outreach and education, equipment costs such as compressors and accessories, and labor. One study suggested the labor rate to check and inflate tires will be approximately $3.75 per vehicle[2]. In addition, some vehicle repair facilities may be required to purchase an air compressor and accessories at an approximate cost of $500[4].

Retrofit technologies exist that can monitor tire pressure at costs ranging from $20 to $600 depending on the system and installation variables (i.e., make and model of vehicle, brakes, ABS, hourly installation rate, etc.)[4]. Additional staff work is needed to determine the feasibility and cost effectiveness of retrofits.

6. Technical Feasibility

There are no technology limitations for this strategy.

7. Additional Considerations

Several State and Federal agencies have public outreach websites that highlight the relationship between tire pressure and saving money (e.g., U.S. DOT – It All Adds Up, CEC – Fuel Efficient Tire Program, California's Energy Efficiency Program – Flex Your Power, IWMB – National Tire Safety Week). Enforcement of this type of strategy will be extremely difficult.

Affected Entities: California's vehicle repair facilities and refueling stations and vehicle owners.

Government Agencies to coordinate with: U.S. DOT, CEC, IWMB, and others as outreach information becomes available.

8. Division: Stationary Source Division
Staff Lead: Theresa Anderson
Wayne Sobieralski
Section Manager: Mike Miguel
Branch Chief: Mike Tollstrup

9. References:

[1] *U.S. Department of Transportation, NPRM on Tire Pressure Monitoring System FMVSS No. 138, 09/2004*

[2] *California Inspection and Maintenance Review Committee, Review of the Smog Check Program, 11/2006*

[3] *Based on Air Resources Board's California Emissions Forecasting System, Population and Vehicle Trends Report, Statewide Daily Vehicle Fuel Consumption (Gasoline), EMFAC 2002, Version 2.2*

[4] *Based on retail quotes obtained by the Air Resources Board, 07/2007*

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #	*B11*
ID NUMBER:	*EJAC- 11/ARB 2-22*
TITLE:	*REQUIRE LOW GWP REFRIGERANTS FOR NEW MACS*[1]
PROPONENT:	*2006 CAT REPORT AND ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE*

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in 4th quarter of 2010.

This strategy is also not a stand-alone measure. It is anticipated to be integrated into larger new measures focused on new vehicle GHG emission standards (e.g., *Pavley II* described as Summary # B33, page B-110 later in this appendix).

The central premise of the proposed strategy is the replacement of high global warming potential (GWP) refrigerants used in California's mobile air conditioning systems (MACS) with lower GWP alternatives that also represent better lifecycle climate performance (LCCP) than the current refrigerant. MACS in today's motor vehicles use nearly universally the refrigerant HFC-134a with a GWP of 1,300. A two-fold approach will be explored under the proposed new regulation. First, the core of the strategy would focus on developing new regulations requiring that new MACS use refrigerants with a lower GWP (e.g., 150 or less) in new vehicles currently not subject to the existing vehicle GHG emission standards (AB 1493). For vehicles subject to AB 1493, this strategy would explore further MACS improvements after the regulation is fully phased in 2016. Second, staff will explore the potential climate benefits from a universal phase out of HFC-134a (or other high GWP refrigerants) used in other remaining vehicle classes in the California fleet such as heavy-duty on- and off-road vehicles including new as well as in-use systems. Again, the identification of suitable alternatives would be based on lifecycle climate performance.

Alternative refrigerant development has been a highly contested arena in recent times. Driven primarily by Europe's landmark directive to phase out the use of HFC-134a in the MACSs of new vehicle types starting in 2011, several low GWP refrigerants are currently

[1] New alternative low GWP refrigerants in MACS are desired to the extent that these alternatives have lifecycle climate performance (LCCP) that exceeds the performance of the current refrigerant HFC-134a. Thus, new low GWP refrigerants are sought in systems that leak less and are more efficient than current systems.

under investigation and evaluation for toxicity, safety, energy efficiency, and technical feasibility by multiple industry entities. Identification of an eligible replacement for the European car market, the largest in the world, would boost efforts in California and could accelerate the implementation of new regulations mitigating the impact of refrigerants in MACS.

3. Early Action Description

This strategy explores the phase out of HFC-134a in all MACS in new vehicles certified for sale in California (heavy- and light-duty, on- and off-road) with the intent to reduce direct and indirect emission impacts and promote only the use of alternative refrigerants with superior lifecycle climate performance. Opportunities in the in-use fleet will also be evaluated.

Regulation of refrigerants is happening globally. The European Union (EU) is taking the lead. In 2006, the European Parliament and the Council decided that the dates for the phase-out of refrigerant HFC-134a in the European community shall be set at January 1, 2011 for new types of vehicles and January 1, 2017 for all new vehicles[1]. The US EPA's I-MAC Program[2] has generated significant debate and progress regarding alternative refrigerants and the options for the US car MACS market with the best lifecycle climate performance. Extensive cooperation between government agencies, NGOs, and industry is needed to accomplish this strategy and fully realize its benefits.

4. Potential Emission Reductions

The proposed strategy was included in the Climate Action Team report of March 2006 and it emerged from ARB's regulatory work for the motor vehicle greenhouse gas emissions regulation (AB1493). That work suggests that potential GHG emission reductions for a universal phase out of HFC-134a in new and in-used MACS in California are on the order of 2.5 MMTCO2E by 2020. However, the uncertainty with the estimate is on the order of 50%.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

Preliminary cost estimates were developed for the revisions to the Climate Action Team Report of March 2006 that ARB and other agencies are undertaking. The numbers generated for that report are first-order estimates based on simple assumptions gleaned from the published literature about alternative MACS. Only estimated capital costs were considered. Additional staff analysis is needed to determine operating costs, cost savings, and economic impacts. The air conditioning system life is expected to be the same as current systems. Capital costs for the introduction of new refrigerants in the California fleet were estimated to be on the order of $150 million by in 2020 based on assumptions that changes begin to phase in around 2013. This estimate is based on an incremental cost per vehicle of €20 to €25 per LDV in 2003[3] and is also applied to the other vehicle categories. For the HFC-152a alternative refrigerant, it is not expected that maintenance costs will change significantly or that there would be cost implications when converting an existing HFC-134a system design to use HFC-152a since development is fairly advanced. Selection of some other alternative refrigerants, for example CO_2, could be significantly costlier. Incremental energy consumption estimates are not presented here. The reference below cites a potential 10% reduction in energy consumption for the

HFC-152a alternative for LDVs, but this will almost certainly vary significantly with vehicle category, engine type, operating cycle, extent of optimization achieved during system redesign, etc. Also, energy consumption for some other alternative refrigerant selections, for example CO_2-refrigerant systems, can actually show an increase under some operating conditions. Significant additional analysis is needed to enable and improve cost and performance estimates of the various alternative technologies.

6. Technical Feasibility

New HFC refrigerants with GWP values less than 150, such as those currently under development for the US market by Honeywell and DuPont, and existing alternative refrigerants such as HFC-152a (with GWP approximately 120[4]) or R744 (CO_2, GWP=1), are possible substitutes for HFC-134a in new vehicles. The feasibility of these low GWP refrigerants is being investigated and evaluated extensively by multiple entities. As suggested by the European directive, all indications are that a feasible refrigerant alternative to HFC-134a is eminent.

7. Additional Considerations

The EU regulation timeline calls for the phase out of HFC-134a beginning with new vehicles types in 2011. Thus, auto makers serving that market face at present time a critical go, no-go decision point regarding refrigerant selection for their systems.

The outcome of the AB1493 legal challenges, including the pending California waiver request to the US EPA, will impact significantly the form and function of the measure as proposed.

Each alternative new refrigerant will be evaluated from a lifecycle emissions standpoint to ensure that the net impact on greenhouse gas emissions is properly characterized and in order to promote improvements not only on refrigerant containment to minimize leakage, but also in system performance to reduce the parasitic impact of the MACS on the vehicle engine.

Affected Entities: Vehicle owners and operators, vehicle manufacturers, mobile air conditioning system repair facilities, mobile air conditioning system and component manufacturers, and air conditioning refrigerant manufacturers.

Government Agencies to coordinate with: U.S. EPA and the European Commission.

8. Division: Research Division
Staff Lead: Pablo Cicero
Section Manager: Tao Huai
Branch Chief: Alberto Ayala

9. References:

[1] *Schulte-Braucks, R., "Implementation of the R134a Phase Out," 2006 Mobile Air Conditioning Summit, Saalfelden, Austria, Feb. 17, 2006.*

[2] *The I-MAC Program is a consortium of government, industry, academia, and other stakeholders led by the US EPA with the objective to develop superior and improved HFC-134a mobile air conditioning technology with 50% lower leakage and 30% greater efficiency than current production-ready systems.*

[3] *Alternative Refrigerants Assessment Workshop, Presentation at the SAE 2003 Alternative Refrigerant Systems Symposium, Phoenix, Arizona, July 14, 2003*

[4] *The GWP limit is intended to be that of HFC-152a, for which the IPCC 3rd Assessment Report suggested a 100-year forcing of 120. The more recent IPCC/TEAP Special Report on HFCs and PFCs suggests a direct forcing of 122.*

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #	*B12*
ID NUMBER:	*EJAC-12/ARB 2-23*
TITLE:	*ADDITION OF AC LEAK TEST AND REPAIR REQUIREMENTS TO SMOG CHECK*
PROPONENT:	*2006 CAT REPORT AND ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE*

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in 1st quarter of 2011.

The strategy proposes to explore the addition of a new motor vehicle air conditioning system (MVACS) leak test and repair requirements to the existing California Smog Check program for HFC-based MVACSs. To the extent that a cost-benefit analysis supports this measure, implementation will require the 1) identification, selection and verification of one or more reliable and low cost HFC refrigerant leak detectors to be used in the Smog Check station setting; 2) development of a new Refrigerant Leak Check I/M procedure and protocol; 3) new and additional training of the Smog Check technicians including achieving appropriate technician A/C repair certification; and 4) working with the Bureau of Automotive Repair (BAR) of the Department of Consumer Affairs (DCA) for mandating the new procedure to be integrated into the statewide Smog Check program. Research will be needed to evaluate the feasibility of the new test and extensive discussions among multiple stakeholders, including first and foremost BAR and legislature staff are anticipated. For this reasons, this strategies cannot be developed before 2010 to meet the definition of a discrete early action.

3. Early Action Description

The proposed strategy will explore the addition of a refrigerant leak check to the "pass" criteria for the California vehicular inspection and maintenance (I/M) program, Smog Check, for all vehicles that undergo the test. As a result, all vehicles that pass Smog Check would have MACS that are either nearly leak-free or empty and excluded from further use of the AC system unless the leak is repaired. Vehicles that are determined to have unacceptable leak rates would be required to be repaired as a condition for registration. A similar requirement is already in place and enforced by some local air quality management districts. Thus, the proposed early action seeks to expand these local requirements statewide.

4. Potential Emission Reductions

The proposed strategy was included in the Climate Action Team report of March 2006 and it emerged from ARB's regulatory work for the motor vehicle greenhouse gas emissions regulation (AB1493). That work suggests that potential GHG emission reductions for a leak test and repair program in California are on the order of 0.45 MMTCO2E by 2020. However, the uncertainty with the estimate is on the order of 50%.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

Some preliminary, but incomplete cost information exists. In 2005, BAR licensed approximately 9,700 Smog Check stations and almost 14,000 Smog Check technicians. Approximately 9.2 million Smog Check inspections were conducted at these Smog Check stations in 2005[1]. Each Smog Check station would have additional one-time estimated expenditures of about $200~$300 for each hand-held HFC leak detector. Technician training for AC service certification would cost up to $280 per person. Based on above information, the total cost for equipment and training in California would be approximately $6M; $2M for equipment and $4M for training. In addition, the leak test would add time to the current Smog Check test, impacting the shop and the customer. Finally, in the case where a MVACS is found to require repairs, the customer would incur additional and potentially significant costs. Technology is also rapidly evolving and improving. Today's MVACS are much tighter than older system and the industry, in response in part to regulatory interest, is proactively seeking refrigerant leak improvements in the system sold to car makers. These factors and many other economic impacts have not been thoroughly researched and additional time is needed to complete a full cost-benefit analysis of the proposed measure.

6. Technical Feasibility

There are several commercially available hand-held HFC leak detectors or "sniffers" on the market. These detectors are currently in use by the AC service and repair industry. The detectors would need to be demonstrated capable of reliable and accurate determination of refrigerant leaks in the Smog Check station setting at rates as determined in the proposed strategy. All MVACSs leak refrigerant naturally as the systems are not hermetic and deterioration is expected. A pass criterion based on a reasonable threshold leak rate requiring professional AC servicing or system disabling needs to be defined rigorously, perhaps as a fraction of the original system charge or other appropriate metric. The current commercially available sniffers can detect a concentration of refrigerant in a sample volume of some currently unknown combination of leakage and ambient air. Further investigation is needed to define the pass criterion for either a threshold concentration or leak rate.

Currently, the service industry standard established by the Society of Automotive Engineers, SAE J1628 Standard[2], requires charging the AC with sufficient refrigerant prior to conducting a leak check. This procedure might be not suitable for the implementation of this strategy because the leak check would be conducted at Smog Check Stations, which normally do not have AC charging equipment. A new leak check protocol would be necessary. The measure must also require professional AC servicing or system disabling when leakage is found. Other methods, such as injection of dye gases, are under investigation.

7. Additional Considerations

ARB and BAR would need to work closely as both agencies share responsibility for Smog Check. Roles and responsibilities for both agencies in the context of the proposed strategy should further analysis suggest to proceed to full development and implementation will need to be defined.

Affected Entities: The I/M program operators at the Smog Check stations, the owners of all vehicles required to undergo I/M, shops that repair vehicular AC systems, BAR, and DCA, The I/M operators would have to become certified for AC maintenance, purchase new instruments for detection of HFC emissions, and adopt the new protocols for including the new test into the Smog Check procedure. BAR and DCA would be expected to develop a new I/M procedure and protocol to accommodate the new HFC leak check. The agencies would be impacted with additional enforcement requirements for the proposed strategy.

8. Division: Research Division
Staff Lead: Tao Zhan
Section Manager: Tao Huai
Branch Chief: Alberto Ayala

9. References:

[1] *California Inspection and Maintenance Review Committee, Review of the Smog Check Program, September 29, 2006. http://www.imreview.ca.gov/reports/final_report.pdf*

[2] *SAE J1628, Technician Procedure for Using Electronic Refrigerant Leak Detectors for Service of Mobile Air-Conditioning Systems, November 1998.*

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY # *B13*
ID NUMBER: *EA B-1, B-2*
TITLE: *WAFFLEMAT SYSTEMS*
PROPONENT: *STAKEHOLDER SUGGESTION*

2. Staff Recommendation

This measure is recommended for evaluation in the Scoping Plan which will be developed as a draft by mid-2008 and must be considered by the Board prior to January 1, 2009.

3. Early Action Description

The WAFFLEMAT System (registered trademark) is a set of interconnected WAFFLEBOXES equally spaced within the area of a new foundation. Concrete is then poured over the WAFFLEBOXES to create a concrete slab, thereby decreasing the volume of concrete used on new foundations and indirectly reducing the amount of CO_2 emitted from the production and transportation of Portland cement. The WAFFLEMAT System is advertised by the manufacturer to reduce CO_2 emissions by 20% when used for new residential home concrete slab foundations built on "marginal" soils (e.g., expansive soil, rocky soil, and/or hydro-collapsible soil), where an increase in slab thickness is required. The 20% CO_2 emission reduction was calculated by comparing the WAFFLEMAT System to a 10 inch uniform thickness slab. The actual percentages of CO_2 emission reductions will vary depending on the type and thickness of the slab which the WAFFLEMATs are compared against.

4. Potential Emission Reductions

Based on information from the manufacturer, ARB staff estimated that utilization of the WAFFLEMAT System on new residential home construction may reduce 3.5 metric tons (MT) of CO_2 emissions per slab for a 2,000 square foot home. If one assumes that 200,000 new residential homes are built each year in California, 25% of those homes are located on marginal soils and all 25% of those homes utilize the WAFFLEMAT System, there may be an annual CO_2 emission reduction of 0.18 million MT. Using 2008 as the baseline year, by 2010 there will be a cumulative 0.35 million MT CO_2 emission reduction and by 2020 there will be a 2.1 million MT CO_2 emission reduction. The primary purpose of the WAFFLEMAT System is to displace the total amount of concrete needed in a residential foundation and still meet or exceed construction requirements. In theory, if less concrete is needed, less needs to be produced. Emission reductions of oxides of nitrogen (NO_x), particulate matter (PM), hydrocarbons, and carbon monoxide

(CO) will also be achieved with the use of the WAFFLEMAT System if it is assumed that overall less concrete will have to be used.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

The WAFFLEMAT System is estimated to cost $1.20 per square foot of foundation. When compared to the cost of concrete for a 10 inch uniform thickness slab foundation on a 2,000 square foot footprint, the WAFFLEMAT System and its reduced volume of concrete may increase the price of a foundation by $1,200. This equates to an approximate cost effectiveness of $340 per MTCO2E. Additionally, the WAFFLEMAT System is advertised to provide cost savings in labor and ground preparation. ARB staff does not have information to quantify labor and ground preparation cost savings at this time.

The use of the WAFFLEMAT System is limited to use with marginal soils that generally require thicker slab foundations. Use of the WAFFLEMAT System with good soils may result in an increased use of concrete.

6. Technical Feasibility

The WAFFLEMAT System was developed in 1995 and has had over 6.5 million square feet of concrete poured on it without one structural callback or failure. Pacific Housing Systems, Inc. (the distributor) and two engineering firms conducted studies to determine the design compliance and capability of the WAFFLEMAT System. Their results showed that the WAFFLEMAT System is technically feasible and has advantages over the traditional slab foundation in areas with marginal soils. Those advantages include, but are not limited to: the slab's ability to withstand larger cantilevers, reductions in labor costs, provides a more definite value for concrete costs, and reductions in overall installation time.

7. Additional Considerations

- The use of the WAFFLEMAT System does not ensure reduction in the production of cement. CO_2 emission reductions are achieved with the use of the WAFFLEMAT System if cement plant operators reduce the production of Portland cement.
- Currently, not every new single-family residence home is built on marginal soils. We are not certain what percentage of new homes is built on marginal soils versus good soils. This could impact the CO_2 emission reduction estimates.
- Geotechnical engineers should be employed to recommend which foundation is suited for a site's soil type.
- ARB will need to work with other state and local agencies to ensure that the use of the WAFFLEMAT System meets building codes.
- ARB staff needs to work closely with legal to determine scope of authority for requiring the use of WAFFLEMAT Systems on new construction.

8. Division: Stationary Source Division
Staff Lead: Alicia Violet
Section Manager: Todd Wong
Branch Chief: Michael Tollstrup

9. References:

Altshuler, Sam. "Lowering the Carbon Footprint When Using the Wafflemat System for Concrete Slab Foundations." Suncoast Post-tension - Pacific Housing System, Inc.. February 2007.

Charlton, Aurora. "Structural Engineering Case Study Report: Wafflemat Slab On Grade Post Tensioned Foundation System." Front Range Engineering, LLC. August 2006.

Cook, John. "Wafflemat System Design Considerations." Pacific Housing Systems, Inc. and MKM and Associates. April 2006.

Richards, Tom. "A Sales/Marketing Comparison and Positioning Statement of the WAFFLEMAT System to Post-Tensioned Slabs." Pacific Housing Systems, Inc.. March 2006.

Richards, Tom. Telephone Interview and email. July 16 and 24, 2007.

State of California – Business, Transportation, and Housing Agency; Department of Housing and Community Development. "California's Deepening Housing Crisis." June 2007.

Treanor, Rich. "Wafflemat Frequently Asked Questions." Pacific Housing Systems, Inc.. March 2006.

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #	*B14*
ID NUMBER:	*EJAC-15/ARB A-15*
TITLE:	*GREEN SHIP INCENTIVE PROGRAM*
PROPONENT:	*ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE*

2. Staff Recommendation

This measure is recommended for evaluation in the Scoping Plan which will be developed as a draft by mid-2008 and must be considered by the Board prior to January 1, 2009. Evaluation as part of the Scoping Plan provides the most effective approach for fully considering the recommendation.

This measure is focused on reducing emissions of diesel particulate matter (PM) and nitrogen oxides (NOx) by phasing in the installation of emission control devices on new or existing vessels. While reductions in NOx and the elemental carbon portion of PM may reduce global warming, other aspects of this measure may contribute to it. For example, some of the emission control devices that can be used to significantly reduce PM and NOx will have fuel penalties associated with them, resulting in higher carbon dioxide (CO_2) emissions. Other control strategies may reduce fuel consumption and CO_2 emissions. However, the overall effect of this measure on GHG emissions is expected to be minimal.

We do intend to analyze the potential to modify this measure to also address GHG emissions. However, for several reasons, this analysis cannot be conducted in a short timeframe due to the complexity of the technical and jurisdictional issues. For example, more advanced ship hull and propeller designs have been proposed as a way to reduce fuel consumption and CO_2 emissions in some studies. However, it is uncertain whether we can influence design changes on vessels built outside the United States. In addition, it is expected that ship operators would already incorporate such changes to reduce their operating expenses unless there are extremely high capital cost impacts or other barriers. Furthermore, to fully address GHG emissions, a review of all the various emissions from ships and their impact on global warming would need to be conducted. The relevant emissions would include CO_2, methane, black carbon PM, sulfur oxides, refrigerants, and NOx. Some of these emissions contribute to global warming, while others have the opposite effect. In addition, some emissions effects may be localized whereas others are not. Finally, the potential control strategies for each type of emissions would need to be determined.

3. Early Action Description

This measure is included in the ARB's Emission Reduction Plan for Ports and Goods Movement. The measure, as currently proposed, seeks to reduce emissions of PM and

NOx by phasing in the use of cleaner ships at California ports. There are two levels of clean ships: "30/30 vessels" that are 30 percent lower in NOx and PM than current vessels meeting International Maritime Organization (IMO) standards, and "60/90 ships" that are 60 percent lower in PM and 90 percent lower in NOx than IMO compliant vessels. By 2020, the goal is to have clean ships make 90 percent of all California port visits, with 30/30 vessels making 40 percent of ship visits, and 60/90 vessels making 50 percent of ship visits. The ship operator would be expected to choose the specific emission control devices. Examples of potential emission controls include selective catalytic reduction, more advanced fuel injectors, fuel/water emulsions, onboard water scrubbers, and cylinder lubricant control systems. This measure seeks to encourage or direct ship operators to either retrofit existing vessels or incorporate emission control devices into new build vessels. The measure could be and incentive program, a voluntary agreement, a regulation, or use some other mechanism.

Although this measure is currently designed to focus on PM and NOx emissions, it could be modified to also control GHG emissions. As a first step, the impact of the existing NOx and PM controls on GHG emissions should be evaluated. Next, additional opportunities to address GHG emissions would need to be investigated. Existing studies suggest a number of potential control measures that would reduce fuel consumption and therefore CO_2 emissions (as well as other pollutants). These measures include the incorporation of optimized hull and propeller designs in new ship builds, operational changes focused on fuel efficiency, new methods of hull maintenance to reduce fouling, and the use of wind, solar power, and fuel cells.

4. Potential Emission Reductions

As mentioned above, this measure is not currently designed to reduce GHG emissions, and the potential impact on GHG emissions has not been quantified. Staff believes that the impact will range from a slight increase to a slight reduction in GHG emissions.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

TBD

6. Technical Feasibility

Improved engine design in new marine engine can improve combustion characteristics and reduce CO_2 emissions. However the impact of control measures to reduce PM, NOx, and SOx may increase CO_2 emissions.

7. Additional Considerations

See discussion under **"Staff Recommendation."**

8. Division: Stationary Source Division
Staff Lead: Paul Milkey
Section Manager: Peggy Taricco
Branch Chief: Daniel Donohoue

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #	*B15*
ID NUMBER:	*EJAC-16/ARB A-19*
TITLE:	*ANTI-IDLING REQUIREMENT FOR CARGO HANDLING EQUIPMENT AT PORTS*
PROPONENT:	*ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE*

2. Staff Recommendation

This measure is recommended for evaluation in the Scoping Plan which will be developed as a draft by mid-2008 and must be considered by the Board prior to January 1, 2009. Evaluation as part of the Scoping Plan provides the most effective approach for fully considering the recommendation.

Staff believes significant informational gaps or constraints exist due to the dynamics of mobile cargo handling equipment operations, union labor contracts, and safety and security concerns, which prevent the implementation of an anti-idling requirement within the timeframe required for early action measures. The very nature of these operations makes it extremely difficult to determine what constitutes unnecessary idling. To illustrate, cargo handling equipment is often required to move rapidly from one location to another; and some equipment, such as rubber-tired gantry (RTG) cranes, have operator cabs approximately 50 feet above the ground, making it unsafe for the operator to exit the cab (i.e., idling limitations prevent air conditioner operation). It is inherently problematic and may complicate the development of idling restrictions at port terminals because they are generally larger than 200 acres and at any given time may have hundreds of pieces of equipment operating. All of these issues need further evaluation and many concerns need to be addressed.

In order to pursue this strategy, it would be necessary to collect complete equipment and facility specific operational data by facility type and/or operation. This data must be analyzed to identify similarities/dissimilarities in idling (equipment specific) at each facility and determine whether certain idling durations can be minimized and still not inhibit the functionality or efficiency of their operation. The next step would be to take this information and determine the extent to which cargo handling equipment engines idle, and what fraction of this total could be considered as unnecessary idling. Data logging would be the recommended method of collecting the various operational data needs. However, the variability in facility operations and the fact that the data must be equipment specific, taking into account the duty cycle of the engine, makes this a significant challenge, albeit achievable. While many data gaps prevent us from determining what is considered unnecessary idling at existing port or intermodal rail yard operations at this time, upcoming emission control retrofit demonstration programs for port equipment (such as top picks, side picks, RTG cranes, and reach stackers) include data logging components that will provide some data to help us evaluate this issue.

These efforts will be undertaken over the next two years and will help inform the decision on the appropriateness of pursuing an anti-idling measure.

3. Action Description

This early action strategy proposes to adopt a statewide regulation to limit or prohibit unnecessary idling of mobile cargo handling equipment that operates at California ports or intermodal rail yards. The limiting or prohibiting of unnecessary idling will result in reduced fuel usage, fuel cost savings, and environmental/health benefits. A reduction in fuel consumption should result in greenhouse gas emission reductions, as well as, reductions of criteria or toxic air contaminants. However, the magnitude of these reductions is unquantifiable at this time due to lack of operational data. In the event it is determined feasible to establish restrictions on idling, the proposed strategy could be considered as amendments to the existing regulation for cargo handling equipment at ports and intermodal rail yards.

4. Potential Emission Reductions

The potential greenhouse gas emission reduction potential of idling restrictions on cargo handling equipment cannot be quantified with any certainty at this time, but is anticipated to be low given the limited number of cargo handling equipment statewide.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

Information is not available to estimate costs or economic impacts of this proposed Early Actions Strategy. However, the sectors that may incur costs from a restriction on idling include engine manufacturers, distributors, dealers, facility owners or operators, shipping lines, industries that contract with the ports or intermodal rail yards for movement of goods, and ultimately the end-user of the applicable consumer products.

6. Technical Feasibility

Limiting or prohibiting engine idling of mobile cargo handling equipment is likely to be technically feasible. However, the environmental benefits, cost effectiveness, emission reduction potential, and potential economic impacts on their operations can only be determined once more research and data collection has been completed and that data substantiates the extent to which unnecessary idling occurs. (See discussion under **"Staff Recommendation."**)

7. Additional Considerations

See discussion under **"Staff Recommendation."**

8. Division: Stationary Source Division
Staff Lead: Lisa Williams
Section Manager: Cherie Rainforth
Branch Chief: Dan Donohoue

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #	*B16*
ID NUMBER:	*EJAC-26/ARB A-17*
TITLE:	*ELECTRIFICATION OF AIRPORT GROUND SUPPORT EQUIPMENT*
PROPONENT:	*ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE*

2. Staff Recommendation

This measure is recommended for evaluation in the Scoping Plan which will be developed as a draft by mid-2008 and must be considered by the Board prior to January 1, 2009. Evaluation as part of the Scoping Plan provides the most effective approach for fully considering this recommendation.

Those categories of ground support equipment (GSE) most amenable to being electric powered already have a high percentage of zero emission vehicles (ZEV). There may be some other categories of GSE that could be candidates for either ZEV technology or hybrid electric vehicle technology. Assessing feasibility for the early action timeframe can be addressed over the next year. The potential greenhouse gas emission reductions from this discrete strategy appear to be negligibly small because the number of affected vehicles is small.

3. Action Description

This Early Action Strategy proposes to accelerate the replacement of airport GSE by specifying electrification. The proponents of this measure did not provide any details on the dates for the accelerated electrification, the categories of GSE units specifically targeted, or the percentage of electrification required.

This measure would overlap with the implementation of two recently-adopted ARB regulations for off-road equipment that include GSE - large spark ignited (LSI) engines and in-use diesel equipment. The LSI regulation, that became effective May 12, 2007, incorporates requirements of the recently-terminated Memorandum of Understanding (MOU) with the airline industry that calls for 30% electrification of the airline-owned GSE fleet in the South Coast Air Basin by 2010. The LSI regulation applies to gasoline and liquid natural gas-powered GSE. On July 27, 2007, ARB adopted an in-use diesel off-road equipment regulation that requires diesel equipment fleet owners to reduce their fleet-average emissions of NOx and PM in future years by turnover of a specified percentage of their fleet horsepower. Until staff sorts through how this measure would mesh with these regulations, it is unclear how or if there would be conflicts between the measure and the regulations.

In addition to these two ARB regulations, the South Coast Air Quality Management District (District) has proposed a statewide measure for emission reductions from GSE in the South Coast Air Basin by requiring accelerated zero emission vehicle penetration and more stringent fleet-average emission standards for GSE. The District's proposed measure would require airlines in the South Coast to increase the percentage of ZEVs in their GSE fleets from 30% to 45% by 2014, an increase of 15% additional ZEV penetration.

4. Potential Emission Reductions

If the measure were to achieve an additional 15% electrification of the GSE fleet by 2014 as suggested by the SCAQMD, this measure would represent about 1,200 additional electric GSE units. The most likely categories of GSE that might be amenable for electrification include push back tractors and cargo loaders for which we have estimated energy requirements, fuel use, and electricity use for replacement ZEV units. Assuming that each diesel unit on average uses 2,800 gallons of diesel fuel per year (about 3.5 gallons per hour), this represents an emission reduction of 0.036 million metric tons per year of CO2 emissions. Providing electricity from the California utility grid to recharge batteries for replacement ZEV units would require approximately 67 million kWh per year and would emit approximately 0.027 million metric tons of CO2 annually, assuming each kilowatt-hour would require on average about 400 grams of CO2 (Source: CEC). Thus, the net expected CO2 emission benefit from this proposed measure would be on the order of 0.007 MMTCO2E per year.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

If we assume that the Early Action Strategy would require an additional 15 % ZEV vehicles in the GSE fleets, the airlines could incur significant costs, since the requirement would mandate the early replacement of nearly 1,200 units by 2014. Assuming average unit costs for ZEV GSE equal to $60,000, the total cost of the measure would be on the order of $70 million. For units that reach the end of their lifetime during this period, there would be no lost revenue from early replacement, but for units that have to be retired early, there would be a revenue impact on airlines.

6. Technical Feasibility

Airlines have already undertaken substantial electrification of certain categories of the GSE fleet including baggage tractors and belt loaders representing an estimated 46% of the total statewide GSE fleet, mostly in the South Coast Air Basin and at Sacramento International Airport. Other categories of GSE that might be targets for electrification are pushback tractors and cargo loaders and cargo tractors, representing about 41% of the 200 GSE fleet. Pushback tractors represent almost 70% of the potential CO2 emissions, while cargo loading and tractor equipment represents about 30% of potential CO2 emissions. Electric pushback tractors are currently deployed in limited quantities in airline GSE fleets, while electric battery powered cargo loading equipment and cargo tractors have not yet been successfully demonstrated.

7. Additional Considerations

None.

8. Division: Planning and Technical Support Division
Staff Lead: Jim Lerner
Section Manager: Gary Honcoop
Branch Chief: Kurt Karperos

9. References:

New Emission Standards, Fleet Requirements, and Test Procedures for Forklifts and Other Industrial Equipment, ARB's LSI Regulation, effective May 12, 2007

Regulation for In-use Off-Road Diesel Vehicles, approved by ARB July 27, 2007

Final Air Quality Management Plan, approved by SCAQMD June, 2007, Off-Road Measure 04

California Electricity Consumption by County in 2005, CEC.

Inventory of California Greenhouse Gas Emissions and Sinks: 1990-2004, Final Staff Report, December 22, 2006, CEC.

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #	*B17*
ID NUMBER:	*EJAC-18*
TITLE:	*ELECTRIFICATION OF CONSTRUCTION EQUIPMENT AT URBAN SITES*
PROPONENT:	*ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE*

2. Staff Recommendation

The ARB recently adopted an off-road diesel rule at its July 2007 Board hearing. This regulatory measure is believed to address the recommendations of the Environmental Justice Advisory Committee regarding the electrification of construction equipment at urban sites. That is because the measure requires or allows for the use of lower emission technologies including electrified equipment.

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #	*B18*
ID NUMBER:	EJAC-19
TITLE:	*HYBRIDIZATION OF MEDIUM- AND HEAVY-DUTY VEHICLES*
PROPONENT:	*ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE*

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in 1ST quarter of 2011.

ARB staff was asked to investigate the feasibility of "hybrid electric technology for medium- and heavy-duty trucks" as an early action item to address greenhouse gas (GHG) emission reductions mandated by Assembly Bill 32. Medium duty trucks are trucks with gross vehicle weight rating (GVWR) between 8,501 and 14,000 pounds and heavy-duty trucks are 14,001 pounds and greater. Staff's evaluation focuses on trucks with GVWR greater than 10,000 pounds, which hereinafter are referred to as heavy-duty trucks.

Despite the wide spread presence of hybrid electric technology in the passenger car industry, heavy-duty hybrid technology for commercial trucks are still in the pre-production development stage. The major factors hindering a rapid introduction of cost-effective hybrid technology in the heavy-duty vehicle sector are the high incremental cost and risk aversion by both hybrid builders and buyers.

Many of the present prototype heavy-duty hybrid vehicles use off-the-shelf components that are not designed and optimized for on-road heavy-duty hybrid vehicles. Some hybrid components are not commercially available and must be custom designed for the application. These components significantly increase the cost of the hybrid system due to the low production volumes. Also, reliability and maintainability of hybrid trucks are still being tested and long term durability of hybrid trucks has not been demonstrated for most applications.

Staff anticipates that hybrid technology will become available in the next 5 or more years as a commercial product for applications on urban delivery, utility, and other specialty work trucks with a potential to provide significant greenhouse gas emission reductions by 2020.

3. Early Action Description

Adopt a regulation and/or incentive program to take advantage of emerging hybrid electric technology for heavy-duty trucks.

Hybrid electric technology offers the potential to significantly improve fuel efficiency and performance while reducing emissions. However, these benefits are highly dependent on the duty cycle of the truck application. Hybrid technology provides the greatest benefit when used in vocational applications that have significant urban, stop-and-go driving, idling, and power take-off operations in their duty cycle. Such applications include parcel delivery trucks and vans, utility trucks, garbage trucks, transit buses, and other vocational work trucks. Line haul trucks are typically operated for long periods of time at high speed and load cruise driving modes and therefore, hybrid technology may not be as beneficial for this type of truck.

Several governmental and non-governmental organizations have been sponsoring research and developing programs that will bring together hybrid developers, truck and engine manufacturers, and truck users in an effort to speed up the introduction of heavy-duty hybrid technology into the marketplace.

Among the governmental organizations, the United States Department of Energy (DOE) has initiated a cost shared research and development program for advanced heavy-duty hybrid propulsion systems that will focus on improving fuel efficiency of heavy duty trucks and buses. DOE is funding approximately $4 million per fiscal year of cost shared projects with the heavy-duty hybrid industry (50/50 cost share) on this program[1].

The United States Department of Transportation (DOT) in partnership with the North American Bus Industries, invested over $50 million, in a program that demonstrated fuel efficiency improvements of a transit bus through hybrid propulsion and weight reduction using composite materials. In addition to investing in other hybrid and fuel cell demonstration programs, DOT also continues to fund the purchase of advanced hybrid electric transit buses[1].

The United States Department of Defense is also a major sponsor in the development of heavy-duty hybrid technologies for combat vehicles and trucks.

The United States Environmental Protection Agency (U.S. EPA) has sponsored a program to develop and demonstrate the benefits of a hydraulic hybrid propulsion technology which is an alternative to hybrid electric propulsion. This system captures and stores a large portion of the braking energy by pumping hydraulic fluid into a high pressure hydraulic fluid accumulator and pressurizing an inert gas. The energy stored in the high pressure fluid is then used to help propel the vehicle during the next vehicle acceleration event[2].

Among the non-governmental organizations are the WestStart-CALSTART operated Hybrid Truck Users Forum (HTUF) and the North West Hybrid Truck Consortium. HTUF assists truck users and hybrid truck makers to move to pre-production manufacturing levels and deployment and reduce overall costs by creating common fleet requirements and joint purchase commitments. Under the HTUF program, working groups that are currently active include the Parcel Delivery Working Group, the Utility Working Group, the Refuse Truck Working Group, and the Shuttle Bus Working Group[3].

The Hybrid Parcel Delivery Truck Working Group focuses on Class 4 to 6 urban parcel delivery trucks and includes members from several major parcel delivery fleets in North America such as Federal Express (FedEx), United Parcel Service (UPS), Purolator Express, and the United States Postal Service (U.S. PS). FedEx was the first truck operator to test parcel hybrid electric trucks. It put 18 hybrid electric trucks on the road in 2005, 75 more in 2006 and is currently considering 75 more. Purolator Express has 10 hybrid electric parcel trucks and plans to add 115 trucks this year. UPS also plans to acquire 50 Eaton hydraulic hybrid trucks this year[3].

The Hybrid Utility Working Group is made up of 14 fleets and focuses on Class 5 to 7 utility and specialty work trucks. The work group has deployed 24 utility trucks nationwide and preliminary results indicate fuel savings ranging between 10 to 50 percent[3].

The Hybrid Refuse Working Group consists of 7 private and municipal refuse truck fleets. The purpose of this working group is to develop a common chassis and vehicle performance specifications in an effort to speed up the introduction of hybrid trucks for refuse fleet operations. In May 2007, the group released a request for proposals to purchase and deploy 8 preproduction hybrid refuse trucks for assessment[3].

The Northwest Hybrid Truck Consortium is a coalition of several county and city governments, and utility companies located in the state of Washington. The group works together with HTUF to identify hybrid opportunities and raise regional and state funding for hybrid deployment. In 2006, the consortium acquired $250,000 in funding from the U.S. EPA's West Coast Collaborative project, to support early hybrid truck deployments by reducing the incremental cost of the purchased hybrid trucks[4].

4. Potential Emission Reductions

To understand the potential of hybrid technology in reducing GHG emissions, staff estimated GHG emission reductions in 2020. Assuming that all new Class 3 to 5 (10,001 to 19,500 lbs) trucks sold in California beginning in 2015, use hybrid technology, the GHG emission reductions from these trucks are estimated to be 0.5 MMT of CO_2e in 2020. These hybrid trucks represent 20 percent of the total California fleet in the same class and their vehicle miles traveled represents 30 percent of the total California fleet of the same class. To put this in perspective, if 100 percent of the Class 3 to 5 trucks were hybrids in 2020, the potential GHG emission reduction could be up to 1.7 MMT of CO_2e.

Table 1

	CY 2020 (MY 2015-2020)	CY 2020 (ALL MYS)	
Vehicles (10,001 to 19,500 lbs)	53,421	273,739	- Fuel economy improvement: 35% - Base truck fuel economy: 7.2 mpg
Daily Vehicle Miles Travel	3,694,200	12,166,000	
GHGs Reduced in 2020 in MMT of CO_2e	0.5	1.7	

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

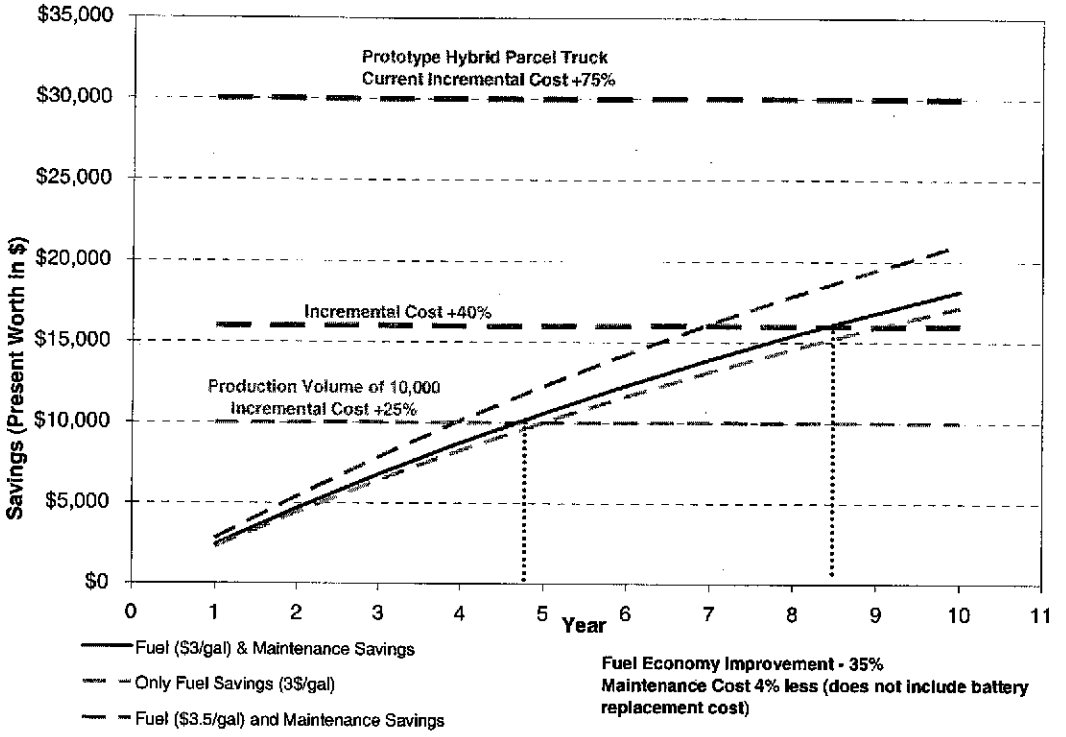
Table 2 compares a base truck with a "replacement" hybrid truck. As shown in the comments column of the table, the data were obtained from different sources. Incremental cost and in-use performance data were obtained from a hybrid truck builder and DOE published reports for hybrid buses and CNG trucks.

Table 2

	Base Diesel Truck	Parcel Hybrid Truck	Comments
Cost ($)	$40,000	$70,000	- Cost of the base truck is from a truck dealership. - Incremental cost is from a hybrid builder: $30,000 (75% above cost of base truck) for preproduction parcel trucks. ($10,000, or 25% above cost of base truck for production volume of 10,000 trucks or more)
Fuel Economy (mpg)	7	9.5	Fuel economy improvement 35% Base truck fuel economy is assumed to be 7 mpg.
Fuel Cost ($/gal)	$3.00	$3.00	In estimating fuel savings, the fuel price per gallon is assumed to remain constant during the 10 year lifetime period of the truck.
Annual VMT (miles)	22,000	22,000	Source: Parcel delivery truck feet operator
Life of the vehicle (years)	10	10	Source: Parcel delivery truck feet operator
Maintenance Cost	Unknown	Unknown	Being pre-production vehicles, the parcel fleet operator has not realized maintenance savings because of problems in software, transmission, parking brake, etc.
Assumed maintenance costs: ($/mile)	$0.16	$0.15	Base truck maintenance $0.16/mi[5] Hybrid truck maintenance cost is assumed 4% less – considers only labor and parts cost without battery replacement[6]

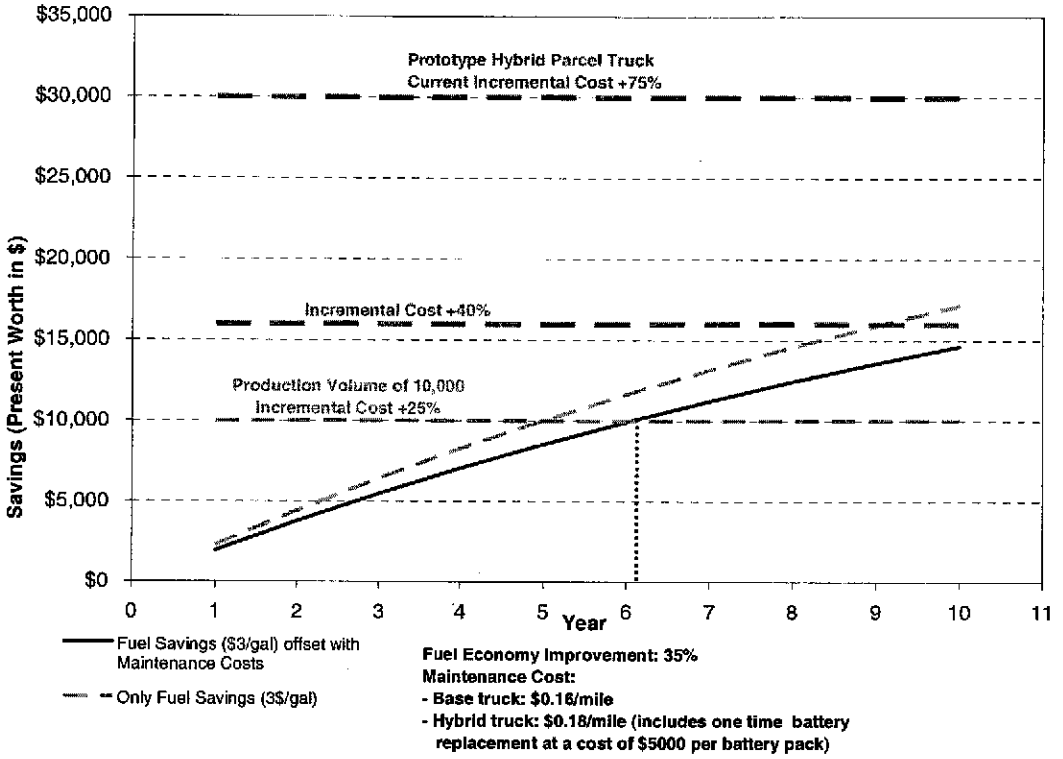
Figure 1 shows the savings realized from fuel economy improvements and reduced maintenance needs for the 10-year life of the parcel delivery truck. Future year savings were converted into 2007 dollars using a 7 percent discount rate. Assuming a 75 percent incremental cost difference, the chart shows that the preproduction hybrid parcel truck never recovers the incremental cost from fuel and maintenance savings. If production volume increases and the incremental cost drops to 25 percent of the cost of the base truck, then the hybrid truck will recover the incremental cost within 4 to 5 years. Note that in Figure 1 the maintenance cost for the hybrid truck is assumed to be 4% less than the base truck and does not include battery replacement.

Figure 1



According to one hybrid truck builder, the hybrid parcel delivery truck equipped with nickel metal hydride (NiMH) will require a one-time battery replacement during its life. The replacement battery pack costs between $5,000 to $8,000. Adding this cost to the maintenance cost of the hybrid truck results in $0.18/mile which is 10 percent higher than that of the base truck. Figure 2, below, shows the savings and payback period for this truck. It can be seen that the payback period for the high volume production hybrid truck (incremental cost of 25 percent) becomes 6 years.

Figure 2



6. Division: Mobile Source Control Division
Staff Lead: Daniel Hawelti
Section Manager: Stephan Lemieux
Branch Chief: Michael Carter

7. References:

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[3] *WestStart-CALSTART. "Hybrid Truck Users Forum". (website: http://www.calstart.org/programs/htuf/, accessed August 6, 2007)*

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[5] *Chandler, K. and K. Walkowic. . "King County Metro Transit Hybrid Articulated Buses: Final Evaluation Results", U.S. DOE Technical Report: NREL/TP-540-40585. December 2006. (http://www1.eere.energy.gov/vehiclesandfuels/avta/pdfs/heavy/king_co_final_12-06.pdf)*

[6] *Chandler, K., K. Walkowic, and Nigel Clark. "United Parcel Service (UPS) CNG Truck Fleet: Final Results", August, 2002. (http://205.168.79.26/vehiclesandfuels/ngvtf/pdfs/31227.pdf)*

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #	*B19*
ID NUMBER:	*EA B-1, B-2*
TITLE:	*CEMENT (A): ENERGY EFFICIENCY OF CALIFORNIA CEMENT FACILITIES*
PROPONENT:	*STAKEHOLDER SUGGESTION*

2. Staff Recommendation

This measure is recommended for addition to the list of early actions. The Board date for consideration of this item is anticipated in 4th quarter of 2010

Staff assessment indicates that significant near term carbon dioxide (CO_2) reductions might be obtained by implementing energy efficient practices and technologies at California's cement facilities.

A proposed measure to consider greater reduction from low-carbon fuels in the cement sector is recommended for evaluation in the Scoping Plan which will be developed as a draft by mid-2008 and must be considered by the Board prior to January 1, 2009. Evaluation as part of the Scoping Plan provides the most effective approach for fully considering the recommendation, which could entail large cost impacts on cement production in California.

3. Early Action Description

California's eleven cement facilities manufacture between 10 to 15 percent of the United States cement production. Annually, these eleven facilities use large amounts of energy: 1440 gigawatt hours (GWh) of electricity (7.2% of total energy used), 17.6 million therms of natural gas (2.6%), 2.3 million tons of coal (87.9%), 0.25 tons of coke (<0.1%), and burns 5.9 million tires[1] (2.3%). The three sources that result in CO_2 emissions from cement facilities are: 1) direct emissions from fuel combustion, 2) direct emissions from limestone calcination, and 3) indirect emissions from electricity use. Reducing CO_2 emissions from fuel combustion, calcination, and electricity use requires facilities to convert to using a low-carbon fuel, decrease fuel consumption, and improve energy efficiency practices and technologies in cement production[2].

4. Potential Emission Reductions

In 2004, CO_2 emissions from fuel combustion, limestone calcination, and electricity use are estimated at 10.8 million metric tons of CO_2 equivalent per year ($MMTCO_2E$). Staff estimates that CO_2 emissions from fuel combustion are 4.1 $MMTCO_2E$, limestone calcination 5.9 $MMTCO_2E$, and electricity use at 0.8 $MMTCO_2E$.

Potential carbon dioxide reductions are estimated for all three of those categories listed below:

A. Fuel Combustion

Clinker production is the most energy-intensive stage in cement production, accounting for over 90% of total industry energy use[3]. The most prominent fuel source used for clinker production in California is coal. Coal accounts for over 95% of all CO_2 emissions from fuel consumption. Coal emits over 210 pounds of CO_2 per million Btu (MBtu) compared to 117 pounds of CO_2 per MBtu of natural gas[4, 5]. If a low-carbon fuel, such as natural gas, is substituted for coal, potential reductions could exceed 1 $MMTCO_2$ reduction per year can be obtained. Further evaluation and information is needed to determine the feasibility of this proposed measure. Issues such as cost, infrastructure, plant modifications, and operational requirements need to be evaluated in more detail to determine if switching to low-carbon fuels can be recommended as a strategy for reducing greenhouse gas emissions.

B. Energy-efficiency Practices and Technologies

Energy-efficiency practices and technologies in cement production can be implemented to decrease CO_2 emissions. Energy consumption in the cement plant sector consists of energy used for raw material preparation, clinker production and finish grinding[6]. Raw material preparation and finish grinding is an electricity-intensive (indirect emissions) production. However, electricity accounts for only 10% of the overall energy use at cement plants[7].

1. Raw Materials Preparation

The standard raw materials used in California for cement production are limestone, chalk, and clay. These materials are usually extracted from a quarry close to the plant. Approximately 1.5 tons of raw materials are required to produce one ton of Portland cement. Raw materials preparation involves transport systems, blending, grinding mills, and classifiers (separators). Using the most highly efficient equipment in this category can save electricity and reduce indirect CO_2 emissions by 0.2 $MMTCO_2E$ at power plants.

2. Clinker Production

The heating of cement kilns to produce clinker is the largest user of energy at these facilities. To improve the energy-efficiency in clinker production, improved control systems, improved combustion system, reduction in kiln heat loss, grate coolers, preheater/precalciner type systems, newer mill drives, and use of secondary fuels can be utilized. Staff lacks sufficient data to estimate potential CO_2 reductions from California facilities. Much of the information available is based on national averages of cement plant efficiencies. Using this data, potential energy efficiency improvements could result in up to 0.7 $MMTCO_2E$ annually. Staff believes this estimate overstates the potential CO_2 reductions because a study by Lawrence Berkeley National Lab[8] found that California plants operate more efficiently than the national average. In order to more accurately assess potential reductions, staff needs to obtain plant specific information from each California facility.

3. Finish Grinding

To produce powdered cement, clinker is ground to the consistency of face powder. Finish grinding involves process control, grinding mills, and classifiers. Carbon dioxide emissions reduction of 0.1 $MMTCO_2E$ can be accomplished with high-efficiency equipment.

5. Estimated Costs/Economic Impacts and the Impacted Sectors/Entities

The estimated cost impact to California's cement industry to use cleaner fuels and more energy-efficient equipment/technologies is about one billion dollars annually. These costs are discussed below.

Coal is the major fuel used in California to heat the kiln used in clinker production. If coal was replaced by natural gas, total annual cost increase for California facilities would be estimated at $500 million. This equates to approximately $200 per metric ton of carbon dioxide equivalent ($MTCO_2E$) reduced per year. It should be noted that this number only reflects the difference in fuel costs. Additional work is needed to determine infrastructure and other costs that may significantly change the cost effectiveness.

Several technologies and practices exist that can reduce the energy intensity of various process stages of cement production. If each cement facility changed to higher energy-efficiency equipment for raw material preparation, the total cost is estimated at $258 million. This corresponds to approximately $1,300 per $MTCO_2E$ reduced. The finish grinding process is estimated at $111 million if all cement facilities changed equipment for higher energy-efficiency. This equates to $1,100 per $MTCO_2E$ reduced. Finally, improved energy-efficiency for clinker production involves many technical stages. Total cost for modification is estimated at $90 million. This corresponds to $125 per $MTCO_2E$ reduced. Additional information is necessary to more accurately determine energy efficiency strategies.

6. Technical Feasibility

This measure is technically feasible by applying low-carbon fuels for heating cement kilns and using more efficient equipment at various process stages of cement production. However, staff lacks information regarding the actual benefits that would be achieved by replacing existing equipment with more energy efficient equipment used at each California cement facility. Administering these measures could be costly to industry.

7. Additional Considerations

- Applicability of technological changes will depend on the current and future situations regarding individual plants. Capital projects would be implemented only if the company has more than 50 years of limestone reserve remaining. Cement plants with a shorter supply would most likely implement minor upgrades and focus on energy management measures.

- Mercury emissions from coal and raw materials needs to be evaluated. An assessment needs to be implemented concurrently with greenhouse gas reduction strategies to better understand impacts to industry.

8. Division: Stationary Source
Staff Lead: Jim Stebbins
Section Manager: Todd Wong
Branch Chief: Michael Tollstrup

9. References

[1] *Coito F, Friedmann R, Powell F, Price L, and Worrell E. 2005. Case Study of the California Cement Industry. Ernest Orlando Lawrence Berkeley National Laboratory, LBNL-59938*

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Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY # *B20*
ID NUMBER: *EA B-1, B-2*
TITLE: *CEMENT (B): BLENDED CEMENTS*
PROPONENT: *ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE*

2. Staff Recommendation

This measure is recommended for addition to the list of early actions. The Board date for consideration of this item is anticipated in 2nd quarter of 2009.

3. Early Action Description

From cement plants, carbon dioxide (CO_2) emissions are released into the atmosphere during the calcination process and the burning of fuels to produce clinker, the main ingredient in Portland Cement. The calcination process involves the decomposition of calcium carbonate (limestone) to calcium oxide (clinker or lime), in which CO_2 is released. Calcination is carried out in furnaces or kilns under very high temperatures.

A strategy to reduce CO_2 emissions involves the addition of blending materials such as limestone, fly ash, natural pozzolan and/or slag to replace some of the clinker in the production of Portland Cement. Currently, ASTM cement specifications allow for replacement of up to 5% clinker with limestone. Most manufacturers could in fact replace up to 4% with limestone. Caltrans allows for 2.5% average limestone replacement until testing of the long term performance of the concrete is complete. Caltrans currently has over $1 million in task orders and is devoting considerable staff resources to the evaluation of limestone blending in cement. Caltrans also currently has standards for using flyash and slag in concrete. Other blending practices will be explored.

Industrial wastes such as coal fly ash, blast furnace slag, and silica fume have cementitious properties and can be blended with clinker or added at the concrete mixing stage. The quality of these blended cements is comparable to Portland cement. The differences are lower initial strength, but higher final strength, and improved resistance to sulfates and seawater. In the United States, one study estimated that these blended cements account for about one percent of the domestic cement shipments. Limitations on further penetration of fly ash, slag, and silica fume into the concrete market depends on the availability, construction standards, transportation costs, and user preferences; however, the potential CO_2 emission reduction potential warrants further examination. Caltrans mandates 25% fly ash in almost all of its concrete and allows up to 35% fly ash replacement of cement. Caltrans also allows up to 60% slag replacement of cement in all concrete. Additional staff work is needed to determine other current blending practices in the State.

4. Potential Emission Reductions

In 2004, cement plants in California produced about 11.2 million metric (MM) tons of clinker, which corresponds to about 10.8 MM tons of CO_2 emitted from the production of clinker. Blending with 25% fly ash, slag, or silica fume has a potential to reduce CO_2 emissions by reducing the need to produce an equivalent amount of clinker. For each percent of cement replaced by these blending materials, CO_2 emissions may be reduced proportionally. At this time, ARB staff does not have information on how much of blended cements are used in California and further evaluations are needed to estimate the potential use of these blended cements to reduce CO_2 emissions. It should be noted that this strategy may not reduce CO_2 emissions in California, but is expected that cement imports would be reduced and thus result in reduced emissions elsewhere.

Fly ash that is typically blended is a by-product of coal combustion and may contain mercury. Mercury levels in fly ash need to be evaluated.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

The production of clinker is an energy intensive process, which involves heating and maintaining high temperatures in the cement kilns and its associated equipment (pre-heaters/pre-calciners). This strategy may result in the production of less clinker per unit of cement produced. In blending with 5% limestone, it is estimated that clinker production could be reduced by 0.56 MM tons, resulting in a reduction in energy use of 2.14×10^6 MMBtu. This is equivalent to not burning 75,000 tons of coal and saving plant operators in the State about $3 million. Due to the lack of information, the economic impacts of blending 25% fly ash or slag can not be determined at this time.

6. Technical Feasibility

The replacement of Portland Cement with limestone is technically feasible and may reduce CO2 emissions per unit of cement produced. However, additional evaluations are warranted to assess the feasibility, availability, and cost of blended cements containing fly ash and slag.

7. Additional Considerations

- The cement plant industry and environmental groups support the use of blending cements.

- The production of clinker at cement plants is also a source of mercury emissions caused by naturally occurring mercury found in the raw materials and from the combustion of coal. ARB staff has begun its efforts to understand the processes involved with the production of Portland cement, gather information to assess the impacts of both CO2 and mercury emissions, evaluate control options for all pollutants, and assess the economic impacts to the industry and the public. It is not yet fully understood the potential impacts of blending on mercury emissions from cement manufacturing facilities.

- Ongoing and future discussions with Caltrans and other agencies will ensure that

the addition of blended cements will meet their specifications and approval.

- Additional work is needed is needed to determine the extent to which blending currently is being done and the technical feasibility of establishing limits for the blending of fly ash and slag as a strategy to reduce CO2 emissions.

8. **Division:** Stationary Source Division
Staff Lead: Duc Tran
Section Manager: Todd Wong
Branch Chief: Michael Tollstrup

9. References

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Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #	*B21*
ID NUMBER:	*EJAC-22*
TITLE:	*RELATIVELY INEXPENSIVE ENERGY SAVINGS MEASURES WITH SHORT PAY BACK TIMES FOR FOSSIL FUEL POWER PLANTS BUILT PRIOR TO 1980*
PROPONENT:	*ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE*

2. Staff Recommendation

This measure is recommended for evaluation in the Scoping Plan which will be developed as a draft by mid- 2008 and must be considered by the Board prior to January 1, 2009. Evaluation as part of the Scoping Plan provides the most effective approach for fully considering the recommendation.

In addition, the ARB staff recommends working with the local air districts to start a dialogue with power plant owners and operators to disseminate information on energy savings measures through an educational outreach program. For these measures, there is already inherent built-in advantages (cost savings and short payback times).

3. Early Action Description

This strategy proposes that the ARB implement relatively inexpensive energy savings measures with short payback times for fossil fuel-fired power plants constructed prior to 1980. The EJAC has identified these older electrical generating units as significant contributors to greenhouse gas emissions due to their lower thermoelectric efficiencies compared to new state-of-the-art combined-cycle power plants.

ARB staff determined that there are 59 fossil fuel-fired thermoelectric power plants within California that came online prior to 1980. In 2005, the CO_2 emissions from these facilities totaled 13.9 million metric tons of CO_2-equivalent per year (MMTCO2E) or about 25 percent of total CO_2 emissions from all power plants in California.

ARB staff has identified two potential measures that could generate energy savings with minimal investment. The U.S. Department of Energy's (DOE) Industrial Technologies Program helps industrial plants operate more efficiently and profitably by identifying ways to reduce energy use in key process systems. The program has identified that minimal improvements in burner efficiency can result in significant savings. The following case from the DOE website (www.eere.energy.gov/industry) provides an example of the potential savings:

> Case: Consider a 50,000 lb/hr process boiler with a combustion efficiency of 79% (E1). The boiler annually consumes 500,000 million Btu (MMBtu) of natural gas. At a price of $8.00/MMBtu, the annual fuel cost is $4 million. The installed cost is

$75,000 for a new burner that provides an efficiency improvement of 2% (E2). The cost savings is:

Cost Savings = Fuel Consumption x Fuel Price x (1 - E1/E2)
= 500,000 MMBtu/year x $8/MMBtu x (1 – 0.79/0.81)
= $98,760/year

The simple payback on investment is:
Simple Payback = $75,000 / $98,760/year = 0.76 year

The table below shows the annual dollar savings for 1% and 3% efficiency improvements.

Burner Combustion Efficiency Improvement	Annual Energy Savings (MMBtu/year)	Annual Dollar Savings
1%	6,250	$50,000
2%	12,345	$98,760
3%	18,290	$146,320

The second measure is the use of newly-developed "automated migration tools," which consist of control and process optimization software to enhance operations by automatically balancing the process for optimum results, coordinating boiler/turbine control, emissions monitoring, economic dispatch, and fleet management. (Westinghouse Process Control, Inc., a subsidiary of Emerson, is one such vendor of this technology.) Some of the benefits include lower maintenance and materials costs, improvements in heat rate, and reductions in unit startup time. The software allows power plants to modernize their operations for greater efficiency and output, while at the same time minimizing their generation downtime.

These efficiency-enhancing measures may be of particular interest to the coastal power plants that have once-through cooling. Once-through cooling is an effective and relatively inexpensive method for re-condensing super-heated steam after it has been used to generate power. Once-through cooling draws sea water into the plant, where it flows through a heat exchanger to cool the steam, and then subsequently returns the heated water back into the environment. Sea water is abundant and cold and represents an efficient means of handling waste heat. However, once-through cooling may have a deleterious environmental impact due to the entrainment and impingement of marine life; therefore, the State Water Resources Control Board is currently developing a statewide policy to implement federal Clean Water Act requirements for power plants that utilize once-through cooling. If a less-efficient cooling method is required by these power plants, they could suffer an energy penalty ranging from 1.7 to 8.6 percent. ARB staff has identified 17 pre-1980 plants that may need to be retrofitted to comply with proposed once-through cooling requirements. Measures to mitigate this loss in overall efficiency may be especially pertinent.

4. Potential Emission Reductions

For the example case above for a single boiler, the potential emission reductions range from 0.12 to 0.34 $MMTCO_2E$ based on the fuel savings from the burner efficiency improvements. A plant-by-plant analysis is required to determine how many generating

units in the State have not already gone through similar modifications and could benefit from this measure. In addition, ARB staff was not able to obtain information on specific efficiency rates associated with the optimization software. Further investigation is required. Therefore, ARB staff cannot yet determine the total emission reduction potential of this strategy. However, depending on annual fuel consumption rates for the 59 pre-1980 power plants and opportunities for at least one percent efficiency improvements, there is a potential for significant emission reduction.

A potential co-benefit of efficiency improvements that lower overall fuel use is a concurrent reduction in criteria pollutant emissions.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

The cost of burner improvements will be site-specific. Also, ARB staff was not able to obtain information on upgrade costs associated with the optimization software, and further research is required. Therefore, the total cost of implementation cannot yet be determined due to the need to assess each generating unit on a case-by-case basis. Costs will be borne by the power plants, but the payback in efficiency and reduced fuel consumption should provide a short payback time and would not be expected to translate into increased electricity rates for consumers.

6. Technical Feasibility

In 2006, the DOE's Industrial Technologies Program completed 200 Energy Savings Assessments at U.S. industrial plants. Their website contains over 50 case studies for companies that have participated in past assessments and that are already saving energy and money. These studies describe demonstrated energy improvement projects, process improvement projects, and/or assessments at the plant level. These projects and accompanying savings can be replicated at similar plants.

With respect to optimization software, Westinghouse Process Control's website (www.emersonprocess-powerwater.com/solutions/pwr-successstories.cfm) describes experience with over 30 power generation projects across the U.S. and internationally.

7. Additional Considerations

- This measure would complement other actions taken by State agencies. In September 2005, the California Public Utilities Commission (CPUC) launched an ambitious energy efficiency and conservation campaign by authorizing energy efficiency plans and $2 billion in funding for 2006-2008 for the State's utilities.

- In addition, this item may be included under two CAT strategies to be implemented by the California Public Utilities Commission—specifically, "Investor Owned Utility Energy Efficiency Programs (including LSEs)" and "Investor-Owned Utility (IOU) Additional Energy Efficiency Programs/Demand Response."

Before taking this item to the Board, ARB staff recommends conducting further research to identify any additional low-cost energy savings opportunities for power plants and to

obtain a more accurate quantification of the potential emission reductions based on a case-by-case analysis of options.

8. Division: Stationary Source Division
Staff Lead: Chris Gallenstein
Section Manager: Mike Waugh
Branch Chief: Mike Tollstrup

9. References:

California Air Resources Board, database on California power plants, based on air district permit information from 2001.

[2] *California Air Resources Board, spreadsheet on greenhouse gas emissions from power plants for 2005, based on Energy Information Administration data.*

[3] *California Energy Commission, "Integrated Energy Policy Report," Appendix A: Aging Power Plant Study Group, publication #CEC-100-2005-1007-CMF, November 2005.*

[4] *California Energy Commission, "Inventory of California Greenhouse Gas Emissions and Sinks 1990 to 2004," Staff Final Report, publication #CEC-600-2006-013-SF, December 2006.*

[5] *California Energy Commission, "Status and Known Plans of Coastal Plants using OTC," April 2007.*

[6] *California Energy Commission, spreadsheet on pre-1980 generating unit ratings and status.*

[7] *California Public Utilities Commission, "PUC's Energy Leadership," January 2007: http://www.cpuc.ca.gov/static/070319_revenergystory0107.pdf*

[8] *Emerson Process Management's Power Success Stories, April 9, 2001: http://www.emersonprocess.com/solutions/power/success_story_1.asp*

[9] *U.S. Department of Energy, Industrial Technologies Program, Energy Efficiency and Renewable Energy, Steam Tip Sheet #24, DOE/GO-102006-2269, January 2006.*

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #	*B22*
ID NUMBER:	*EJAC-23/EJAC-29/ EJAC-31*
TITLE:	*IDENTIFY AND IMPLEMENT ENERGY EFFICIENCY MEASURES AT REFINERS THAT INCLUDE, BUT ARE NOT LIMITED TO, CONDUCTING AN ENERGY AUDIT*
PROPONENT:	*ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE*

2. Staff Recommendation

This measure is recommended for evaluation in the Scoping Plan which will be developed as a draft by mid-2008 and must be considered by the Board prior to January 1, 2009. Evaluation as part of the Scoping Plan provides the most effective approach for fully considering the recommendation.

Several of the measures that could be implemented to realize energy efficiency savings with potential greenhouse gas (GHG) benefits are listed in the section(s) below. Staff reviewed specifics of the necessary steps/processes necessary to implement such actions. This includes permitting and construction activities. Staff has concluded that all these measures could potentially provide moderate to significant GHG benefits. However, given the remaining uncertainties with identifying a viable strategy, staff does not recommend adding the suggested measures to the list of early actions. As part of its ongoing assessments, staff plans to:

a) Perform an evaluation to determine refiner's energy use and energy efficiency.

b) Develop a detailed strategy to define a plan to monitor changes in refinery energy uses and efficiency over time.

c) Define regulatory measures that could be implemented.

Each of these activities requires detailed analyses to ensure a comprehensive plan is adopted by each refinery before energy efficiency measures could be implemented.

3. Early Action Description

U.S. Department of Energy, the American Petroleum Institute, and large refinery facilities have completed a number of energy efficiency projects and demonstration studies in the last ten years. The results from these activities are the basis of the suggested measures for energy efficiency savings. The potential measures that could achieve modest to significant energy savings include: use of an energy management assessment system to continually optimize refinery processes, installation of new or expanding existing co-generating capacity, use of new (low-energy) technologies for desulfurization of fuels, incorporating low level heat streams back into refinery processes, reducing fouling and corrosion in cooling water streams, and treating and using low BTU refinery plant gas as an energy source. Some of these measures are currently under evaluation by refiners.

4. Potential Emission Reductions

Current ARB GHG combustion estimates suggest that California refineries emit 30 million metric ton equivalents of CO_2 annually. However, energy and GHG savings need to be determined for each refinery. Co-generation reduces CO_2 emissions by ~ 25% (not plant wide but just from this source of energy) compared to steam and electricity being delivered by an external utility. Savings are mainly derived by lower transmission losses, export of electricity and better heat management at the facility. The other measures when implemented could provide for marginal to moderate reductions (< 10%) reductions in energy needs for a given refinery with attendant GHG reductions.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

All the measures indicated above have moderate to significant costs associated with planning, design, permitting, construction and maintenance. Most if not all costs associated with implementation would be the responsibility of the refinery.

6. Technical Feasibility

Most of the proposed measures have been demonstrated to be feasible and cost effective by industry and government agency projects. However, refinery specific technical feasibility analyses need to be conducted to ensure that the specifics of each refinery are considered before adopting or mandating any energy efficiency measure.

7. Additional Considerations

Significant technical challenges exist to adapting findings from energy assessments of even a small refinery. Completing such assessments could take anywhere from 12-18 months before a report could be delivered. Based on the recommendation, construction, permitting, etc. may require additional time. Hence, adoption of measures to conduct such energy assessments is reasonable but not as discrete early action measures due to the time needed to conduct a complete assessment.

A study conducted by the California Energy Commission in participation with California refiners concluded that implementation would entail time frames of 3 or more years even for measures for which there was no significant technical, regulatory, enforcement, or other challenges. This conclusion is similar to staff's assessment of timelines necessary for adoption of any of the measures discussed above.

8. Division: Stationary Source
Staff Lead: Reza Lorestany
Section Manager: John Courtis
Branch Chief: Dean Simeroth

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #	*B23*
ID NUMBER:	*EJAC-24*
TITLE:	*ACCELERATE THE REPLACEMENT OF CARGO HANDLING EQUIPMENT AT PORTS*
PROPONENT:	*ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE*

2. Staff Recommendation

This measure is recommended for evaluation in the Scoping Plan which will be developed as a draft by mid-2008 and must be considered by the Board prior to January 1, 2009. Evaluation as part of the Scoping Plan provides the most effective approach for fully considering the recommendation.

Accelerating the replacement of cargo handling equipment at ports and intermodal railyards beyond that required by the Air Resources Board's (ARB) regulation for Mobile Cargo Handling Equipment at Ports and Intermodal Rail Yards (Cargo Handling Rule) could compromise the expected reductions in NO_x and diesel PM from that rule and would have negligible impacts on greenhouse gas emissions. Accelerating the implementation dates for compliance could potentially jeopardize the overall benefits that can be realized from the Cargo Handling Rule. While there may be some near-term increase in emission reductions, a large portion of the overall benefits that are scheduled to be realized would be lost since operators would not be able to purchase the cleaner Tier 4 engines that will be available in the post 2011 timeframe. For example, for some larger equipment, such as rubber tire gantry cranes (RTG) that have long useful lives (up to 20 years or more), high horsepower ratings, and are costly (upwards of over 1 million dollars), the regulation was designed to accelerate the turnover of this equipment such that, in most cases, a new RTG would be purchased when the ultra-low emission Tier 4 engines would be available. Having this equipment replaced sooner, as proposed in this early action measure, would result in the loss of the significant emissions benefits from a Tier 4 engine since the operator would have to purchase either a Tier 2 or Tier 3 engine. Since this equipment has a long useful life, the benefits of a Tier 4 engine would be foregone for up to 20 years.

Furthermore, it is expected that the Cargo Handling Rule, or the acceleration of that rule, would result in a negligible effect on global warming. Because the Cargo Handling Rule requires operators to move from uncontrolled engines to cleaner engines with NO_x and PM controls and in some cases to apply exhaust retrofits, there can be a fuel economy penalty as high as two to four percent. When more fuel is burned, more CO_2 is produced, and CO_2 is a greenhouse gas. However, the Cargo Handling Rule does result in the reduction of black carbon emissions which also contribute to global warming and this may offset the fuel penalty effects.

Accelerating the turnover would result in the loss of NO_x and diesel PM emission reductions over the life of the equipment resulting in a loss of public health protection and without achieving any measurable greenhouse gas benefits.

3. Early Action Description

The Cargo Handling Rule became effective December 6, 2006, and established performance standards based on the best available control technology (BACT) for new and in-use cargo handling equipment operating at these facilities. Compliance with the regulation will be phased in beginning in 2007 based on the age of the engine, whether or not it is a yard truck or non-yard truck equipment, and the size of the fleets. The performance standards and compliance dates in the regulation were designed to maximize the public health benefits from the rule, taking into account the useful life of the equipment, the use and cost of new equipment, the horsepower of the engines, and when cleaner new engines, in particular the 2007 on-road engines and Tier 4 off-road engines, would be available.

This Early Action Strategy proposes to accelerate the replacement of cargo handling equipment at ports and intermodal rail yards earlier that the compliance schedules required by the existing statewide regulation for Mobile Cargo Handling Equipment at Ports and Intermodal Rail Yards. The proponents of this measure did not provide any details on the dates for acceleration or the equipment targeted.

4. Potential Emission Reductions

As discussed under **"Staff Recommendation"**, we do not expect any greenhouse gas emission benefits from this proposed early action measure.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

The costs associated with accelerating the implementation dates in the Cargo Handling Rule could be significant. In most cases, the useful life of equipment would be decreased even more than required by the rule, resulting in increased costs to terminal operators, shippers, and consumers.

6. Technical Feasibility

It is technically feasible to require faster turnover of equipment at ports and intermodal rail yards. However, as discussed in "**Staff Recommendation**," accelerating the turnover would decrease the expected emission reductions of NO_x and diesel PM from the rule and have negligible impacts on greenhouse gas emissions.

7. Additional Considerations

8. Division: Stationary Source Division
Staff Lead: Lisa Williams
Section Manager: Cherie Rainforth
Branch Chief: Dan Donohoue

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #	*B24*
ID NUMBER:	*EJAC-25*
TITLE:	*EVALUATE ENCLOSED DAIRY BARNS AS AN ADDITIONAL STRATEGY FOR THE CAPTURE AND COMBUSTION OF METHANE EMISSIONS AT DAIRIES*
PROPONENT:	*ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE*

2. Staff Recommendation

This measure is recommended for evaluation in the Scoping Plan which will be developed as a draft by mid-2008 and must be considered by the Board prior to January 1, 2009. Evaluation as part of the Scoping Plan provides the most effective approach for fully considering the recommendation.

In addition to this measure, ARB staff will be evaluating potential measures for modified feed management, manure removal frequency, covered and treated lagoons, and digesters as potential strategies for reducing methane emissions.

This evaluation will be undertaken as part of ARB's actions for reducing methane emissions at dairies. These actions are not appropriate for consideration as early action measures because the time-frame is not sufficient to conduct the required in-depth cost-effective analyses, develop consistent emissions testing methods, and evaluate emerging technologies or technology-transfers. These activities must be conducted in advance of proposing any measures for reducing GHG emissions from dairy operations. ARB Planning and Technical Support Division (PTSD) staff is currently developing a protocol for calculating changes in GHG gas emissions resulting from the voluntary installation of a manure digester at animal agricultural facilities. The development of this voluntary protocol has been proposed as an early action measure and is discussed in a separate white paper prepared by PTSD.

3. Early Action Description

This strategy proposes that the ARB develop a regulation to require that housing and milking barns at dairies be vented to an incinerator or biofilter/bioscrubber as a means of controlling methane emissions from enteric fermentation. This strategy consists of fully enclosing barns and exhausting the air to an incinerator or a biofilter/bioscrubber.

Incinerators can achieve a 90 percent or greater reduction in methane emissions. However, incinerators emit oxides of nitrogen, carbon dioxide, toxic air pollutants and require the use of a fuel to promote the destruction of compounds such as methane.

Biofilter/bioscrubber technology can achieve approximately 80 percent control of emissions of volatile organic compounds (VOCs), ammonia, and hydrogen sulfide. ARB staff was not not able to confirm any control efficiencies for methane from biofilters/bioscrubbers. By-products of biofilters/bioscrubbers are water and carbon dioxide.

In their May 7, 2007 letter to the Chairman of the Air Resources Board, the Center on Race, Poverty & the Environment argues 1) that cow housing is where most enteric fermentation takes place, 2) biofilter systems are already in use for swine facilities and have been reported for dairies, and 3) have been proposed by industry in California. ARB staff has not been able to confirm the extent to which these statements are true. In addition, ARB staff is not aware of any information about the cost of these technologies or their ability to reduce GHG emissions at any enclosed animal facility.

4. Potential Emission Reductions

California's dairy cow population produces about 4.7 MMTCO2E of methane from enteric fermentation. Although biofilters/bioscrubbers and incinerators can reduce methane emissions, the overall net GHG emissions (that would occur after discounting the GHG emissions emitted from electricity required to operate the technologies and as a by-product of the technologies themselves) have not been determined.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

A detailed cost-effectiveness analysis of such systems needs to be performed prior to their application. In addition, the calculation of net reduction in GHGs must include the electricity used to move contaminated air from the barns to the filtration device or incinerator. The agriculture industry, particularly sectors involved in confined animal facilities, would be impacted by this proposal.

6. Technical Feasibility

These technologies could theoretically be transferred to dairies. However, the extent to which enclosed animal barns outfitted with these technologies could achieve a net reduction in GHG emissions, particularly carbon dioxide, has not been demonstrated.

7. Additional Considerations

This is an untested technology with likely high-energy requirements for airflow and high-water requirements for evaporative cooling. There may be some benefits in milk production by maintaining the proper temperatures inside the freestall barns. Manure handling in the confined spaces may be more difficult. An increased risk to animals will occur from overheating. Marketing campaigns based on "unconfined cows" might be compromised. Animal health and welfare issues may arise.

8. Division: Stationary Source Division
Staff Lead: Dan Weller
Regulatory Assistance Section
Section Manager: Kitty Howard
Branch Chief: Michael Tollstrup
Staff Attorney: George Poppic

9. References:

1. *Dairy Permitting Advisory Group, Recommendations to the San Joaquin Valley Air Pollution Control Officer Regarding Best Available Control Technology for Dairies in the San Joaquin Valley, Final Report – January 31, 2006, at 108-110 ("DPAG Report")*

2. *Letter to Dr. Robert Sawyer, Chairman of the California Air Resources Board. Dated: May 7, 2007. Received from Avinash Kar (Center on Race, Poverty, & the Environment) and Tom Frantz (Global Warming Environmental Justice Advisory Committee)*

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Strategy Name and Proponent

SUMMARY #	*B25*
ID NUMBER:	*EJAC-26*
TITLE:	*COMPOSTING – ADOPT SOUTH COAST AND SAN JOAQUIN RULES STATEWIDE*
PROPONENT:	*ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE*

2. Staff Recommendation

This measure is recommended for evaluation in the Scoping Plan which will be developed as a draft by mid-2008 and must be considered by the Board prior to January 1, 2009. Evaluation as part of the Scoping Plan provides the most effective approach for fully considering the recommendation.

3. Description

South Coast Air Quality Management District (SCAQMD) Rule 1133.2 and San Joaquin Valley Unified Air Pollution Control District (SJV) Rule 4565 were adopted for the purpose of controlling volatile organic compounds (VOC) and ammonia from co-composting facilities. This strategy would adopt SCAQMD and SJV rules for enclosed co-composting facilities statewide. Co-composting is the composting of a mixture of biosolids and manure with bulking agents to produce compost. Greenwaste facilities use green waste or food waste as the primary feedstock, and may add small amounts of manure or other biosolids as an amendment; chipping and grinding facilities reduce the size of greenwaste or wood waste to be used in composting, or as cover for landfills.

4. Potential Emission Reductions

This action is expected to have a low (0-0.1 million metric ton carbon equivalent) emissions reduction potential. The composting rules in SCAQMD and SJV were designed to reduce emissions of VOC and ammonia (as precursors to ozone and PM10). GHG emissions were not evaluated during the development of the district rules.

According to U.S. EPA, composting may result in emissions of methane from anaerobic decomposition, and non-biogenic emissions of carbon dioxide (CO_2) from the collection and transport of the organic materials to the composting site. U.S. EPA considers CO_2 emissions from aerobic decomposition to be "biogenic" and therefore does not include them in the *Inventory of U.S. Greenhouse Gas Emissions and Sinks*. Research indicates that efficient composting will not result in significant methane emissions, will have minimal CO_2 emissions from transportation and mechanical turning of compost piles, and can result in some carbon storage (sequestration) from the application of compost to soils. Methane emissions were estimated to be essentially zero and CO_2 emissions per ton of material composted was estimated to be 0.01 million ton carbon equivalent (MTCE) indirect CO_2. U.S. EPA estimated that centralized composting of organics

results in net GHG storage of 0.05 MTCE/wet ton of organic inputs composted and applied to agricultural soil.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

SCAQMD evaluated the cost effectiveness of Rule 1133.2 under several scenarios. Under the most likely scenario for an existing facility, with enclosures for all phases of the operation, and biofiltration, the cost was $8,700 to $10,000 per ton of VOC and ammonia reduced, depending on the type of enclosure selected. Costs for a new facility were between $11,000 and $12,000 per ton. Although greenwaste composting facilities have the largest throughput of any composting operation, they are exempt because the control options were determined to be cost-prohibitive.

6. Technical Feasibility

It would be technically feasible to have all large composting facilities in the State comply with a statewide control measure similar to the SCAQMD or SJV rules. However, it is unclear at this time if the control measure would reduce GHG emissions.

7. Additional Considerations

While implementation of this strategy would certainly result in additional statewide VOC and ammonia benefits statewide, GHG reduction benefits are currently unclear. An analysis is needed to determine whether the controls (enclosure and biofilters) will reduce GHG emissions. Additionally, the Market Advisory Committee report on the establishment of a Cap and Trade Program reported that composting does not produce net greenhouse gas emissions. Furthermore, U.S. EPA has estimated that there is a net GHG storage of 0.05 MTCE/wet ton of organic inputs composted, once they are applied to agricultural soil. Data on GHG emissions from composting operations in the SCAQMD and SJV, as well as other areas of the State, need to be obtained and analyzed in order to determine if this strategy has the potential to result in GHG emission reductions.

With low-to-zero anthropogenic GHG emissions, regulating composting facilities for their GHG emissions alone may be cost prohibitive. The Market Advisory Committee noted that local governments have created incentives for increased composting based on the need to reduce the amount of material sent to landfills. Cities and counties were mandated to achieve a 50 percent source reduction by the year 2000, compared to a 1990 baseline. The current statewide diversion rate is 42 percent. If new regulations are imposed on these facilities, it could hinder further progress towards this goal. Composting, alternatively, may be considered a method of carbon sequestration and therefore a potential offset measure (for example, United States Department of Agriculture research indicates that compost usage can reduce fertilizer requirements by at least 20 percent thereby significantly reducing net GHG emissions), which would enhance the economic viability of composting. These issues need to be carefully considered and analyzed prior to proceeding with this strategy.

8. Division: Stationary Source Division
Staff Lead: Kate MacGregor
Section Manager: Richard Boyd
Branch Chief: Dan Donohoue

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #	*B26*
ID NUMBER:	*EJAC-27*
TITLE:	*PHASE OUT PRE-1980 POWER PLANTS GENERATING AT LEAST 100 MW AND PROVIDE INCENTIVES TO REPLACE THEM WITH CLEAN ENERGY*
PROPONENT:	*ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE*

2. Staff Recommendation

This measure is recommended for evaluation in the Scoping Plan which will be developed as a draft by mid-2008 and must be considered by the Board prior to January 1, 2009. Evaluation as part of the Scoping Plan provides the most effective approach for fully considering the recommendation.

ARB staff determined that the greenhouse gas reduction potential of this strategy appears to range from low (actually an increase in emissions) to large, depending on what assumptions are used. ARB staff recommends working with the local air districts to analyze the best options for each generating unit. This work would include determining to what extent natural phase-out is occurring and at what pace; considering how the existing power plants operate versus how the replacement plants will operate (combined-cycle generation is designed for baseload operation and using it as peaking capacity could result in higher emissions due to frequent startup and shutdowns where combustion systems and controls are not optimized); analyzing how planned transmission upgrades will affect the need for Reliability Must Run (RMR) units; and looking at whether new proposed power plant projects will replace the need for old generating units.

3. Early Action Description

This strategy proposes that the ARB develop a permitting system to phase out, by 2010, fossil fuel-burning thermoelectric power plants that generate at least 100 MW and were built prior to 1980. The EJAC argues that these represent the oldest, most inefficient units. The mechanism for this phase out would be through a scaled and planned annual reduction in CO_2 emissions between 2007 and 2010. The 2010 end-goal would be an emission standard equivalent to the 2007 cleanest combined-cycle plant operating at a heat rate of 6,500 Btu/kWh. Generating units that cannot meet the emission standard would be required to shut down. The proposed phase-out would occur according to the following increments of progress:

Year	Allowable CO_2 Emission Level
2007	equivalent to 2006 emissions
2008	at least 1/2 less than the difference between 2007 emissions and the 2010 standard
2009	at least 2/3 less than the difference between 2007 emissions and the 2010 standard
2010	equivalent to California's most efficient plants built in 2007 rated at 100 MW and 6,500 Btu/kwh

EJAC also suggests that ARB prohibit an RMR designation by the California Independent System Operator (CAISO) as a means to allow a unit that does not meet the emission levels to operate.

ARB staff assumes that the power plants in question will be replaced by modern combined-cycle power plants consisting of natural gas-fired combustion turbine generators where heat is recovered from the gas turbine exhaust gases to heat water and generate steam, which is sent through a steam turbine to produce additional electricity. Therefore, the amount of fossil fuel burned to generate electricity is less than older units with no heat recovery. For example, the typical electric generation efficiency of a combined-cycle plant is estimated from 40-58 percent, while a utility boiler is estimated from 25-40 percent.

ARB staff assumes that the power plants in question will be replaced by modern combined-cycle power plants consisting of natural gas-fired combustion turbine generators where heat is recovered from the gas turbine exhaust gases to heat water and generate steam, which is sent through a steam turbine to produce additional electricity. Therefore, the amount of fossil fuel burned to generate electricity is less than older units with no heat recovery. For example, the typical electric generation efficiency of a combined-cycle plant is estimated from 40-58 percent, while a utility boiler is estimated from 25-40 percent.

ARB staff determined there are 59 fossil fuel-fired thermoelectric power plants within California that came online prior to 1980. In 2005, the CO_2 emissions from these facilities totaled 13.9 million metric tons of CO_2-equivalent per year (MMTCO2E) or about 25 percent of total CO_2 emissions from all power plants in California. Of these, 30 power plants are also rated at 100 MW or more. The 30 plants represent three percent of the number of power plants statewide, yet contribute approximately 21 percent of the total MW plant capacity in the State. If all 30 plants are phased out by 2010, the State would need to secure about 20,000 MW of capacity. The facilities are located within the jurisdiction of the following air districts: Bay Area, South Coast, Mojave Desert, San Diego, San Luis Obispo, North Coast, and Ventura. The generating units consist of natural gas-fired utility boilers and combustion turbines, with the exception of one facility that uses jet fuel.

Of these 30 power plants, high heat rates and future longevity may soon be less of an issue due to several factors. First, ARB staff has determined that 18 plants have either replaced all or a portion of their generating units or the old generating units are retired or soon to be retired. Secondly, the State Water Resources Control Board is currently developing a statewide policy to implement federal Clean Water Act requirements for cooling water intake structures related to the mitigation of entrainment and impingement

of marine life at power plants that utilize once-through cooling. ARB staff has identified 17 plants (14,479 MW) that may need to be retrofitted to comply with proposed once-through cooling requirements. These plants may be retired due to the cost to retrofit or may suffer an energy penalty ranging from 1.7 to 8.6 percent (at 67 percent load) to install wet or dry cooling.

Regarding reliance on RMR units, one of the ways to reduce the need to sign RMR contracts is to invest in transmission upgrades. Upgrades that increase the ability to import energy from neighboring states and Mexico, and increase the amount of energy that can be delivered to the major load centers in California, minimize the need to sign RMR contracts with aging facilities in these areas for local reliability purposes. Two major upgrades are scheduled to operating by 2008 and will increase the transmission networks import capability into Southern California by as much as 1,160 MW. The Miguel-Mission 230 kV line #2 will increase the import capability into San Diego by 560 MW and is expected to be operating by June of 2006. The short-term Southwest Transmission Expansion Plan upgrades will increase the import capability into the Los Angeles Basin by approximately 500 MW. There are no other major projects planned to increase the transmission capacity into California before 2009.

As a companion to the phase out of older, higher-emitting plants, this strategy proposes that incentives be provided to encourage clean energy substitutions. Identifying available incentive programs would be included as part of the evaluation for the Scoping Plan. However, there is a potential incentive in Assembly Bill 32 (AB 32) for facilities that implement voluntary reduction measures. AB 32 requires that adopted regulations ensure entities that have voluntarily reduced their greenhouse gas emissions prior to the implementation of these regulations receive appropriate credit for early voluntary reductions (Health and Safety Code Section 38562 (b)(3)). To support these reductions, ARB is required to adopt methodologies for the quantification of voluntary greenhouse gas emission reductions, and adopt regulations to verify and enforce any voluntary reductions that are authorized for use to comply with emission limits established by ARB (Health and Safety Code Section 38571).

4. Potential Emission Reductions

In 2005, the 59 pre-1980 power plants produced 13.9 million metric tons of CO_2-equivalent per year (MMTCO2E), which is equivalent to 24 percent of the CO_2 produced by power plants. Although available data were incomplete, plant numbers indicate capacity factors[1] ranging from 1.3 to 36.1 percent (average 13.2 percent). While recent data shows these plants operate infrequently, replacing them with new natural gas combined-cycle units would mean that the new plants will operate more because they are designed for baseload generation. Combined-cycle plants tend to have capacity factors around 85 percent[2]. Based on these assumptions, ARB staff estimates the potential emissions impact due to shut down of pre-1980 power plants and replacement with combined-cycle generation in 2010 ranging from a 2.4 MMTCO2E reduction (at

[1] A percentage that tells how much of a power plant's capacity is used over time. It is the ratio of the electrical energy produced by a generating unit for the period of time considered to the electrical energy that could have been produced at continuous full power operation during the same period.

[2] Assumed CO_2 emission factor for combined-cycle generation is 1,100 lb CO_2/MWh, as proposed in SB 1368 regulations.

13.2 percent capacity factor) to a 60.4 MMTCO2E increase (at 85 percent capacity factor). Therefore, the emission reduction potential of this strategy is considered from low to large.

Depending on how well-controlled the existing plants are, there is the potential for criteria pollutant reductions from combined cycle. At the same time, depending on how the new facilities are operated, there is the potential for an overall increase in emissions due to frequent startups and shutdowns or higher capacity factors.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

ARB staff estimates that the cost to implement this strategy is simply the cost of replacing the old power plants with new combined-cycle power plants of identical capacity. As mentioned above, the potential replacement capacity is 20,000 MW. To replace this capacity with equivalent combined cycle generation is estimated to range from $1.4 to 8.7 billion (using a levelized cost for combined cycle of 5.85 cents/kWh[3]) based on capacity factors from 13.2 to 85 percent. If there is a reduction in emissions, the cost effectiveness is $564 per-$MTCO_2E$. The bulk of the costs will be borne by the electric utility industry. In turn, this could impact consumers in the form of increased electricity rates.

6. Technical Feasibility

The siting of large natural gas-fired combined-cycle plants in California started in 1997, coinciding with the passage of legislation in 1996 deregulating the California electric utility industry. Since then, 19 of these plants, totaling over 10,000 MW, are currently operating throughout the State. Therefore, the technology is proven and well-established.

7. Additional Considerations

Rules of the Oregon Energy Facility Siting Council set CO_2 emission standards for new energy facilities. The standards apply to baseload gas plants, non-baseload power plants, and non-generating energy facilities that emit CO_2. For baseload gas plants and non-baseload plants, the standard sets the net emissions rate at 0.675 pounds CO_2/kWh (675 pounds CO_2/MWh).

On October 30, 2006, the California Energy Commission (CEC) instituted a proceeding to establish a greenhouse gas emission performance standard to implement Senate Bill 1368 (Stats. 2000, Ch. 598). The bill directs the CEC, in consultation with the California Public Utilities Commission and the California Air Resources Board, to establish a greenhouse gas emission performance standard for all baseload[4] generation of local publicly owned electric utilities at a rate no higher than the rate of emissions for natural gas-fired combined-cycle baseload generation. The proposed standard was set at 1,100 pounds of CO_2/MWh, based on evaluating the performance of existing

[3] Represents an average of several cost estimates.

[4] ARB staff is awaiting interpretation from the CEC and California Public Utilities Commission regarding whether plants currently operating with low capacity factors (but which were originally designed and intended for baseload operation) are subject to SB 1368 regulations.

combined-cycle natural gas baseload plants throughout the west, with special attention paid to the performance of units in California.

The CEC adopted the regulations pursuant to SB 1368 on May 28, 2007. The final rulemaking package was submitted to the Office of Administrative Law on June 1, 2007. On June 29, 2007, OAL issued a decision disapproving the action. The CEC is currently working on addressing the decision and determining what changes should be made to the proposed regulations to address OAL's concerns.

8. Division: Stationary Source Division
Staff Lead: Chris Gallenstein
Section Manager: Mike Waugh
Branch Chief: Mike Tollstrup

9. References:

[1] *California Air Resources Board, database on California power plants, based on air district permit information from 2001.*

[2] *California Air Resources Board, spreadsheet on greenhouse gas emissions from power plants for 2005, based on Energy Information Administration data.*

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[18] *U.S. Department of Energy, National Energy Technology Laboratory, "Cost and Performance Baseline for Fossil Energy Plants," Volume I, DOE/NETL-2007/1281, May 2007.*

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #	*B27*
ID NUMBER:	*EJAC-28*
TITLE:	*PROHIBIT FUEL OIL BURNING IN PRE-1980 POWER PLANTS GENERATING AT LEAST 100 MW*
PROPONENT:	*ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE*

2. Staff Recommendation

This measure is recommended for evaluation in the Scoping Plan which will be developed as a draft by mid-2008 and must be considered by the Board prior to January 1, 2009. Evaluation as part of the Scoping Plan provides the most effective approach for fully considering the recommendation.

ARB staff determined that the greenhouse gas reduction potential of this strategy is low. All power plants in California built prior to 1980 and rated at 100 MW or more with oil-firing capability utilize fuel oil only for backup purposes. There is one small plant on Catalina Island rated at 9.3 MW that uses diesel as the primary fuel.

3. Early Action Description

This strategy proposes that the ARB develop a regulation to prohibit the burning of fuel oil at power plants that generate at least 100 MW and were built prior to 1980. ARB staff determined there are no power plants of 100 MW or more in California that were constructed before 1980 and that burn fuel oil as the primary fuel. There are, however, 11 plants greater than 100 MW that are permitted to burn fuel oil as backup. They are located within the jurisdiction of the following air districts: Imperial, San Diego, South Coast, North Coast, and Bay Area. During 2005, four of these 11 plants used fuel oil for some portion of the year. The combined diesel and residual fuel oil consumption during 2005 emitted an estimated 0.068 million metric tons of CO_2-equivalent (MMTCO2E), or only 0.12 percent of the total CO_2 emissions from all California power plants.

In addition, there are five power plants rated less than 100 MW that utilize fuel oil as the primary fuel. They are located in South Coast, Placer County, and Northern Sierra air districts. Generating units at four of the five plants have been retired; only the Pebbly Beach Generating Station on Catalina Island remains operational.

The longevity of four of the 11 power plants may be affected by proposed State Water Resources Board policy pertaining to coastal power plants that have once-through cooling. Once-through cooling draws sea water into the plant, where it flows through a heat exchanger to cool the steam, and then subsequently returns the heated water back to the source. Sea water is abundant and cold and represents an efficient means of handling plant waste heat. However, once-through cooling may have a deleterious

environmental impact due to the entrainment and impingement of marine life; therefore, the State Water Resources Control Board is currently developing a statewide policy to implement federal Clean Water Act requirements for power plants that utilize once-through cooling. The policy may require retrofit with an alternative cooling system such as wet or dry cooling. These plants may be retired due to the cost to retrofit.

4. Potential Emission Reductions

To determine potential emission reductions, ARB staff looked at the difference in emissions due to use of alternative fossil fuels with a lower carbon profile using 2005 as the baseline and assuming 2010 consumption data will be similar. As stated above, diesel and fuel oil burning in 2005 produced 0.068 MMTCO2E. Replacing fuel oil with liquefied petroleum gas (LPG) would result in a 14 percent reduction (0.010 $MMTCO_2e$) in 2010. To replace with natural gas would result in a 25 percent reduction (0.017 $MMTCO_2e$). Therefore, the emission reduction potential of this strategy is considered to be low.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

The primary cost associated with this strategy is expected to consist of either the cost of lost power when it is needed (i.e., during a gas curtailment) or the price and cost of an alternative fuel, such as LPG, and its associated infrastructure. It is also possible that some of the generating units (e.g., burners) may need to be retrofitted to accommodate a different fuel.

The costs to businesses and consumers for lost power requires more in-depth research and was not determined for purposes of this analysis; however, it is expected to be significant, particularly depending on the frequency, timing, and duration of these events.

With respect to the use of alternative fuels, the cost of an equivalent amount of LPG is less than the combined diesel and fuel oil consumption for 2005. However, without specific plant information, ARB staff cannot determine any additional costs associated with infrastructure and equipment retrofits at this time.

6. Technical Feasibility

Power generating boilers, combustion turbines, and reciprocating engines that operate on a variety of fossil fuels are not new technologies. Some of the generating units in question may already have dual-fuel firing capability and thus the conversion from oil burning to a lower carbon fuel is not expected to require any equipment retrofits. Other units will have to be looked at on a case-by-case basis to determine the feasibility of retrofits such as replacement of burner orifices to accommodate various fuels.

Another factor to consider with respect to feasibility is that facilities may be limited by geography in terms of fuel supply choices. For example, the Pebbly Beach Generating Station is located on Catalina Island just off the coast from Los Angeles and utilizes diesel fuel in their reciprocating engine generators. In addition, some regions have the need for dual-fuel capability due to natural gas curtailments. Adverse weather conditions, particularly in Northern California, during which commercial and industrial

space heating loads are high, can result in natural gas curtailments and spur the need for dual-fuel capability to meet power requirements.

7. Additional Considerations

Some California local air districts have prohibitory rules that apply to power generating units that directly prohibit oil burning after a certain date. Other district rules may indirectly result in the phase out of oil burning through average emission standards that apply to multiple generating units. In order to maximize operation, these power plants would be motivated to switch to cleaner-burning fuels, install emission control technologies, or a combination of both.

8. Division: Stationary Source Division
Staff Lead: Chris Gallenstein
Section Manager: Mike Waugh
Branch Chief: Mike Tollstrup

9. References:

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[4] *California Energy Commission, "Integrated Energy Policy Report," Appendix A: Aging Power Plant Study Group, publication #CEC-100-2005-1007-CMF, November 2005.*

[5] *California Energy Commission, "Inventory of California Greenhouse Gas Emissions and Sinks 1990 to 2004," Staff Final Report, publication #CEC-600-2006-013-SF, December 2006.*

[6] *California Energy Commission, "Resource, Reliability and Environmental Concerns of Aging Power Plant Operations and Retirements," Draft Staff White Paper, publication #100-04-005D, August 13, 2004.*

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[9] *Energy Information Administration, Spot Prices for Crude Oil and Petroleum Products, last updated 7/25/07: http://tonto.eia.doe.gov/dnav/pet/pet_pri_spt_s1_d.htm*

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Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #	B28
ID NUMBER:	*EJAC-30/ARB 1*
TITLE:	*REFINERY METHANE EMISSIONS*
PROPONENT:	*2006 CAT REPORT and STAKEHOLDER SUGGESTION*

2. Staff Recommendation

This measure is recommended for evaluation in the Scoping Plan which will be developed as a draft by mid-2008 and must be considered by the Board prior to January 1, 2009. Evaluation as part of the Scoping Plan provides the most effective approach for fully considering the recommendation.

Currently, there is no reporting system that identifies the sources and quantity of methane emissions from refineries. However, the draft 2004 California GHG inventory lists California petroleum refinery emissions as 30 million metric tons of CO_2 equivalents. Using Air Resources Board (ARB) Emission Inventory Data[1] and ARB refinery speciation profiles it is estimated that refinery methane emissions are 1.4 million metric tons of CO_2 equivalents. Recent refinery studies[2] suggest that the majority of the methane emissions come from crude oil transfer operations, fugitive losses (valves and fittings), flares, cooling towers, and wastewater treatment.

Staff proposes to:

(a) Perform an evaluation to determine sources and magnitude of refinery methane emissions; and

(b) Develop a detailed strategy to define regulatory measures for monitoring and control of methane exemptions granted to refineries. This will include methane control measures for refinery processes currently controlled under non-methane volatile organic compounds emission limits, and for some sources with limited control requirements, e.g., cooling towers, wastewater treatment, and ponds.

3. Early Action Description

Methane is emitted from many refining operations. The major sources of methane emissions are vapor displacement from crude tanks from marine off-loading and refinery desalter emissions. During the refining processes, methane is separated from the crude oil through vacuum or atmospheric distillation. Methane emissions occur when gaseous streams are transported at various points in the refinery. The primary method for

[1] ARB Almanac database

[2] *Phone communication with Don Robinson, ICF Consulting, 7/20/2007. ICF Consulting is performing a methane study for the American Petroleum Institute. The study will determine the GHG emissions for refineries. This analysis will determine CO_2, methane, and N_2O for all U.S. refineries.* Email Communication: Don Robinson DRobinson@icfi.com

controlling methane emissions is the use of combustion devices, i.e., flare. If one excludes marine off-loading and refinery desalter emissions, most if not all refinery methane sources are low energy, i.e., low heating value, vapor streams[3] that cannot be economically recovered.

4. Potential Emission Reductions

The potential emission reductions from this measure are unknown.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

There is no accurate estimate of the costs or the economic impacts. It is expected that the costs, depending on the source, could range from low to high. For new or exempt sources the costs may be high. In contrast, existing non-methane hydrocarbon control systems already control methane emissions by default. The major impact on existing control systems would be to require that methane be included in emission capture or destruction efficiencies.

6. Technical Feasibility

Monitoring and implementation of methane emission control measures is technically feasible. However, many California refineries do not use Best Available Control Technology (BACT) for known methane sources. Use of methane BACT may require additional work for design, local planning approval, and installation. Technology that meets refinery methane BACT has been installed in some California refineries. Use of a catalytic combustion device at the Shell Martinez marine loading terminal is a good example of a methane BACT installation. Mandatory use of BACT for all crude transfer operations and refinery desalter emissions will control most methane emissions by default.

7. Additional Considerations

None

8. Division: Stationary Source Division
Staff Lead: Tim Dunn
Section Manager: John Courtis
Branch Chief: Dean Simeroth

[3] Ernest Orlando Lawrence Berkeley National Laboratory, Environmental Energy Technologies Division, *Profile of the Petroleum Refining Industry of California* (March 2004). The report was supported by the California Energy Commission through the U.S. Department of Energy under Contract No. DE-AC03-76SF00098.

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY#	*B29*
ID NUMBER:	*EJAC 2/CAPCOA-6/ARB 2-3*
TITLE:	*SPECIFICATIONS FOR COMMERCIAL REFRIGERATION*
PROPONENT:	*2006 CAT REPORT, ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE, AND CALIFORNIA AIR POLLUTION CONTROL OFFICERS ASSOCIATION*

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in 4th quarter of 2010.

This timing will allow staff the time necessary to complete inventory research[1], interagency coordination, economic analyses, staff reports, stakeholder workshops, and public hearings to support the necessary regulation(s).

3. Early Action Description

This early action strategy was extracted from the updated Climate Action Team (CAT) work plan entitled "Reducing Direct and Indirect Greenhouse Gas (GHG) Emissions from Stationary Refrigeration and Air Conditioning (RAC) Sources[2]".

The strategy involves regulatory measures to require supermarket leak tightness and advanced design requirements for new systems as well as energy efficiency measures for new and existing systems. Direct and indirect emissions need to be considered together over the lifetime of the RAC equipment, so that choices made to reduce direct emissions (e.g., low-GWP refrigerants or standalone systems) do not adversely impact energy consumption and vice versa.

Based on current technologies, commercially available solutions for leak reduction in retail food systems (which contain more piping, fittings, and valves than other types of systems), can support establishing a 5 percent maximum annual leak rate for new

[1] Inventory work in this area is expected to be complete by late 2008.
[2] Direct GHG emissions refer to the high global warming potential (GWP) emissions of CFCs, HCFCs, and HFCs used as working fluids in RAC systems. Indirect GHG emissions refer to CO2 emissions associated with electricity required to operate the RAC equipment.

systems in 2011 and 2 percent for new systems by 2016[3]. Currently it is estimated that the average leak rate for new systems is approximately 15 percent minimum. The 5 percent maximum annual leak rate by 2011 is based on industry estimates for controlling leaks in centralized direct expansion (DX) systems, which are the predominant systems currently being installed in retail food stores[4]. To reach the proposed 2020 limit of 2 percent for the maximum annual leak rate, it is expected that indirect supermarket refrigeration systems will have to be adopted rather than low-leak or low-charge DX designs or distributed systems.

Additionally, based on commercially available technologies, the following energy efficiency improvements to reduce energy consumption in existing and new retail food stores are proposed: 10 percent reduction in energy usage from the current baseline in 2011 and 30 percent in 2016[5]. These measures will be pursued in coordination with the California Energy Commission (CEC).

The technologies required for leak reduction in retail food systems include the following: sensitive leak detection equipment, fixed leak detection methods, utilizing brazed (welded) joints instead of flanged or threaded (mechanical) joints, compressor vibration reduction, and improved or reduced numbers of Schrader valves. Additionally, owners and operators of retail food systems would be required to adopt general policies to have full accessibility to all refrigerant pipe work.

Technologies involved in advanced-design retail food refrigeration systems include reduced charge DX systems, distributed systems, secondary loop (indirect) systems, and CO_2 systems (indirect, cascade, and trans-critical systems). Advanced retail food refrigeration designs serve to reduce refrigerant charge (which is important in case of ruptures) as well as reducing leaks through shorter lines that employ fewer fittings.

The improvement of energy efficiency of retail food systems includes the following technologies: evaporative condensers, high efficiency compressor designs, floating head pressure controls, heat recovery, ambient or mechanical sub-cooling, variable speed fans/motors, improved heat exchangers, hot gas defrost, adding doors or night curtains to display cases, energy-efficient reach-ins, anti-sweat heater controls, indirect or energy-efficient case lighting.

4. Potential Emission Reductions

Estimated emission reductions of **4.7 $MMTCO_2E$** in 2020 are possible based on a growth rate of 2 percent for new retail food systems in California (from the updated CAT Work Plan); this number only includes reduced leak rate designs for new systems and energy efficiency improvements for new and existing supermarket systems. If closed cases or night curtains are required, further CO_2 reductions are possible.

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[3] This strategy, which could be applied to all RAC systems over a given capacity, basically applies to retail food systems since other "large" systems currently have much lower leak rates than retail food systems, which have baseline leak rates of 15%.

[4] Industry estimates of improvements and target dates were obtained from European studies, and were presented by The Alliance for Responsible Atmospheric Policy (ARAP) in a meeting with ARB on 10/10/06.

[5] Adding doors or night covers to display cases is not included in the energy reduction estimate, and is expected to result in even greater energy benefits if utilized.

The US EPA has indicated that statewide reductions of approximately 6.8 $MMTCO_2E$ in 2020 are possible for various RAC strategies ranging from leak reduction and refrigerant recovery to indirect retail food ammonia systems[6]. Their estimate includes measures, such as mandatory leak repair for existing systems, which ARB is considering separately. Furthermore, the estimate of 4.7 MMTCO2E is a lower bound, as other measures such as mandatory reporting/repair/refrigerant deposit and return, are expected to increase the turnover rate of old systems and lead to further GHG reductions.

5. Estimated Costs/Economic Impacts and the Impacted Sectors/Entities

The estimated cost of the strategies discussed in this evaluation are expected to be on the order of \$10-\$20/$MTCO_2E$ in 2020. Estimates by the US EPA range from a savings of \$3/TCO_2E (for enhanced leak repair and refrigerant recovery) to costs of \$10/$MTCO_2E$ (for installation of an ammonia-based indirect supermarket system). Costs in the updated CAT report were estimated to be \$14/MTCO2E, based on incremental cost differences of 20% between indirect systems and traditional DX systems.

Cost-effectiveness will improve as contractors gain comfort with installation of indirect systems and energy saving devices, and as prices for such devices/system components drop with increased production.

6. Technical Feasibility

Leak reduction technologies were obtained from industry estimates of possible leak tightness improvements. Performance of advanced systems designs has been documented in US EPA, California Energy Commission (CEC), and Oak Ridge National Lab (ORNL) reports.

Information on energy saving technologies were obtained from US Department of Energy (DOE), American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), and US EPA reports, and from presentations given by Charles Zimmerman (Wal-Mart), and Denis Clodic (ARMINES) at ARB's International Symposium On Near-Term Solutions for Climate Change Mitigation in California on March 6, 2007.

All leak reduction and energy efficiency improvement technologies appear to be proven commercially-available technologies; ARAP presented leak reduction technology to ARB based on European experiences with retail food systems, and Wal-Mart has employed advanced design refrigeration systems (secondary loop with heat reclaim) as well as other energy saving measures (LED lighting, closed cases, motion detection for lighting, machine room improvements) with aggressive energy efficiency goals of 25-30 percent reductions in 4 years.

[6] Obtained from subtracting out motor vehicle A/C reductions and distributing the national reductions to California using the 2005 population fraction of approximately 12.2%.

7. Additional Considerations

Given the necessary inventory research, technical complexity and stakeholder input process, staff believes this item could be developed into a regulatory proposal to be considered by the Board by the fourth quarter of 2010.

The affected entities will be owners and operators of retail food (or similar built-up) refrigeration systems, as well as contractors/technicians who install/repair such systems and manufacturers of system components.

A partial list of trade associations possibly impacted, either positively or negatively, by the regulation follows: ARAP (described previously), the Air-Conditioning and Refrigeration Institute (ARI), ASHRAE, North American Technician Excellence (NATE), California Grocers Associations.

Coordination with the US EPA and CEC with respect to developing the regulation is ongoing.

8. Division: Research Division
Staff Lead: Whitney Leeman
Section Manager: Michael Robert
Branch Chief: Richard Corey

9. References

Alliance for Responsible Atmospheric Policy (ARAP)/CARB workshop, 10/06.

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Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #	*B30*
ID NUMBER:	*SCAQMD-1*
TITLE:	*ACCELERATE INTRODUCTION AND DEPLOYMENT OF LIGHT-DUTY VEHICLE (PASSENGER) HYBRID TECHNOLOGY*
PROPONENT:	*SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT*

2. Staff Recommendation

Hybrid technology is an element anticipated to be embedded in additional regulatory measures aimed at further reducing greenhouse gas emissions from new motor vehicles. Thus, this measure is recommended to be considered as part of the analysis for the strategy to strengthen light-duty vehicle standards (B33).

During ARB development of the GHG regulation in response to AB 1493, staff carefully considered the strong benefits of hybrids in reducing CO_2 emissions. One of the hurdles identified to accelerating the introduction of light-duty vehicle hybrid-technology is that hybrid electric powertrains, which include an electric motor, battery pack, power controller and other components are relatively expensive. Accordingly, staff needed to consider the degree of hybridization appropriate and cost effective for the 2009-2016 timeframe. Staff concluded implementation of full hybrid electric vehicles would be premature prior to 2016 but believed that much could be done to prepare the vehicle fleet for incorporation of full hybrids in the meantime.

Accordingly, staff included integrated starter/generator (ISG) components in nearly half of the vehicle technology package combinations that were modeled and subsequently utilized to set the adopted GHG emission standards. This provides the incentive and foundation for vehicle manufacturers to include ISG components into high volume applications, thereby driving down costs of these hybrid systems. Staff concluded that once ISG components were integrated across most of the vehicle fleet, it would be further cost-effective to increase the capability and size of these components to permit cost-effective full hybrids to be developed for deployment in the post 2016 timeframe, i.e., ones that could operate on all electric power and provide plug-in capability, assuming battery development in the meantime progresses favorably to reduce their size and cost and to improve performance and durability.

Staff also identified another hurdle - lead time for incorporating major powertrain changes throughout vehicle manufacturers' product lines. Generally powertrain changes require fairly long lead times due to the need to first develop the new components, integrate them seamlessly into the powertrain, and then test and refine them for optimum performance, reliability and durability. In addition, new machinery for producing such powertrains requires considerable planning, lead time and investment. As a result, staff provided long lead times to enable major powertrain upgrades such as incorporating

hybrid systems into vehicles when manufacturers would be doing major revisions anyway as part of their normal vehicle powertrain life cycle process. This was done to avoid the excessive costs that accompany premature tear up of existing powertrains before their cycle life has expired.

3. Early Action Description

Modify the existing light-duty motor vehicle GHG emissions standards to require greater reductions, thereby forcing vehicle manufacturers to accelerate the introduction and deployment of hybrid technology.

4. Potential Emission Reductions

The currently adopted standards call for about a 30 percent reduction by 2016. Assuming that the new standards would call for about a 50 percent reduction, phased-in beginning in 2017, this measure would achieve about a 4 MMT reduction in 2020. The reduction achieved by this measure would significantly increase in subsequent years as clean new vehicles replace older vehicles in the fleet – staff estimates a 2030 reduction of about 27 MMT.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

Since the technology is at an early stage of development, it is premature to estimate costs and economic impacts.

6. Technical Feasibility

While this measure is technically feasible, for the reasons stated above staff does not believe it would be cost-effective prior to 2017.

7. Additional Considerations

Hybrid technology needs further development and cost reduction if it is to be accepted by large numbers of consumers.

8.

Division:	Mobile Source Control Division
Staff Lead:	TBD
Section Manager:	Tony Andreoni
Branch Chief:	Analisa Bevan

9. References:

Initial Statement of Reasons for Proposed Rulemaking, Public Hearing to Consider Adoption of Regulations to Control Greenhouse Gas Emissions from Motor Vehicles.

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #	*B31*
ID NUMBER:	*SCAQMD-2*
TITLE:	*NATURAL GAS REQUIREMENT OF 1360 WOBBE INDEX*
PROPONENT:	*SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT*

2. Staff Recommendation

Staff is aware that there are several outstanding issues related to establishing a statewide Wobbe Index standard and the relationship of Wobbe Index and GHG emissions. Thus, staff recommends that ARB continue to coordinate with the SCAQMD to further evaluate the appropriateness of a statewide natural gas Wobbe Index specification.

3. Early Action Description

Establishing a statewide natural gas specification of 1360 Wobbe Index would ensure that California's historical average Wobbe Index level would be maintained. California imports about 85 percent of its natural gas supplies via the interstate pipeline; this gas historically meets a 1360 Wobbe Index. However, sources of high Wobbe Index gas, which includes California gas production and potential imported gas derived from liquefied natural gas (LNG), could significantly increase the Wobbe Index of natural gas in Southern California.

Preliminary information indicates that, in general, natural gas inherently meeting a Wobbe Index of 1360 at production has a lower GHG emissions potential than natural gas inherently meeting a Wobbe Index greater that 1360. This is also true for natural gas that has been processed for natural gas liquids (NGLs) extraction to reduce the level of a high Wobbe Index gas to a lower level. In these cases, the methane content (higher hydrogen to carbon ratio) is greater in natural gas natural gas meeting a lower Wobbe Index than natural gas meeting a higher Wobbe Index. However, reducing the Wobbe Index of natural gas by inerts injection (e.g. nitrogen), would likely result in no or minimal GHG benefits since the dilution effect does not change the GHG potential on an energy (BTU) basis.

Recent action by the California State Lands Commission on the North Baja Pipeline Expansion project recognized the significance of introducing high Wobbe Index gas into California. Although the Commission approved the project, the Commission conditioned the approval by requiring the project proponent to monitor the Wobbe Index level of the gas being brought into California from the project and to mitigate possible NOx increases that could result from the use of that gas.

By establishing a natural gas specification of 1360 Wobbe Index, all gas would have to meet this standard, therefore maintaining the historical average Wobbe Index level. However, depending on the strategies used to meet this specification, GHG emission reductions may or may not be significant.

This strategy would be regulatory and affect the natural gas production and supply sectors.

4. Potential Emission Reductions

The GHG emissions benefit of this strategy is associated with the potential to avoid GHG emissions that may result from increasing the natural gas Wobbe Index above historical average levels. As discussed, the GHG emissions benefit associated with this strategy is highly dependent on the strategies used to meet a 1360 Wobbe Index specification. If natural gas liquids extraction is applied to natural gas to reduce the level of Wobbe Index to meet proposed specification, then there is a likely GHG benefit of about 1.5 percent going from a Wobbe Index of 1385 to 1360. If inerts injection were used, there would be zero to minimal GHG emissions benefit.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

The cost of this strategy has not been specifically evaluated. However, rough estimates may be applicable from prior evaluations of natural gas treatment options which include NGLs extraction and inerts (e.g. nitrogen) injection. NGLs extraction can range as low as $0.04 per million BTU of gas processed and ranges from $0.24 to $0.42 per million BTU of gas processed when considering added storage and distribution infrastructure. Also, when considering inerts injection, this option ranges from $0.05 to $0.10 per million BTU of gas processed.

The natural gas industry and rate payers would be affected.

6. Technical Feasibility

Establishing a natural gas specification of 1360 Wobbe Index is technically feasible. Technology to treat natural gas to reduce the Wobbe Index is well proven but the degree of treatment is economically driven depending on the source of natural gas production and the market where the natural gas is to be sold.

7. Additional Considerations

The California Public Utilities Commission (CPUC) previously held rulemaking to establish a natural gas pipeline specification for Wobbe Index. After considering comments including a recommendation to establish a Wobbe Index of 1360, the CPUC approved a natural gas specification of 1385 Wobbe to ensure adequate supplies of natural gas. The CPUC at that time did not consider the impact of GHG emissions in their decision.

As mentioned, the jurisdiction of establishing a statewide natural gas pipeline specification for Wobbe Index needs to be clarified. Obviously, the CPUC has historical authority to regulate natural gas quality. However, under AB32, the authority to regulate

natural from a GHG perspective suggests that other agencies such as ARB now have some aspects of regulatory authority.

Currently, proposed SCAQMD -2 is not a Climate Action Team strategy.

Proposed SCAQMD-2 would be a regulatory item. Given the regulatory and technical issues that need to be addressed, development of this strategy would exceed 18 months. Further complications in developing this strategy are tied to efforts to address natural gas interchangeability. There are ongoing interchangeability test programs being sponsored by the California Energy Commission that are evaluating the effects of natural gas variability on the performance, durability, and emissions of stationary and mobile combustion equipment. Limited data indicates that certain combustion equipment can be adversely impacted as the Wobbe Index of natural gas increases resulting in increased criteria pollutants. These test programs will provide the technical basis for establishing a statewide natural gas interchangeability specification. These programs are scheduled to be completed within the next 12 to 18 months.

8. Division: Stationary Source Division
Staff Lead: Jim Guthrie
Section Manager: Gary Yee
Branch Chief: Dean Simeroth

9. References:

- *CPUC Order to Institute Rulemaking R.04-01-025*
- *CEC Public Interest Energy Research (PIER) program on natural gas interchangeability*
- *Decision of the California State Lands Commission on the North Baja Pipeline Expansion Project, July 13, 2007.*

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #	*B32*
ID NUMBER:	*SCAQMD-3/ARB 2-9*
TITLE:	*LIGHT COLORED PAVING, COOL ROOFS, AND SHADE TREES*
PROPONENT:	*SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT*

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, it is recommended that this measure remain as an early action item. The Board date for consideration of this item is anticipated in 3rd quarter of 2008.

A non-regulatory strategy (guidance) for further action by businesses, developers, and/or individuals to reduce GHG emissions remains an early action as approved by the Board at its June 2007 hearing. In coordination with the California Energy Commission and the Lawrence Berkeley National Lab (LBNL), staff will develop research and real-world experience-based guidelines on actions that could be taken, documenting options, costs, and benefits. We would draw from local, national, and international experience. The guidelines would be neither a complete nor a necessarily suitable recommendation for every community, but rather a foundation or menu of options applicable to a broad range of communities. The development of the guidance may reveal the need for supplemental tools (e.g., calculators, sector targeted guidelines). Guidelines will be developed in close collaboration with business, community, and environmental stakeholders to ensure that the approach is as effective as possible.

3. Early Action Description

We recommend a non-regulatory voluntary program with a set of guidelines to be adopted to foster the establishment or transition to cool communities in California. The affected economic sector is the construction industry. Many of the technologies are already well established. Below is a brief description of the strategies expected to be addressed in the guidelines.

Cool Roofs

Cool roof programs as part of the Building Energy Efficiency standards (Title 24) which can save as much as 15 percent of cooling energy use during hot months of the year. Such a program has already been proposed (Hebert, 2005). Confined to a residential cool community program, the per-house cost premium is estimated at about $500 (Professor Akbari).

Cool Pavements

Pomerantz (1999) suggests that for the urban area of Los Angeles (10,000 km^2 and 1,250 km^2 paved), a change to cool pavements can result in reduction of ambient

temperature by 0.6℃ (1℉). This reduction is esti mated to result in ozone avoidance benefits of $75 million ($228 million extrapolated to California) and energy conservation benefits of $15 million per year. In 1990, California had 410,000 km^2 in total area with 28 urbanized areas with a total of 15,624 km^2 (5,091 km^2 in Los Angeles). By 1999, the urban area of the state may have reached 30,689 km^2 and the total paved area may have been 3,836 km^2 (3800 km^2 available for cool pavement retrofit).

It is estimated that a cool pavements program would require a premium price of $0.5 per square yard as there are additional costs associated with painting the surfaces. Manville and Shoup (2005) identified the fraction of paved area devoted to parking as 24% for the Los Angeles business district, leaving 76% of paved area for the cool pavement program; this is to keep separate the cool pavement and the parking shade program.

Shade Trees and Urban Forest

The Tree Benefit Estimator reports that a mature tree system would save about 700 kWh of energy (1,100 kg of CO_2 per household) (http://www.appanet.org/treeben/calculate.asp). Mature trees can cost as much as $300 per tree or $1200 for 4 trees surrounding a residence.

Taha et al. (2000) reported ("Three Cities,") an ambient temperature reduction of 1.2K to 1.6K for a heavily vegetated scenario; Scott et al. (1999) reported increased parking lot shade reductions of 5℃ to 7℃ (2,592 m^2 shaded area covered by 23 mature trees) while the City of Sacramento guidelines recommend 22 trees providing 776 m^2 of shade. Manville and Shoup (2005) identified 24 percent of the paved area of Los Angeles central business district (LACBD) devoted to parking. Following that same logic and using Scott et al. nearly 8 million mature trees would be needed to offer complete shade to every parking lot in California. For Sacramento, 486 mW peak power (and 92,000 $MTCO_2$ emissions) may be avoided (Taha et al.).

4. Potential Emission Reductions

As the proposed strategy consists of voluntary guidance, estimating the emission reductions is a function of the actual strategies employed as well as the magnitude of adoption. As such, potential emission reduction estimates are to be determined as part of the development of the guidelines.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

Developing effective guidelines will also increase energy independence, reduce peak energy that is quite often highly polluting, have air pollution benefits through reductions in precursors to ozone and particulate matter, and offer impetus to gentrification and increases in real estate values (Thériault et al. (2005)). Application of the guidance would likely increase construction costs in California. Rise of a new California-specific construction sector would however be a significant boon to our economy. Small businesses have the flexibility of becoming a part of this new expertise construction sector. Environmental justice communities would benefit from gentrification and increases in real estate value. Significant funding from point sources, local and state governments, and the public sector could be expected.

6. Technical Feasibility

Cool roofs are already a part of Title 24, and urban forestry has long been recognized a key to energy conservation and urban gentrification, thus, these technologies are feasible and proven.

7. Additional Considerations

Affected Entities: Construction permit jurisdictions, state and local governments, construction industry

Trade Associations: Construction industry associations

Government Agencies to coordinate with: California Energy Commission & LBNL

8. Division: Research Division
Staff Lead: Ash Lashgari
Section Manager: Eileen McCauley
Branch Chief: TBD

9. References

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Hebert, Elaine (2005), "Cool Roofs in California's Title 24 2005 Building Energy Efficiency Code," California Energy Commission, Presentation http://www.buildingmedia.com/calbo/sg/PlanReview.pdf.

Langford, S & Williams, K (2007), "The State of Housing, HCD Director Lynn Jacobs Outlines California's Housing Shortage — and How to Fix It — In 2007," California Builder, Official Publication of California Building Industry Association, April. http://www.californiabuildermagazine.com/internal.asp?pid=325&spid=

Manville, M. & D. Shoup (2005), "Parking, People, and Cities," Journal of Urban Planning & Development, ASCE, pp. 233-244, December.

Pomerantz, Melvin (1999), "Benefits of Cooler Pavements," Lawrence Berkeley National Laboratory, posted presentation http://eetd.lbl.gov/HeatIsland/Pavements/Overview/index.html

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Taha, H., Chang, S-C, & Akbari, H. (2000), "Meteorological and Air Quality Impacts of Heat Island Mitigation Measures in Three U.S. Cities," Lawrence Berkeley National Lab Report No. 44222, April.

Thériault, M. Yan Kestens and François Des Rosiers (2005), "The impact of mature trees on house values and on residential location choices in Quebec City,"
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http://www.census.gov/acs/www/Products/Profiles/Single/2003/ACS/Tabular/040/04000US063.htm

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #	*B33*
ID NUMBER:	*SCAQMD-4*
TITLE:	*STRENGTHEN LIGHT-DUTY VEHCILE STANDARDS*
PROPONENT:	*SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT*

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in 4th quarter of 2012.

In September 2004 the California Air Resources Board approved regulations to reduce greenhouse gas emissions from new motor vehicles. The regulations apply to new passenger vehicles and light duty trucks beginning with the 2009 model year. The standards adopted by the Board phase in during the 2009 through 2016 model years. When fully phased in, the near term (2009-2012) standards will result in about a 22 percent reduction as compared to the 2002 fleet, and the mid-term (2013-2016) standards will result in about a 30 percent reduction.

The proposed strategy is the second phase of the 2004 regulation. This timing of 2012 will allow staff the time necessary to complete inventory research, interagency coordination, economic analyses, staff reports, stakeholder workshops, and public hearings to support the necessary regulation(s).

3. Early Action Description

Adopt new standards to phase in beginning in the 2017 model year (following up on the existing mid-term standards that reach maximum stringency in 2016). The technologies that might be employed include highly efficient hybrid vehicles, use of lightweight materials to reduce vehicle mass, and reductions in air conditioning related emissions through the use of cool paints, low-GWP refrigerants, or other approaches.

4. Potential Emission Reductions

The currently adopted standards call for about a 30 percent reduction of GHGs by 2016. Assuming that the new standards call for about a 50 percent reduction, phased in beginning in 2017, this measure would achieve about a 4 MMT reduction in 2020. The reduction achieved by this measure would significantly increase in subsequent years as clean new vehicles replace older vehicles in the fleet—staff estimates a 2030 reduction of about 27 MMT.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

Not yet determined.

6. Technical Feasibility

The technologies involved in this strategy are either being proved or showing promising technical feasible. For example, available technologies that could be widely used on light-duty vehicles by 2012 include:

- Variable valve timing & lift
- Cylinder de-activation
- Gasoline direct injection - stoichiometric
- Turbocharging or cylinder deactivation
- 6-speed automatic and automated manual transmission
- Electric power steering
- Improved alternator
- More efficient, low-leak air conditioning
- Improved aerodynamics
- E85 vehicles

Additional technologies that could be widely used by 2016

- Extensive use of E85 vehicles
- Homogenous Combustion Compression Ignition (HCCI)
- Integrated Starter Generators (ISG)
- Camless Valve Actuation (CVA)
- Diesels
- Hybrids

7. Additional Considerations

In the near term, staff will continue to evaluate emerging technologies that have the potential to provide additional greenhouse gas reductions. Some technologies discussed under this subject can be implemented via separated early actions. Please refer to this report for detailed discussion.

8. Division: Mobile Source Control Division
Staff Lead: TBD
Section Manager: TBD
Branch Chief: TBD

9. References:

Work Plan for Potential GHG Reduction Measure, Air Resources Board 2-1.

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #	*B34*
ID NUMBER:	*SCAQMD-5*
TITLE:	*OFF HIGHWAY RECREATIONAL VEHICLE (OHRV) EVAPORATIVE EMISSIONS CONTROL*
PROPONENT:	*2007 STATE IMPLEMENTATION PLAN AND SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT*

2. Staff Recommendation

Staff recommends that this measure not be listed as an early action. Staff is aware of the potential climate benefit from hydrocarbon emission reductions, but additional developments are needed to address remaining scientific uncertainties regarding their climate impacts. Staff recommends that ARB continue to track the subject and further evaluation be conducted as appropriate. The strategy will remain on track for its air quality benefits.

3. Early Action Description

The OHRV category includes off highway motorcycles, ATVs, sand cars, and specialty vehicles. The OHRV evaporative emissions regulation will control primarily hydrocarbon emissions. Hydrocarbons are ozone precursors and ozone is a greenhouse gas. OHRVs will use proven automotive control technology including:

- Low Permeation Fuel Lines
- Low Permeation Fuel Tanks
- Carbon Canisters
- Fuel Injection

Additionally ARB will evaluate two implementation approaches:

1. A performance standard that will require equipment to be tested and meet a certain emission standard.
2. A design standard that will require equipment to use certified components. Each component must be tested and meet a certain emission standard.

4. Potential Emission Reduction

The OHRV regulation is expected to be implemented in 2012. When fully implemented in 2020, hydrocarbons are projected to be reduced by 11.3 TPD[1,2]. A reduction of hydrocarbon emissions will lead to a reduction in ozone. However, currently there is no model that projects the CO_2-equivalent warming impact for hydrocarbon emissions.

5. Estimated Cost / Economic Impacts and Impacted Sectors / Entities

An initial staff estimate of the increased cost to consumers to purchase an OHRV with evaporative controls is $350. It is expected that OHRV manufacturers will pass the cost of the regulation onto the OHRV consumer. When fully implemented in 2020 the total cost will be $588 million[3]. OHRV dealers may be adversely affected by an increase in equipment price of OHRVs.

6. Technical Feasibility

Potential technology that will control hydrocarbon emissions from OHRVs includes low permeation fuel tanks, low permeation fuel lines, carbon canisters, and fuel injection. These types of control technology have been proven on on-road vehicles for over 25 years. Recently evaporative controls have also been required on off-road categories such as land and garden equipment.

7. Additional Considerations

Currently ARB has aligned its regulatory approach with a U.S. EPA regulation that sets permeation standards for fuel tanks and fuel lines. However, ARB's OHRV regulatory initiative will evaluate the stringency of those standards to see if they can be tightened. ARB will also seek emission reductions from other sources within the category such as carburetors and running losses.

8. Division: Monitoring and Laboratory Division
Staff Lead: Pippin Mader
Section Manager: James Watson
Branch Chief: Manjit Ahuja

9. References

[1] Full implementation assumed at 95%

[2] All emission calculations based on ARB's Off-road 2007 Model and 75% control

[3] Controlled population of~1.68 million in 2020 times $350

2. Early Actions Strategy Name and Proponent

SUMMARY #	*B35*
ID NUMBER:	*SCAQMD-5*
TITLE:	*DETERMINATION OF EVAPORATIVE EMISSIONS FROM PLEASURE CRAFT*
PROPONENT:	*2007 STATE IMPLEMENTATION PLAN AND SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT*

2. Staff Recommendation

Staff recommends that this measure not be listed as an early action. Staff is aware of the potential climate benefit from hydrocarbon emission reductions, but additional developments are needed to address remaining scientific uncertainties regarding their climate impacts. Staff recommends that ARB continue to track the subject and further evaluation be conducted as appropriate. The strategy will remain on track for its air quality benefits.

3. Early Action Description.

The Pleasure Craft category includes inboard, outboard, sterndrive, and personal watercraft. The Pleasure Craft evaporative emissions control regulation will reduce hydrocarbon emissions. Hydrocarbons are ozone precursors and ozone is a greenhouse gas. Pleasure Craft will use proven automotive control technology including:

- Low Permeation Fuel Lines
- Low Permeation Fuel Tanks
- Carbon Canisters
- Fuel Injection

4. Potential Emission Reduction

The Pleasure Craft regulation is expected to be implemented in 2012. Hydrocarbon emissions are projected to be reduced by 16 TPD in 2012. When fully implemented in 2035[1,2], hydrocarbons are projected to be reduced by 53 TPD. However, currently there is no model that projects the CO_2-equivalent warming impact for hydrocarbon emissions.

5. Estimated Cost / Economic Impacts and Impacted Sectors / Entities

An initial staff estimate of the increased cost to consumers to purchase a boat with an evaporative control system is $350[3]. The estimated increased cost is minimal when

compared to the current cost of a new boat. When partially implemented in 2020, the cost to consumers is projected to be $310 million. When fully implemented in 2035 the total cost to consumers is estimated at $1.13 billion[4]. There is no foreseeable adverse impact on any businesses or individuals.

6. Technical Feasibility

Potential control technology that will reduce hydrocarbon emissions from Pleasure Craft includes low permeation fuel tanks, low permeation fuel lines, carbon canisters, and fuel injection. These types of control technology have been proven on on-road vehicles for over 25 years. Recently evaporative controls have also been required on off-road categories such as land and garden equipment. Furthermore, a 2005 in-use study of Pleasure Craft retrofitted with carbon canisters conducted by the National Marine Manufacturers Association demonstrated technical feasibility for marine applications and lessened boat manufacturer concerns.

7. Additional Considerations

The proposal being developed does not seek to retrofit existing boats with control technology due to cost and safety issues. Because of their lengthy useful life, it may take up to three decades for the inventory of Pleasure Craft to become fully compliant subsequent to implementation of the regulation 2012.

8. Division: Monitoring and Laboratory Division
Staff Lead: Fredrick Burriell
Section Manager: James Watson
Branch Chief: Manjit Ahuja

9. References

[1] Full implementation assumed at 95%

[2] All emission calculations based on ARB's Off-road 2007 Model and 70% control reduction

[3] Cost estimates based on a per vehicle control technology cost of $350

[4] Controlled population of ~3.22 million in 2035 times $350.

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY # *B36*
ID NUMBER: *EA 3-3*
TITLE: *VESSEL SPEED REDUCTION*
PROPONENT: *AIR RESOURCES BOARD*

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. At this time, staff is evaluating whether this is most appropriately managed as a regulatory item or a voluntary measure.

The staff recommends retaining the vessel speed reduction (VSR) measure as an early action for the following reasons:

- the need to gather additional information on the scope, emissions impact, cost, and environmental impacts of the measure; and
- the need for stakeholder input on whether a voluntary or regulatory approach should be taken.

Based on preliminary emissions estimates, the overall weight of evidence suggests that this measure would fall under the medium category for regulatory action (see subsection 4 for emission benefits).

3. Action Description

As part of our efforts under the Diesel Risk Reduction Plan, Goods Movement Emissions Reduction Plan, and Assembly Bill 32 - Greenhouse Gas Initiative, the Air Resources Board (ARB) staff is evaluating the need to develop an ocean-going VSR program. Ocean-going VSR is primarily a measure designed to reduce oxides of nitrogen (NOx) emissions, but also provides reductions in diesel PM emissions, oxides of sulfur (SOx) emissions, and carbon dioxide (CO_2) emissions.

Over the past six years, a VSR program has been in place at the Port of Los Angeles and Port of Long Beach (POLA/POLB). The program requests that vessels reduce their speed to 12 knots beginning 20 nautical miles (nm) off shore from the POLA/POLB. Currently, the POLB maintains a Green Flag Program which is an incentive program that offers reduced dockage fees for those vessels in compliance with VSR. The compliance rate for the POLB Green Flag Program is about 80 percent.

ARB staff has begun a technical assessment of the impacts associated with VSR for ocean-going vessels. As part of the technical assessment, staff will be evaluating

emission reduction benefits of a VSR measure in and out of California ports and along the California coast within 24 nm, 40 nm, and 100 nm.

The staff assessment is in its very early stages. ARB staff held its first VSR workshop on July 12, 2007. At this workshop, ARB staff presented an overview of their activities related to the VSR assessment and shared some key elements needing industry's assistance. To conduct a full evaluation, ARB staff is in need of additional data to refine our emissions inventory, such as emission factors, speed data from ports other than POLA/POLB, as well as, an understanding of the operating cost impacts to the industry. ARB staff expects to release a draft technical assessment report with the results of their evaluation by the end of 2007. The evaluation in this report will be key to determining the need and best approach to implement a regulatory or a voluntary VSR measure.

4. Potential Emission Reductions

VSR is primarily a measure designed to reduce NOx emissions, but also provides reductions in diesel PM emissions, SOx emissions, and CO_2 emissions. ARB staff has estimated the potential emissions reductions as a result of implementing a statewide VSR program within 24 nm and 100 nm of the California coastline. This preliminary assessment is based on the emissions benefits estimated using emissions factors from the use of low sulfur (0.1%) marine distillate in marine main and auxiliary engines and 2006 port call data from the California State Lands Commission. Our preliminary assessment suggests that the implementation of VSR reduces pollutants such as NOx, diesel PM, and SOx by an average of 30 percent within 24 nm of the California coast. In addition to these criteria pollutant emission reduction benefits, if a VSR program is implemented at 24 nm, the potential CO_2 emission reductions in 2010 are estimated to be 0.62 million metric tons of CO_2 ($MMTCO_2$) and increasing to 0.97 $MMTCO_2$ by 2020. If a VSR measure was implemented at a distance of 100 nm, then the additional CO_2 emission reductions in 2010 are estimated to be approximately 0.5 $MMTCO_2$ and in 2020 approximately 0.83 $MMTCO_2$. These estimates exclude the emissions benefits already achieved by the POLA/POLB at a compliance rate of about 80 percent.

A VSR program at other ports, such as San Diego and Hueneme, may also provide emissions benefits, and to a lesser extent, San Francisco Bay Area ports. It is questionable whether a coastline VSR measure will achieve significant emission benefits.

The CO_2 emission reduction potential rating for a VSR measure within 24 nm of the California coast is estimated to be in the medium (>0.1 to 1.0 $MMTCO_2$) category.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

The estimated costs and economic impacts of a regulatory or voluntary VSR measure have not been evaluated. A cost impact analysis for either a regulatory or voluntary VSR measure would need to include an estimate of the increase in the cost of operation to shipping companies due to reducing speeds in and out of California ports and along the coastline, increase cost of fuel used in auxiliary engines due to increased time traveling to port versus the fuel savings due to decreased ship engine power requirements, costs borne by the industries/terminals affected by a VSR measure, costs to ports in developing infrastructure improvements (i.e., radar equipment), and costs needed for enforcing any speed reduction measure. In addition to the POLA/POLB, staff is currently evaluating other major ports such as those in the Bay Area, San Diego, and

Hueneme. Staff is also looking at the impact to the industry if VSR was implemented while transiting along the California coastline within 24 nm and 100 nm.

Voluntary measures, such as seen in the POLB Green Flag Incentive Program, may require port and terminal-specific costs. Some of the incentives of this program include reduced dock fees for those complying with the VSR program and tariff reduction incentives. The San Pedro Bay Clean Air Action Plan adopted in 2006 for the POLA/POLB, have estimated the costs of controls for the voluntary VSR measure to be approximately 4.4 million dollars for 2010. The POLA/POLB has already committed to fund a maximum of 11.3 million dollars through 2010/2011 for each port to implement the port's Clean Air Action Plan.

6. Technical Feasibility

A voluntary VSR program has been in place at the POLA/POLB over the past six years. The POLA/POLB accounts for over half of the port calls statewide. This VSR program requested ships to voluntarily reduce their speed to 12 knots at a distance of 20 nm from the California coast. Currently, the POLB maintains the Green Flag Incentive Program which offers reduced dockage fees and environmental awards for vessels that voluntarily reduce their speeds in and out of the POLB. This program has been very successful as shown by its current 80 percent compliance rate. A VSR program is clearly technologically feasible. However, reducing speeds for an extended period of time transiting along the coast has not been evaluated. There is some information that maintaining a slower speed for extended distances may cause adverse mechanical effects on a vessel's main engine. This analysis will need further evaluation.

7. Additional Considerations

- With the exception of the voluntary programs at the POLA/POLB, no federal or other state VSR regulations are currently in place.
- VSR activity falls under ARB jurisdiction and legal authority. ARB's authority to regulate emissions beyond 3 nm is being challenged in court. Significant legal challenges are likely if the ARB elects to implement a VSR regulation beyond 24 nm.
- At this time, we are evaluating the feasibility of both regulatory and voluntary measures. Both approaches will consider speed reductions from direct travel in and out of major ports and evaluate the inclusion of transiting up and down the California coast. Voluntary approaches can include agreements or incentive programs between port and terminal operators, vessel owners and operators, and government agencies. Regulatory measures would take the form of an airborne toxic control measure.

8. Division: Stationary Source Division
Staff Lead: Hafizur Chowdhury
Section Manager: Robert Krieger
Branch Chief: Dan Donohoue

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #	*B37*
ID NUMBER:	*ENVIRO-2*
TITLE:	*ANTI-IDLING ENFORCEMENT*
PROPONENT:	*ENVIRONMENTAL STAKEHOLDERS*

2. Staff Recommendation

This measure is recommended for addition to the list of early actions. The Board date for consideration of this non-regulatory item would be the 4th quarter of 2008.

This strategy will ensure that climate change benefits are realized from an existing anti-idling rule. It is believed that the 0.7 million metric tons per year CO_2 reduction listed in the 2005 staff report for the anti-idling rule have not yet been claimed.

Summary: Restricting vehicle idling (in this case, heavy-duty commercial diesel vehicles) reduces the amount of fuel burned which in turn, causes fewer emissions of greenhouse gases. Staff recommends that this measure become an early action item for the following reasons:

1) An anti-idling regulation is currently in place;
2) An enhanced version of the current anti-idling regulation is slated to commence enforcement on January 1, 2008; and
3) Proposed legislation (Assembly Bill [AB] 233, Jones), if adopted, would authorize and require ARB to further enhance its enforcement of the anti-idling regulation. This bill calls for an enhanced enforcement plan to be adopted by the Board by January 1, 2009.

If this bill is not enacted, staff could include enforcement enhancements through a Board action directed at reviewing and amending the current anti-idling regulation (with Board hearing no sooner than 2011).

3. Early Action Description

The burning of diesel fuel contributes to greenhouse gas emissions. This strategy will reduce greenhouse gases by reducing the amount of fuel burned through unnecessary idling. AB 233 calls for adoption of an enhanced enforcement plan that would be heard by the Board as a non-regulatory item.

1) ARB adopted a diesel particulate air toxic control measure (Title 13 of the California Code of Regulations, Section 2485) in June 2004 to control idling of diesel-fueled commercial motor vehicles. Enforcement commenced the following year. This rule prohibits, with some exceptions, the idling of diesel-fueled commercial motor vehicles for more than five minutes, and applies to both trucks and buses greater than 10,000 lbs. gross vehicle weight. The measure also

prohibits operation of a diesel-fueled auxiliary power system for more than five minutes within 100 feet of individual or multi-family housing units. The penalty for violating the idling regulation is currently a minimum of $100.

2) In October 2005, the Board approved an additional regulatory measure that eliminated the exemption for new and in-use trucks with sleeper berths starting in January 2008, thus requiring sleeper berth trucks to shut down and use alternative cab climate control technologies. In addition, the Board approved an amendment requiring that all new California-certified 2008 and subsequent model year heavy duty diesel engines be equipped with a non-programmable engine shutdown system that automatically turns off the engine after five minutes of idling. Enforcement of these provisions will begin in 2008.

3) AB 233, Jones, currently pending approval by the California Legislature, calls for:

   a) Enhanced field enforcement of anti-idling and other ARB regulations. AB 233 would require ARB to review existing enforcement regulations and adopt a plan for enhanced and coordinated enforcement of these regulations by January 1, 2009. Implementation of the plan would address staffing needs, goals for inspection efforts, education and training. Increases in field enforcement would flush out additional violators and give them fewer opportunities to disobey the regulation.

   b) Increased penalties for violations of anti-idling regulations. It is assumed that increasing the penalty from $100 to $300 per violation will increase the deterrent effect, resulting in improved compliance.

   c) Restriction on registrations of heavy-duty diesel vehicles with uncorrected idling violations. This would serve as an additional enforcement tool to encourage compliance.

4. Potential Emission Reductions

The emission numbers in the tables below do not represent an additional benefit due to enhanced enforcement. Rather, the numbers show the benefits of 100% compliance with the existing anti-idling rule. Enhanced enforcement is necessary in order to achieve a high compliance rate.

The elimination of non-essential diesel fueled vehicle idling reduces greenhouse gases as reported in ARB's anti-idling program staff reports. According to ARB's Initial Statement of Reasons for Proposed Rulemaking dated September 2005, the proposed sleeper berth anti-idling regulation amendments alone will reduce CO_2 emissions by nearly 1,751 metric tons per day (MTPD) and 0.6 million metric tons per year (MTPY) in 2010, and 2,068 MTPD and 0.7 million MTPY in 2020. (See www.arb.ca.gov/regact/hdvidle/isor.pdf, page 46). Enhanced enforcement of these anti-idling regulations will reduce greenhouse gas emissions by ensuring that the intended benefit of 0.7 million MTPY is fully realized by 2020.

The tables below provide the estimated statewide emissions benefits projected in metric tons per year for the currently enforced anti-idling regulation and the sleeper berth exemption amendments to these regulations. However, these benefits assume 100% compliance. History has shown that no program achieves 100% compliance and that enhanced enforcement does lead to higher compliance rates. Based on a relatively small

sample of idling inspections, the current program's rate of compliance is approximately 95%. However, given the limited number of idling inspections (due to resource constraints), it is assumed that this is not representative of statewide compliance rates.

Estimated Statewide Idling Emission Benefits - Non-Sleeper Trucks (Metric Tons/Year) – Beginning in 2005

	PM	NO_X	HC	CO	CO_2
CA Registered	151	4717	671	2631	312,344

Source: ARB's Initial Statement of Reasons for Proposed Rulemaking, July 22, 2004.

2010 Estimated Statewide Idling Emission Benefits – Sleeper Trucks Only

Baseline Emissions (Metric Tons/Year) Calendar Year 2010

	Vehicles	NO_X	ROG	PM	CO_2
CA Registered Sleeper Trucks	30,161	6570	694	128	397,485
Out-of-State Sleeper Trucks	45,241	10,950	840	113	596,045
Total Baseline	75,402	17,520	1533	241	993,530

Emission Reductions (Metric Tons/Year) Calendar Year 2010

	Vehicles	NO_X	ROG	PM	CO_2
CA Registered Sleeper Trucks	30,161	5475	621	88	255,135
Out-of-State Sleeper Trucks	45,241	9490	730	55	383,980
Total Baseline	75,402	15,330	1387	139	639,115

2020 Estimated Statewide Idling Emission Benefits – Sleeper Trucks Only

Baseline Emissions (Metric Tons/Year) Calendar Year 2020

	Vehicles	NO_X	ROG	PM	CO_2
CA Registered Sleeper Trucks	35,652	8760	657	55	470,120
Out-of-State Sleeper Trucks	53,478	12,775	913	26	705,180
Total Baseline	89,130	21,535	1606	81	1.18M

Emission Reductions (Metric Tons/Year) - Calendar Year 2020

	Vehicles	NO_X	ROG	PM	CO_2
CA Registered Sleeper Trucks	35,652	7300	584	26	301,490
Out-of-State Sleeper Trucks	53,478	11,315	876	7.3	453,695
Total Baseline	89,130	18,615	1460	33	754,820

Source: ARB's Initial Statement of Reasons for Proposed Rulemaking, September 1, 2005

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

The current anti-idling regulations provide for savings of approximately $100 million per year in reduced fuel and maintenance costs. The sleeper berth exemption amendments to these regulations provide an additional annual savings of approximately $20 million per year in reduced fuel and maintenance costs. The sleeper berth exemption also is projected to save approximately 70 million gallons of diesel fuel per year.

To comply with the sleeper berth exemption amendments, vehicle owners may spend between $1,000 and $10,500 depending on the type of alternative power selected and the application needed. However, it is expected that vehicle owners will recover their initial investments over time through the fuel and maintenance savings discussed above. Although ARB estimates cost recovery times to range between 8 months and 3 years, actual recovery times will solely depend on the alternative(s) selected and the amount of time spent at idle. Financial incentives may be available for qualified zero-emissions technologies through the Carl Moyer Program.

Costs to State – If enhanced enforcement is to be achieved, additional resources will be necessary to increase enforcement presence.

6. Technical Feasibility

Technologies that will allow vehicle operators to maintain cab comfort while not running the vehicle's main engine are currently available. Some of these technologies are diesel-fueled auxiliary power systems, fuel-fired heaters, battery-electric auxiliary power systems, vehicle-battery-powered systems, truck stop electrification (on-board and off-board power infrastructure), and thermal energy storage systems.

7. Additional Considerations

A number of states have similar laws and some are more stringent than California's current law. However in 2008, California's law will no longer exempt idling of a vehicle's main engine while the operator sleeps in a sleeper berth.

This existing rule can be enforced by ARB staff, as well as by peace officers and air district personnel. This strategy is not a regulatory item. If AB 233 is approved, it calls for ARB to adopt a comprehensive enforcement plan by January 1, 2009.

AB 233 has not yet been approved (as of August 15, 2007).

8. Division: Enforcement Division
Staff Lead: Nancy O'Connor
Section Manager: Judy Lewis
Branch Chief: Paul E. Jacobs

9. References:

Assembly Bill 233 of 2007, Jones.

Senate Transportation & Housing Committee Analysis of AB 233, June 1, 2007.

ARB webpage: http://www.arb.ca.gov/msprog/truck-idling/truck-idling.htm

ARB webpage: http://www.arb.ca.gov/regact/hdvidle/isor.pdf

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #	*B38*
ID NUMBER:	*ARB 4-4*
TITLE:	*SF_6 REDUCTIONS FROM THE NON-ELECTRIC SECTOR*
PROPONENT:	*STAKEHOLDER SUGGESTION*

2. Staff Recommendation

This measure is recommended for addition to the list of discrete early actions. The Board date for consideration of this item is anticipated in 1st quarter of 2009.

The staff recommends developing regulations that ban the use of sulfur hexafluoride (SF_6) for non-electricity sector/semiconductor applications where technologically feasible and cost-effective alternatives are available. As part of the assessment, strategies for achieving voluntary reductions will also be evaluated.

3. Early Action Description

This strategy applies to uses of SF_6 other than the electrical utility industry and the semiconductor industry, which will be evaluated under separate strategies. The largest non-utility industry, non-semiconductor industry uses of SF_6 identified by the staff to date include the magnesium manufacturing and casting operations, air quality tracer studies, and a gas for testing laboratory hoods to ensure worker safety and that Cal-OSHA ventilation requirements are met. Other uses cited include accelerators, leak detection, optical fiber production, glazing, medical, and refining, but the extent of these uses in California is currently unknown. The staff plans to identify all of the uses of SF_6 in California, and the amount used, as part of its evaluation. As part of the regulatory development process, the staff will assess other uses of SF_6, the associated emissions, mitigation options as well as cost to determine whether action is warranted. The U.S. EPA has formed a "Magnesium Industry Partnership" to voluntarily phase-out the use of SF_6 in the magnesium industry by the end of 2010, so a regulation of this industry may be unnecessary. Nationwide, emissions from the magnesium industry are about 2.7 $MMTCO_2E$ per year. There are currently only three companies in California that have magnesium production and casting operations and that are members of the EPA partnership. The SF_6 emissions from these companies are currently unknown. But scaling the nationwide estimated of 2.7 $MMTCO_2E$ per year to California by the number of production facilities gives a California number of about 0.09 $MMTCO_2E$ per year.

The staff envisions banning the use of SF_6 in non-utility, non-semiconductor applications where safe, cost-effective alternatives are available. These applications may include magnesium production and casting operations, air quality tracer gas studies, and ventilation tests for laboratory hoods. The staff will investigate other possible uses of

SF_6 during the development of the regulations. It is important that all uses of SF_6 be investigated and considered given its high GWP, particularly if the application is one in which the compound is deliberately emitted, such as tracer gas applications. One pound of SF_6 emitted is equivalent to about 10 metric tons of carbon dioxide, from a global warming perspective.

4. Potential Emission Reductions

Statewide Emission Inventory

2020 GHG Emission Inventory: It is estimated that, nationwide, about 10 percent of the total SF6 is used in applications other than the utility and semi-conductor industries. It is also estimated that about half of this 10 percent is used in the magnesium industry. The most recent estimate of emissions in California from both electric utilities and semiconductor manufacturing operations is about 1.6 MMTCO2E per year (CEC, 2006). Assuming that the proportion of SF6 emitted to the amount of SF6 used in other applications is the same as that for the utility and semiconductor applications, emissions from the other applications would be about 0.18 MMTCO2E per year in California. Nationwide, SF6 emissions from the magnesium industry are currently about 2.7 MMTCO2E per year. Scaling this number down to the number of production facilities in California gives a California emission estimate of about 0.09 MMTCO2E per year. However, if the U.S. EPA Magnesium Industry Partnership is successful in phasing out the use of SF6 by the end of 2010, the emissions from the magnesium industry will be zero in 2020. This leaves at least 0.09 MMTCO2E per year from other applications such as tracer studies and laboratory hood tests. However, it is likely that emissions from these other applications are somewhat higher than 0.09 MMTCO2E per year due to the fact that the ratio of amount of gas emitted to amount used in these applications is higher than that for utilities. In the utilities, the gas is emitted gradually as it escapes from enclosed systems, while in tracer studies and hood tests it is emitted instantaneously.

Anticipated 2020 Reductions: It is anticipated that all, or nearly all, of the emissions from non-utility, non-semiconductor use would be eliminated under the staff proposal. Therefore, the reductions are estimated to be on the order of 0.1-0.2 MMTCO2E per year.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

Alternative gases have been identified for magnesium production and casting operations, and for laboratory hood tests performed to ensure adequate ventilation rates. The cost and economic impacts of using these gases will be evaluated during the regulatory development process, but the difference in cost would be expected to be modest.

6. Technical Feasibility

As part of the U.S. EPA's Magnesium Industry Partnership, magnesium production and casting operations have been developing the use of gases other than SF_6 to provide the

cover gas protection provided by SF_6. The partnership is attempting to meet the goal of phasing out SF_6 by 2010.

The staff will investigate both the technical and economic feasibility of using alternative gases in air quality tracer studies and laboratory hood tests done to comply with Cal-OSHA ventilation standards. The technical and economic feasibility of using alternative gases will also be evaluated for any other use of SF_6 identified by the staff.

7. Additional Considerations

Some of the factors that will need to be carefully evaluated include determining if there are alternative gases as safe and effective as SF_6 with lower lifecycle GHG emissions. To the extent that alternatives are available, staff would also investigate whether a voluntary measure such as a voluntary phase-out program would be as effective as a regulatory approach.

Affected Entities: Companies that produce magnesium or magnesium castings, air pollution and air quality researchers, universities, industries, and other institutions that have laboratory hoods that are subject to Cal-OSHA standards.

Trade Associations: North American Die Casting Association (DADCA), Compressed Gas Association, Associations which include industrial hygienists. American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE).

Government Agencies to coordinate with: U.S. EPA, Cal-OSHA

Proposed Board Hearing Date: January, 2009

8. Division: Research Division
Staff Lead: Kevin Cleary
Greenhouse Gas Technology and Field Testing
Section Manager: Mike FitzGibbon
Branch Chief: TBD

9. References:

Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2005, United States Environmental Protection Agency, April 15, 2007

Inventory of California Greenhouse Gas Emissions and Sinks: 1990-2004, California Energy Commission, December, 2006

Communications with Cal-OSHA staff (Mike Horowitz)

Nationwide SF_6 Sales by End Use: 1961-2003, Fourth International Conference on SF_6 and the Environment, November, 2006, the Rand Corporation

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #	*B39*
ID NUMBER:	*N/A*
TITLE:	*REDUCTION OF HIGH GWP GHGs USED IN CONSUMER PRODUCTS*
PROPONENT:	*AIR RESOURCES BOARD STAFF*

2. Staff Recommendation

This measure is recommended for addition to the list of discrete early actions. The Board date for consideration of this item is anticipated in 4th quarter of 2008.

Some data regarding emissions of greenhouse gases is available from a recent survey of consumer products, which may represent possible reductions within the discrete early action timeframe. Manufacturers are also currently being surveyed to determine the extent of usage of high global warming potential (GWP) gases in several more categories of consumer products. These future survey results may lead to additional strategies with emission reduction potential that can be pursued after the deadline for discrete early action items.

3. Early Action Description

Consumer product formulations may be modified to reduce or eliminate the use of greenhouse gases with high GWP. Gases of interest include HFCs, HCFCs, HFEs, carbon dioxide, and nitrogen oxides, which are used as propellants in tire inflators, electronics cleaners, dust removal products, hand held sirens, hobby guns (compressed gas), party products (foam string), and other formulated consumer products. The objective of this discrete early action strategy would be to reduce the impact of high GWP GHGs used in these products when alternative formulations are available. For example, one possible form of the strategy would be to require switching when feasible from using a high GWP GHG such as HFC-134a (GWP=1300) to a GHG with a lower GWP such as HFC-152a (GWP=120). The Consumer Products Program is implemented through regulations and this proposed new discrete early action strategy would occur as part of that regulatory process.

4. Potential Emission Reductions

ARB staff estimate a potential emissions reduction of up to 0.25 MMTCO2E from consumer products. ARB is currently surveying consumer product manufacturers for specific information on product ingredients. Categories listed above that may contain high GWP GHGs are included in the survey. The required submission date for the survey is November 21, 2007. Analysis of survey data will provide an accurate estimate of potential emission reductions.

In 2002, A. D. Little reported that the annual North American consumption and emissions of HFCs in consumer products was 10 MMTCO2E with the two highest-use products being dust removal products and tire inflators at 4.7 and 3 MMTCO2E, respectively. California's population is about eight percent of the North American population. Assuming product usage is similar across North America and scaling with population, HFC emissions from consumer products in California are about 0.8 MMTCO2E. This value seems to be confirmed by initial results from ARB's 2003 Consumer and Commercial Products Survey.

5. Estimated Costs / Economic Impacts and the Impacted Sectors/ Entities

Costs per MTCO2E are not available at this time. However, other regulations in the Consumer Products Program have been implemented in a cost effective manner. The manufacturers would bear the cost of formulation changes, then presumably pass the cost on to the consumer. Each product category would be fully evaluated for estimated costs as regulations are implemented. Any potential disproportionate impacts would depend on the individual product and whether it is used to a greater extent by any given sector of the population.

6. Technical Feasibility

The ARB staff believes technology is available to make changes in some consumer product categories to decrease the use of high GWP GHGs without increasing other emissions. ARB has not previously worked with representatives of certain segments of the industry, such as manufacturers of hobby guns that use compressed gas, so determination of the technical feasibility of GHG reductions in some applications cannot be made at this time.

7. Additional Considerations

Consumer Products are under ARB jurisdiction with legal authority for regulation. New regulations are scheduled to be heard by the Board in 2008. These regulations may address the use of high GWP GHGs in several product categories. An initial public meeting for the development of this regulation is scheduled for August 29, 2007. These regulations, already under development, will meet the statutory deadline for discrete early actions. Development of regulations for other categories of consumer products would fall under the Scoping Plan of The California Global Warming Solutions Act of 2006.

8. Division: Stationary Source Division
Staff Lead: Jessica Dean
Section Manager: David Mallory
Branch Chief: Janette Brooks

9. References:

Arthur D. Little, Global Comparative Analysis of HFC and Alternative Technologies for Refrigeration, Air Conditioning, Foam, Solvent, Aerosol Propellant, and Fire Protection Applications, Final Report to the Alliance for Responsible Atmospheric Policy, March 21, 2002

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #	*B40*
ID NUMBER:	*N/A*
TITLE:	*COLLABORATIVE RESEARCH TO UNDERSTAND HOW TO REDUCE GREENHOUSE GAS EMISSIONS FROM NITROGEN LAND APPLICATION*
PROPONENT:	*STAKEHOLDERS SUGGESTIONS*

2. Staff Recommendation

This measure is recommended for addition to the list of early actions. The Board date for consideration of this item is anticipated in 4th quarter of 2010.

3. Early Action Description

Staff analysis suggests that nitrogen land application may be a significant source of nitrous oxide, which is a potent greenhouse gas. In order to reduce greenhouse gases while benefiting agricultural systems, landscaping and other uses staff needs to identify methodologies for better characterizing California's nitrogen cycle.

An important first step to better characterizing the relationship between nitrogen land application and nitrous oxide formation in California agriculture, landscaping and other uses as well as opportunities for emission reductions is a collaborative research effort with stakeholders. The research is expected to focus on identifying optimal ways to reduce nitrous oxide emissions while increasing soil retention of nitrogen for plant uptake. Factors such as the total acreage of crop field, the annual amount and type of nitrogen applied, the method of application, soil properties, the irrigation regime, and drainage conditions can all play a role in characterizing nitrous oxide formation and would therefore be expected to be studied as part of the work. As part of the research the ARB will collaborate with the California Department of Food and Agriculture, Department of Pesticide Regulation, commodity groups, and other stakeholders. The research is expected to ultimately support the development of guidance to improve the characterization of nitrous oxide emissions from nitrogen land applications as well as identify effective strategies for emission reductions.

4. Potential Emission Reductions

The potential benefit of nitrous oxide emission reductions following from the research effort requires further assessment and is therefore to be determined. However, given the current nitrogen fertilizer use efficiency and portfolio, possible reductions from guidance that builds on the research may be on the order of 1 $MMTCO_2E$.

5. Estimated Costs / Economic Impacts and the Impacted Sectors/ Entities

Entities expected to participate in the collaborative research effort as well as the subsequent development of guidance includes farm owners and operators, nitrogen fertilizer manufacturers and distributors, the California Department of Food and Agriculture, Department of Pesticide Regulation, Regional Water Boards, commodity groups, and other stakeholders. The estimated costs of the research are to be determined as are any costs or savings associated with implementing subsequent guidance.

6. Technical Feasibility

The ARB has an established track record of collaborating with stakeholders to ensure that high quality research is conducted and that the research facilitates the identification of effective mitigation strategies. It is anticipated that the necessary expertise to conduct the research can be secured via a contract with in-state experts.

7. Additional Considerations

The ARB will coordinate with the California Department of Food and Agriculture, Regional Water Control Boards, and local air quality management districts in their efforts related to Nutrient Management Plans.

8. Division: Planning and Technical Support Division/Research Division
Staff Lead: TBD
Section Manager: TBD
Branch Chief: TBD

9. References:

Blaylock, A.D., R. D. Dowbenko, J. Kaufmann, G. D. Binford, and R. Islam. 2004. ESN® controlled-release nitrogen for enhanced nitrogen efficiency and improved environmental safety. Picogram and Abstracts, America Chemical Society, Philadelphia, PA. http://membership.acs.org/a/agro/Picogram/PicogramV67Fall2004.pdf

Brontrager, B. 2001. Stretch your 'N' dollars using urease, nitrification inhibitors. http://www.agprofessional.com/croptalk.php?id=1135

Burt, C. M., K. OConnor, and T.A. Ruehr. 1995. Fertigation. pp. 320Irrigation Training and Research Center. California Polytechnic State University, San Luis Obispo, CA.

Li, C.S., W. Salas, and M. L. Huertos. 2004. Quantifying carbon dynamics and greenhouse gas emissions in agricultural soils of California: A scoping study. PIER Project Report, P500-04-038. California Energy Commission, Sacramento, California. (http://www.climatechange.ca.gov/research/options/pdfs/2004-10-08_500-04-038.pdf).

Scholefield, D. and N.M. Titchen. 1995. Development of a rapid field test for soil mineral nitrogen and its application to grazed grassland. Soil Use and Management 11 (1), 33–43.

APPENDIX C – Staff Evaluation of Remaining Previously Approved Early Actions

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY # *C01*
ID NUMBER: *ARB 2-2*
TITLE: *STATIONARY AGRICULTURAL ENGINE ELECTRIFICATION*
PROPONENT: *AIR RESOURCES BOARD STAFF*

2. Staff Recommendation

This strategy was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this strategy is recommended.

However, given that electrification of stationary agricultural diesel engines must be considered on a case-by-case basis due to operational and cost issues, a control measure to require the electrification of these engines is impractical and cost-prohibitive for many growers (see Parts 5 and 7 for additional information). Accordingly, the approach currently being implemented is an outreach effort and therefore a Board hearing is not anticipated.

3. Early Action Description

As part of the outreach being conducted for the amendments to the airborne toxic control measure (ATCM) for Stationary Compression-Ignition Engines, ARB staff is working with the local air districts to encourage replacement of diesel engines with electric motors and to take advantage of incentive funding opportunities. Outreach materials and workshops will provide information regarding ATCM compliance options, including electrification. ARB staff is encouraging growers to consider switching to electric motors, especially in those cases where irrigation pumps are located in close proximity to residential areas, schools, and hospitals.

4. Potential Emission Reductions

This effort is expected to have a low emission reduction potential. Based on discussions with the agricultural community and electric utilities, up to 20 percent of existing stationary diesel agricultural irrigation pump engines are expected to be replaced with electric motors by 2020. This would result in a 2020 reduction of approximately 0.1 million metric tons of carbon dioxide. Given the compliance schedule in the ATCM and uncertainty regarding some incentive programs, staff is unable to estimate reductions for 2010 at this time.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

ARB staff estimates the cost to electrify stationary agricultural engines at about $26 million (8,600 pump engines x 20 percent x $15,000 (average capital cost of an electric motor)). This estimate does not account for possible additional line extension and/or electrical hook-up charges (highly variable for agricultural electric customers depending on location, crop,

well-depth, and other variables), which are likely to be cost prohibitive for many growers in remote areas. The estimate also does not account for any potential incentive funds that may be available to switch from diesel- to electric-powered agricultural irrigation pumps as these funds are limited and available on a first-come, first-served basis.

6. Technical Feasibility

Outreach efforts will encourage the use of electric motors, which are established and proven in agricultural operations. Approximately 82 percent of all stationary agricultural irrigation pumps in California are currently powered by electric motors, 15 percent are diesel-powered, and three percent are powered by other means (e.g., natural gas, liquefied petroleum gas, propane, butane, or gasoline).

7. Additional Considerations

The Board approved the amendments to the ATCM for Stationary Compression-Ignition Engines at the November 2006 public hearing. The amendments contain emission performance standards for agricultural engines but do not mandate electrification or any other specific compliance option. As explained in the September 2006 staff report for the ATCM, the Board had previously directed ARB staff to investigate the opportunities and challenges associated with replacing California's existing population of stationary diesel agricultural engines with electric motors. During the investigation, ARB staff identified many variables associated with farm and ranch electrical power use in California. These variables include irrigation method and schedule, availability of surface water, well pumping depth, quantity of water needed, fuel costs, electricity costs, and electrical infrastructure proximity and adequacy. Because of these variables, ARB staff concluded that any decision about the desirability or difficulty of converting stationary diesel agricultural engines to electric motors must be made on a site-by-site basis. Nonetheless, ARB staff believes that most engines will be replaced with new cleaner certified diesel engines or with electric motors. Retrofit and alternative fuels are other potential means of compliance. Staff is unable to predict which compliance option farmers will choose.

8. Division: Stationary Source Division
Staff Lead: Jon Manji
Section Manager: Richard Boyd
Branch Chief: Dan Donohoue

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #	*C02*
ID NUMBER:	*ARB 2-4*
TITLE:	*REDUCTION OF PERFLUOROCARBONS (PFCs) FROM THE SEMICONDUCTOR INDUSTRY*
PROPONENT:	*AIR RESOURCES BOARD STAFF*

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, it is recommended that this measure be reclassified as a discrete early action. The Board date for consideration of this item is anticipated in 4th quarter of 2008.

3. Early Action Description

The semiconductor industry uses PFCs primarily for etching circuits in silicon wafers and cleaning chemical vapor deposition tool chambers where thin films of chemicals are laid down onto silicon wafers. During these processes, a portion of the PFC gases used is released to the atmosphere.[1] There are four technologies industry has either employed or considered to reduce PFC emissions from semiconductor production:

- Process Optimization (optimizing the use of PFCs, such as in the chamber cleaning process);
- Alternative Chemistry Development;
- Emission Abatement; and
- Recovery/Recycling (separation of fluorinated compounds from other gases for further processing and reuse).

This discrete early action item will consider mandating the process optimization and alternative chemistry development technologies currently in use by some manufacturers. ARB would also evaluate the technical and economic feasibility of requiring emissions abatement and recovery/recycling strategies that may further reduce PFC emissions.

A few California manufacturers currently participate in voluntary national efforts to reduce PFC emissions to 10 percent below 1995 levels by 2010. A 2001 Memorandum of Understanding (MOU) agreement with the U.S. EPA provides details of these efforts.[2] Only three of 93 California manufacturers (about 15 percent of California production) participate in the MOU agreement.[3] Manufacturers and the U.S. EPA reached the agreement well before the adoption of Assembly Bill 32. Consequently, the State and federal courses of action have different goals and timeframes and information on any actions being taken by the remaining California companies to reduce PFC emissions is limited. A survey of the industry will be necessary to improve the accuracy of the emissions data.

4. Potential Emission Reductions

ARB staff proposed a GHG reduction goal of 0.5 $MMTCO_2$ equivalent in 2020 for the semiconductor industry in the April 2007 early actions report.[4] This goal will be further evaluated based on survey results from the industry and other data that become available over the next few months.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

The complete cost of this regulation has not been determined at this time. For process optimization, higher costs could be incurred by older fabrication facilities as process parameters such as chamber pressure, temperature, cleaning gas flow rates and gas mixture ratios are changed to reduce gas use. Alternative chemistry development is expected to result in minor cost impacts as the cost of alternative gases would be about the same as PFC gases. The manufacturers could pass on any additional costs to the consumers through higher product prices. The significance of this impact is not known.

6. Technical Feasibility

The technical feasibility of two of the four technology options for reducing PFC emissions within the semiconductor industry is fairly well known at this time. Two technologies currently used by manufacturers are:

- Process optimization
  This technology reduces the amount of PFCs used and has been primarily applied to the chamber cleaning process because of high use of PFC gases for cleaning.
- Alternative Chemistry Development
  Nitrogen trifluoride (NF_3) has been used as a substitute for hexafluoroethane (C_2F_6) in the chamber cleaning process to reduce PFC emissions since NF_3 is more effectively destroyed in the process.

Two technologies that would be further evaluated are:

- Emissions abatement
  Commercially available technologies can be applied to the chamber cleaning or the etching process to reduce emissions. High temperature and catalytic oxidation and plasma destruction are the most common technologies used to abate PFCs, but little is currently known about the extent of use by California manufacturers. Furthermore, the performance of abatement systems can vary greatly depending on the abatement device and process parameters, such as temperature and PFC gas flow rates.
- Recovery/Recycling
  These technologies have not achieved as much success as others as they are more costly or require more maintenance. The recovered compounds that are separated from other gases contain more impurities than virgin chemicals and are less likely to be used by the industry.

7. Additional Considerations

Additional considerations that pertain to the measure include:

This item is regulatory and falls under ARB jurisdiction. ARB has the legal authority to pursue this discrete early action item and the Climate Action Team supports further PFC reductions by the semiconductor industry.[5] Staff recommends that this item be presented to the Board within 18 months.

Leakage Considerations: The movement of semiconductor production facilities and older equipment from California to regions beyond California may result in leakage effects. The Semiconductor Industry Association (SIA) has indicated that California semiconductor manufacturing has been in decline over the last decade. The reasons vary from high capital costs, to tax advantages offered by other state and foreign governments, to lower financial risks associated with overseas foundry manufacturing compared to self-manufacture. The illustration provided by SIA is that from 1995 to 2006, three of the six MOU California companies ceased manufacturing operations. The corresponding decline in emissions was that California went from representing nearly 8 percent of U.S. emissions to just 3 percent. Staff needs to determine if the decline in California's emissions represents a shift of PFC emissions to other countries such as China. If so, we will need to determine if those manufacturers are using older equipment sold by California firms which may result in high emissions.

Affected Entities
Industry:

- Semiconductor fabrication industry
- Semiconductor Industry Association

Government:

- Local air pollution control districts
- California Energy Commission
- U.S. EPA

8. Division: Stationary Source Division
Staff Lead: Dale Trenschel
Section Manager: Terrel Ferreira
Branch Chief: Barbara Fry

9. References:

1. Emission Reduction Opportunities for Non-CO2 Greenhouse Gases in California, Public Interest Energy Research Program: Final Project Report, California Energy Commission, July 2005.

2. Memorandum of Understanding between the Semiconductor Industry Association (SIA) and the United States Environmental Protection Agency, January 2001.

3. Internal estimate, spreadsheet filename cost.xls, 2007.

4. Proposed Early Actions to Mitigate Climate Change in California, Air Resources Board, April 20, 2007.

5. Climate Action Team Report to Governor Schwarzenegger and the Legislature, California Environmental Protection Agency, March 2006.

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY # *C03*
ID NUMBER: *ARB 2-5*
TITLE: *FOAM RECOVERY/DESTRUCTION PROGRAM*
PROPONENT: *AIR RESOURCES BOARD STAFF*

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in 4th quarter of 2011.

This timing will allow staff the time to complete inventory research[1], interagency coordination, economic analyses, staff reports, stakeholder workshops, and public hearings to support the necessary regulation(s).

An alternative or complimentary approach may include establishing a voluntary agreement for recovery and destruction for certain foams, if the agreement can be implemented more cost-effectively and can be expected to yield similar CO_2E benefits as mandatory compliance.

3. Early Action Description

This strategy involves a regulatory measure(s) to implement a program to recover and destroy high-GWP insulating foams from buildings, other construction/demolition (C/D) waste, and appliances at end-of-life (EOL). The appliance foam recovery would be coordinated with the US EPA, as they have implemented a similar, voluntary program with some utility providers[2].

Many foams contain high-GWP GHG blowing agents, especially older insulating foams used in appliances and buildings, that contain chlorofluorocarbon (CFC) blowing agents such as CFC-11 (100-year direct GWP of 4,600).

Currently, foams are either broken (building panels) or shredded (appliances) and landfilled; at this time, no federal or state laws require that foams containing ozone depleting substance (ODS) or other high-GWP blowing agents in the foam be removed and destroyed[3].

Foam recovery from appliances may either be done manually, or as part of a fully automated recovery system in which appliance refrigerant is removed/de-gassed, the appliance is

[1] Inventory work in this area is expected to be complete by late 2009.
[2] Responsible Appliance Disposal program, or RAD: http://www.epa.gov/ozone/snap/emissions/radp.html
[3] Although refrigerant removal is required at appliance EOL under federal and state law, it is unknown at this time whether foam and refrigerant recovery would be performed by the same people at the same time; the process and technician certification requirements are expected to differ.

shredded, with the refrigerant in the foam collected from the gaseous and solid phases and subsequently destroyed.

4. Potential Emission Reductions

Estimated annual emission reductions of 0.9 $MMTCO_2E$ are currently possible for residential refrigerator and freezer foam recovery[4]. This number may be offset somewhat by CO_2 emissions associated with foam destruction[5]. Of the 0.9 $MMTCO_2E$, 0.8 $MMTCO_2E$ is due to recovery of foam containing R-11.

The CO_2E emission reductions are calculated for 2005 with only refrigerators and freezers considered since quantities of insulating foams recovered from A/Cs and building wastes annually in California are unknown. Without knowledge of the numbers and age distributions of appliances in California, 2020 emissions reductions based on sector growth and transitional blowing agent use estimates were not possible. However, it is reasonable to assume that approximately 0.9 $MMTCO_2E$ reductions will be possible every year until refrigerators and freezers containing R-11 are gone.

To summarize, by about 2012 annual emissions reductions of **0.9 $MMTCO_2E$** may be possible by recovering foams banked in old refrigerators and freezers that would otherwise go to landfills. Emissions benefits associated with foam recovery from building and additional C/D wastes could not be estimated.

5. Estimated Costs/Economic Impacts and the Impacted Sectors/Entities

The US EPA estimates that automated foam recovery at appliance EOL costs approximately **$6.5/$TCO_2E$**, while manual foam recovery at appliance EOL costs approximately **$48/$TCO_2E$**. The US EPA states that foam recovery from steel faced building panels is cost effective where large volumes of panels are in one place[6].

The impacted sectors and entities would mostly be appliance salvagers/recyclers and possibly individuals disposing of foam-containing appliances, as recovery costs are expected to be passed along to the user. Recovery of foam from buildings is not currently performed.

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[4] The following assumptions were used: 1) 20 year lifetimes for refrigerators, 2) R-11 use in refrigerators stopped in 1995; from 1995 – 2005 HCFC-141b was used, 3) in 2005, half of disposed refrigerators contain R-11 as the foam blowing agent and the other half contain 141b, 4) 25% of the foam blowing agent is lost into the cabinet and is released into the atmosphere and that the remaining 75% is recoverable, 5) 13,000,000 refrigerator/freezers are disposed of annually in the US and 60% go to landfills or transfer stations 6) the California population fraction was roughly 13% in 2005, 7) 100-year direct GWPs of 4600 and 700 were used for R-11 and HCFC-141b, respectively, 8) blowing agent masses of 0.45 kg/appliance and 0.38 kg/appliance for R-11 and HCFC-141b, respectively, were obtained from USEPA (Dave Godwin, personal conversation, 2/07).

[5] An additional 0.8 MMT CO2E should be avoided at appliance EOL, as refrigerant recovery is mandated by federal and state law; this is discussed in the following strategy, ARB 4-2. Foam destruction would require a large amount of additional analysis; currently, USEPA is developing a plan to destroy ODSs at RCRA facilities, and the operating assumption is that the CO2 emissions associated with relatively small amounts of foams and refrigerants are small compared to the hazardous waste destruction throughput of a typical RCRA facility, but this supposition is subject to further analysis and change.

[6] USEPA, Draft Proposed Measures Arising from the IPCC/TEAP Special Report & its Supplement, by End-Use, Expert Workshop on IPCC/TEAP Special Report, July 2006.

A foam recovery program for appliances is currently operating as an incentive program between the US EPA and utility companies, some of which are located in California (Responsible Appliance Disposal program, or RAD, see following strategy, ARB 4-2). The program was started in 2006 and the success of the program has not been gauged yet, although it is anticipated that a mandatory program would be more effective.

6. Technical Feasibility

The technology required to remove foam blowing agents from appliances and other construction and demolition wastes is feasible, but labor intensive if manual removal is employed. Automated foam removal from appliances is technically feasible, and can be performed during scrap metal processing and recovery.

7. Additional Considerations

Ozone depleting substances (ODSs) were used in the past as foam-blowing agents; CFC-11 (100-year direct GWP of 4,600) was used for many years, and phaseout of its replacement, HCFC-141b (100-year direct GWP of 700), from appliance foam has only been occurring in the past four years. Recovering and destroying ODSs may be a cost-effective way to reduce high-GWP gas emissions, and also reduces negative impacts on stratospheric ozone.

It is also possible that special facilities will need to be constructed if automated foam removal is deemed more economically feasible than manual foam removal and would therefore need to be considered in any estimates of cost-effectiveness.

The impacted sectors and entities would mostly be appliance salvagers/recyclers and possibly individuals disposing of foam-containing appliances, as recovery costs are expected to be passed along to the user. California trade associations associated with recycling of scrap metals are unknown. Coordination with the US EPA with respect to this regulation is ongoing.

8. Division: Research Division
Staff Lead: Whitney Leeman
Section Manager: Vacant
Branch Chief: Richard Corey

9. References

Arthur D. Little, Inc., Global Comparative Analysis of HFC and Alternative Technologies for Refrigeration, Air Conditioning, Foam, Solvent, Aerosol Propellant, and Fire Protection Applications, Final Report to the Alliance for Responsible Atmospheric Policy, March 21, 2002.

David Godwin (USEPA), Marian Martin Van Pelt and Katrin Peterson (ICF Consulting), Modeling Emissions of High Global Warming Potential Gases from Ozone Depleting Substance Substitutes, 2003.

IPCC/TEAP, IPCC Special Report on Safeguarding the Ozone Layer and the Global Climate System, Issues related to Hydrofluorocarbons and Perfluorocarbons, 2005.

SEPA, Guidance on the Recovery and Disposal of Controlled Substances Contained in Refrigerators and Freezers, 2002: http://www.sepa.org.uk/pdf/consultation/closed/2003/fridge/fridge_consultation.pdf

USEPA, Draft Proposed Measures Arising from the IPCC/TEAP Special Report & its Supplement, by End-Use, Expert Workshop on IPCC/TEAP Special Report, July 2006.

USEPA, RAD program website: http://www.epa.gov/ozone/snap/emissions/radp.html

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #	*C04*
ID NUMBER:	*ARB 2-6*
TITLE:	*GUIDANCE AND PROTOCOLS FOR LOCAL GOVERNMENTS TO FACILITATE GHG EMISSION REDUCTIONS*
PROPONENT:	*AIR RESOURCES BOARD STAFF*

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in 3nd quarter of 2008.

Local governments have the power to affect the main sources of pollution directly linked to climate change through infrastructure investments, land use decisions, building codes, and municipal service management. While a handful of local governments in California have already started to plan and implement local GHG reduction measures, development of a State guidance document and local government protocols is needed to encourage and support greater and coordinated local action statewide. Furthermore, development of these items will help ensure consistency and coordination between the multiple state agencies involved with implementing AB 32, with regard to supporting and advising Local Government actions for GHG reductions.

Staff recommend developing guidance documents for Local Governments that outline GHG reduction opportunities, as well as protocols for emission reduction accounting.

3. Early Action Description

The first step of this strategy will be to coordinate with the Climate Action Team, local governments, the California Climate Action Registry, and local government support organizations like ICLEI (Local Governments for Sustainability). The guidance document will address: 1) best practices for local governments to reduce GHG emissions; 2) categorization and prioritization of strategies by applicability to community types (i.e., urban, suburban, rural), cost-effectiveness, time needed to achieve reductions, etc.; 3) local government protocols for emission reduction accounting; and 4) appropriate modeling tools to support emission quantification at the local level.

Specific recommendations could include: implementing green building standards, stronger recycling programs, energy conservation, changing municipal fleets to cleaner alternatives (gas-electric hybrids, natural gas fueled vehicles, etc.), promoting sustainable communities and smart growth; encouraging LED street and traffic lights; promoting alternative energy (e.g. solar).

These are effective actions that local governments can implement to reduce carbon emissions, which not only help the environment but could be cost effective.
Guidance documents and protocols from this strategy will be voluntary not regulatory and will be developed in close coordination with stakeholders representing state, local, regional and industry perspectives. A strong long-term local level education program will be necessary for successful implementation.

Groups to work with include:

Trade Associations: California Building Industry Association (CBIA), League of California Cities, California State Association of Counties (CSAC), California Association of Councils of Governments (CALCOG).

Government Agencies: Governor's Office of Planning and Research, California Air Pollution Control Officers Association (CAPCOA), and Local Air Pollution Control Districts, local government agencies, Cal/EPA's Climate Action Team and its Land Use/Smart Growth Subgroup, Department of Community and Housing Development, Department of Transportation, California Energy Commission, Integrated Waste Management Board.

4. Potential Emission Reductions

Potential emission reduction impacts are difficult to predict with current knowledge.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

Estimated costs and economic impacts are difficult to determine and this time.

6. Technical Feasibility

With regard to developing a best practices document for Local Government, many other cities, states, and private organizations have acknowledged the need to reduce global warming pollution and have taken steps to coordinate concerted efforts. Below is a list of just a few national and international programs that staff will consider closely:

- U.S. Mayors for Climate Protection - promote actions that city governments can do to profitably and reduce carbon emissions.
- The Clinton Climate Initiative - works with C40 Large Cities Climate Leadership Group, an association of large cities dedicated to tackling climate change—to develop and implement a range of actions that will accelerate greenhouse gas emissions reductions.
- ICLEI's Cities for Climate Protection™ (CCP) Campaign - assists cities to adopt policies and implement quantifiable measures to reduce local greenhouse gas emissions, improve air quality, and enhance urban livability and sustainability. More than 800 local governments participate in the CCP, integrating climate change mitigation into their decision-making processes.

As for protocols for emission reduction accounting, the California Climate Action Registry (CCAR) is currently under contract with the ARB to develop a suite of protocols for reporting and certifying GHG emission reductions for Local Governments. As part of this effort, CCAR will be preparing a scoping document that describes the full scope of local government activities and operations to which quantification protocols can be applied. Data and analysis from this work will support development of a Local Government guidance document.

7. Additional Considerations

Many of the actions that may be recommended fall under the jurisdiction of other state and local agencies therefore this strategy will provide advice and support action, rather than mandate.

An important aspect of this strategy will be verification of the emission reductions and the value associated with it. Future efforts will focus on how local governments can take credit for net reductions and best uses for those credits.

Proposed Board Hearing Date: July 2008

8. Division: Office of Climate Change
Staff Lead: James Goldstene

Staff Analysis of Proposed Early Action for Climate Change Mitigation In California

1. Early Actions Strategy Name and Proponent

SUMMARY #	*C05*
ID NUMBER:	*2-7*
TITLE:	*GUIDANCE/PROTOCOLS FOR BUSINESSES TO FACILITATE GHG EMISSION REDUCTIONS*
PROPONENT:	*AIR RESOURCES BOARD STAFF*

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in 2nd quarter of 2008.

Currently, California businesses' energy consumption contributes approximately 12 MMTCO2E GHG emissions per year. Through strategies such as efficient building practices, motor vehicle fleet changes, operational changes, fossil fuel switching, and recycling, local businesses can reduce cost effectively their carbon footprint. These emission reductions range from quite minor to very significant and all reductions will assist the State in meeting its targets under AB32.

Greenhouse gas emission reduction guidance and suggested strategies for local businesses will be presented to the Board in July 2008. At present, it is anticipated that implementation of local business reduction measures will be strongly encouraged, but strictly on a voluntary basis with a dedicated and aggressive educational outreach effort. It is also anticipated that initially, guidance will be broad and, hence applicable to a broad spectrum of businesses. In time, the guidance will evolved into focused, sector-specific recommendations. To the extent possible, a robust emission verification element will be integrated into the guidance so that reductions can be quantified.

3. Early Action Description

This strategy will provide guidance and informational resources to local businesses on best practices, emission calculation and verification methods, case studies, cost-effectiveness information, and other tools to assist in reducing greenhouse gas emissions. The guidance will seek to distill and translate the vast amount of information already existing into tangible and concrete steps that local business can implement. Staff's efforts will be focused on reaching out to small/mid-size businesses to engage them in the development of actions, to offer guidance for estimating emissions, identifying and quantifying reductions, and facilitating actions to reduce carbon footprints. Information on relevant options, particularly those that have been implemented successfully by others at a local or national level will be highlighted.

This strategy will focus on businesses ranging from a small office to mid-size corporations and will address the climate benefits of both operational and behavioral changes. Operational changes could include the use of *Energy Star* equipment, compact fluorescent light bulbs, water conservation, recycling, and motor vehicle fleet changes. In addition to physical changes to the

operation of the business (e.g., new construction, retrofits to existing buildings), the guidance will address the benefits of behavioral changes such as incentives for carpooling/walking/bicycling to the workplace, facilitate employees walking to lunch, procuring "green" products, incentives for reducing waste/electricity consumption, Governor's Awards program to recognize green business leaders, etc. Businesses that choose to pledge to participate in the effort for climate protection will be encouraged and assisted to inventory and report their emissions via recognized channels such as the California Climate Action Registry.

To be successful, this strategy must convince businesses to embrace new projects and initiatives from both environmental and economic perspectives. Thus, a key element of success in the strategy will be to determine how enhancements of operational efficiencies can result in increased profits for a participating business via savings in energy consumption. In addition to working with established organizations that represent or have strong ties with the targeted audience (small and medium business owners/managers), emphasis will be placed on implementation through a variety of means (e.g., information in association newsletters, presentations at trade meeting, web-based tools, etc.). ARB staff will monitor the effectiveness of and response to efforts in order and make necessary adjustments as needed to strengthen the program into the future.

4. Potential Emission Reductions

Energy efficiency measures associated with green buildings address lighting, heating and cooling, water conservation, refrigeration, and recycling and often lead to a large decrease in GHG emissions. The US Department of Energy states that new energy-efficient design can cut energy usage by 50%; renovation of existing buildings can yield savings of up to 30%. Governor Schwarzenegger signed Executive Order S-20-04 in 2004, which sets a goal of reducing energy use in State-owned buildings 20% by 2015 (from a 2003 baseline). The private commercial sector is encouraged to do the same. The California Energy Commission estimated 2004 GHG emissions in the commercial sector to be approximately 12 MMTCO2E. Thus, achieving a 20% reduction in GHG emissions as called for in the Executive Order could potentially realize a reduction of more than 2 MMTCO2E in the commercial sector.

5. Estimated Costs / Economic Impacts and the Impacted Sectors/ Entities

Cost information will vary widely depending on the specific action implemented by a local business. Thus, it is premature to report this information at this time. However, information coming from existing examples that have successfully achieved improvements indicates that the return on investment for energy efficiency measures is often recovered in three to five years, resulting in long term cost savings due to lower utility bills. Measures that could be implemented pursuant to this proposed early action are quite varied and potentially include installation of LED exit signs, efficient refrigeration systems, improved building insulation, purchase of *Energy Star* appliances and office equipment, and implementation of recycling programs. Improvements that are scaleable to square footage of operations will be pursued so that the emission reduction benefits can be pursued across all sizes of businesses.

6. Technical Feasibility

The proposed strategy benefits from the successful experience from several local businesses and other entities that have already set targets and developed climate action plans. The mitigation strategies will likely be a suite of best practices already in use and proven to be

feasible and effective. Staff will work with the business community to ensure that this strategy focuses on activities and provide information that will promote real, quantifiable, and sustainable reductions. We will also focus on the most effective ways to target the information at decision makers. Hurdles may include developing and implementing guidance that is sufficiently specific and documented.

7. Additional Considerations

ARB will work in consultation with several agencies including: 1) California Energy Commission, 2) Business Associations 3) California Climate Action Registry 4) California Chamber of Commerce, 5) Utility providers, as well as many others.

8. Division: Research Division/Planning and Technical Support Division/Office of Climate Change

Staff Lead: TBD

Section Manager: Annmarie Mora

Branch Chief: Alberto Ayala

9. References:

California Energy Commission, Inventory of California Greenhouse Gas Emissions and Sinks: 1990 to 2004, October 2006.

U.S. Department of Energy, Energy Efficiency and Renewable Energy, Building Technologies Program, http://www.eere.energy.gov/buildings/info/office/index.html, January 27, 2006.

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY #	*C06*
ID NUMBER:	*ARB 2-8*
TITLE:	*REDUCE SULFUR HEXAFLUORIDE (SF_6) FROM ELECTRICAL GENERATION*
PROPONENT:	*AIR RESOURCES BOARD STAFF*

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in 2nd quarter of 2011.

3. Early Action Description

This strategy proposes that the ARB develop a measure to reduce sulfur hexafluoride (SF_6) emissions from the electric power industry, which is the primary user of SF_6. SF_6 is a synthetic gas used as an insulating medium. The most common use for SF_6 is as an electrical insulator in high-voltage equipment that transmits and distributes electricity. Since the 1950's, the U.S. electric power industry has used SF_6 widely in circuit breakers, gas-insulated substations, and other switchgear used in the transmission system to manage the high voltages carried between generation stations and customer load centers. Fugitive emissions of SF_6 can escape from gas-insulated substations and switchgear through seals. It can also be released during equipment installation and when equipment is opened for servicing. Several factors affect SF_6 emissions from electric power systems, such as the type and age of the equipment (e.g., older circuit breakers can contain up to 2,000 pounds of SF_6, while modern breakers usually contain less than 100 pounds), and the handling and maintenance procedures practiced by the utilities.

SF_6 is a highly potent greenhouse gas. Over a 100-year period, SF_6 is 23,900 times more effective at trapping infrared radiation than an equivalent amount of carbon dioxide. SF_6 is also a very stable chemical, with an atmospheric lifetime of 3,200 years. Consequently, it will accumulate in the atmosphere.

The U.S. Environmental Protection Agency (U.S. EPA) reports that the most promising and cost-effective options to reduce SF_6 emissions are leak detection and repair, use of recycling equipment, and employee education and training.

4. Potential Emission Reductions

U.S. EPA estimates that the SF_6 emissions from electric power systems in the U.S. in 2005 were 4.9 million metric tons of CO_2-equivalent (MMTCO2E). The Cal/EPA Climate Action Team

Report states that hydrofluorocarbons, perfluorocarbons, and SF_6 accounted for about 3.5 percent of gross 2002 greenhouse gas emissions in California (CO_2-equivalent). USEPA reports that use of recycling equipment can reduce SF_6 emissions by about 10 percent, and leak detection and repair can reduce SF_6 emissions by 20 percent.

Further investigation is required to determine the portion of SF_6 emissions attributed to the California electric power industry and the most appropriate and effective emission reduction equipment and practices. Therefore, ARB staff cannot yet determine the total emission reduction potential of this strategy.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

U.S. EPA reports that cost-effective operational improvements and equipment upgrades can be accomplished at an average cost of $9.00 per pound. The cost impacts of this strategy specific to the California power sector cannot be determined at this time as further investigation is required. ARB staff assumes that costs will be borne by the power companies and could translate into increased electricity rates for consumers.

6. Technical Feasibility

The most cost-effective SF_6 emission reduction options reported by USEPA focus on maintenance and education, and therefore do not appear to have any associated major technical issues. However, to the extent that repair and replacement activities are used to reduce emissions, scheduling to minimize electrical system disruption could be an issue.

7. Additional Considerations

8. Division: Stationary Source Division
Staff Lead: Chris Gallenstein
Section Manager: Mike Waugh
Branch Chief: Mike Tollstrup

9. References:

[1] *California Environmental Protection Agency, "Climate Action Team Report to Governor Schwarzenegger and the Legislature," March 2006.*

[2] *U.S. Environmental Protection Agency, "SF6 Emission Reduction Partnership for Electric Power Systems," April 17, 2007: http://www.epa.gov/electricpower-sf6/index.html*

[3] *U.S. Environmental Protection Agency, "SF6 Emission Reduction Partnership for the Magnesium Industry," November 28, 2006: http://www.epa.gov/highgwp/magnesium-sf6/faq.html*

[4] *U.S. Environmental Protection Agency, "U.S. High GWP Gas Emissions 1990-2010: Inventories, Projections, and Opportunities for Reductions," publication #EPA-000-F-97-000, June 2001.*

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY # *C07*
ID NUMBER: *ARB 2-10*
TITLE: *ALTERNATIVE SUPPRESSANTS IN FIRE PROTECTION SYSTEMS*
PROPONENT: *STAKEHOLDER SUGGESTION*

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in 4th quarter of 2011.

Staff recommends developing a proposal for the use of lower GWP substances in fire protection systems to the extent that safe, technically feasible, and cost-effective alternatives are available. These systems, called total flooding systems, are typically used to protect large computer data management areas in commercial buildings, clean room manufacturing facilities, telecommunications equipment, museums and archives. If further evaluation supports the use of this measure as a early action, the proposal will be considered by the Board by December 2011.

One possible approach (for illustrative purposes only): By 2012, require that all new total flooding fire suppressant systems use fire suppressants with a GWP below a specified threshold. The analysis may also explore requiring, providing the options are technologically feasible and cost-effective, that existing total flooding fire suppressant systems enhance inspections of or replace systems using substances with a GWP above a specified threshold, which may or may not be different than the above-mentioned threshold.

3. Early Action Description

Use lower global warming potential (GWP) gases in new fire protection systems to the extent that safe, technically feasible, and cost-effective alternatives are available.

4. Potential Emission Reductions

Statewide Emission Inventory[1]
2005 GHG Emission Inventory: 0.05 $MTCO_2$
2020 Projected GHG Emissions: 0.23 $MTCO_2$
Anticipated 2020 Reductions: <0.1 MMT CO_2E which assumes 43 percent control

[1] All emissions estimates based on USEPA Vintaging Model scaled to California based on population assuming only HFC 227 since HFC 23 is only 1%, Halon emission data are not available at this time. Reduction estimates based on technical feasibility from EPA 2006 for new systems. Including reductions from replacement of systems with Halons or HFCs would increase the reduction potential.

Prior to the 1990s, most total flooding fire suppression systems used Halon 1301, however, it is an ozone depleting substance and, based on the Montreal Protocol on Substances that Deplete the Ozone Layer, its production in the US was completely phased out by the mid-1990s. Due to this fact, new systems have moved to Halon replacements, however, with the exception of the US Department of Defense, there has been no concerted effort to remove existing Halon 1301 systems and recycled Halon 1301 is inexpensive and widely available for recharge needs (Wickham 2002). The lifetime of a system ranges from 10 to 35 years.

There are several Halon alternatives being used in fire suppression systems. The US EPA estimates that HFC 227ea covers approximately 16 percent of the total new flooding fire protection systems with HFC 23 (<1%), inert gas (10%) and not-in-kind alternatives (NIK) such as powdered aerosols, water sprinklers and mist systems making up the remainder of the market (74%) (US EPA, 2006). Although these Halon alternatives are not ozone depletors, HFC 227ea and HFC 23 do have significant global warming potentials (GWP) of 2990 for HFC 227ea and 11700 for HFC 23 (IPCC, 1996). In comparison, Halon 1301 has a GWP of 7030, much higher than the common alternative of HFC 227ea (WMO, 2002).

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

The US EPA estimates that the least cost alternative would be approximately $40/tonne CO_2E (US EPA, 2006) in the US for new systems. The estimate reflects the relative cost of alternative formulations, space costs, and costs associated with installing a new, and sometimes weightier, type of system. The costs may need to be updated and revised to reflect the situation in California. For example labor costs and heating and cooling costs differ from the average for the US. This analysis did not consider costs for replacement systems.

Total flooding systems are used by a wide variety of sectors with uses varying from data processing centers to the oil and gas industry to military weapons systems. Any requirements effecting new systems will be fairly evenly distributed among the sectors. Systems with low expected lifetimes (10-15 years) will be impacted most in the short-term as systems need to be replaced sooner. Any requirements to replace existing systems may have a larger impact on sectors with systems that have long expected lifetimes (35 years). These sectors were expecting the system to last up to 35 years but may have to upgrade the system much sooner.

6. Technical Feasibility

There are a number of low GWP alternatives to Halons and HFCs for use in total flooding fire suppression systems, however, they need to be analyzed for effectiveness, space constraints, safety concerns, and other issues. Not every alternative will work in every situation and technical feasibility will be vary based on space needs, human exposure potential for asphyxiates, and other constraints.

7. Additional Considerations

Some factors that need to be considered as part of the evaluation include whether the alternatives are as effective, do the alternatives have increased toxicity, are there any multi-media environmental impacts and whether the strategy would this apply to only new installations or would existing installations need to be retrofitted? Other questions that need to be considered include what happens to the HFCs and Halons from any systems that are phased out, and will other agencies and insurance companies allow their use? Another fundamental

question concerns whether another agency would be more appropriate to adopt the strategy as well as determining if a voluntary measure be just as effective?

Affected Entities: Commercial building owners and property management companies, fire suppressant manufacturers (e.g., 3M, Great Lakes Chemical, Brownell, Dupont, Stat-X) and system manufacturers/suppliers (Sea fire, Nautical, Many suppliers – CA based include CalProtection, Chemetron, Diversified Protection, Facilities Protection Inc., Intelligent Technologies and Systems, and RFI Communications & Security).

Trade Associations: Building Industry Association, Chemical Manufacturers Association, Building Insurance, Fire Suppression Systems Association, Fire Equipment Manufacturers Association and others.

Government Agencies to coordinate with: California Department of Fire Protection, State Fire Marshall's Office, Department of General Services, OEHHA, DHS, Cal-OSHA, and others.

Proposed Board Hearing Date: December 2011

8. Division: Research Division
Staff Lead: Elizabeth Scheehle
Section Manager: Mike FitzGibbon
Branch Chief: TBD
Staff Attorney: TBD

9. References:

Intergovernmental Panel on Climate Change (IPCC). 1996. Climate Change 1995: The Science of Climate Change. J.T. Houghton, L.G. Miera Filho, B.A. Callander, N. Harris, A. Katternberg, and K. Maskell (eds.). Cambridge, UK: Cambridge University Press.

USEPA, 2006. Global Mitigation of Non-CO_2 Greenhouse Gases, EPA Report 430-R-06-005. Available at: http://www.epa.gov/nonco2/econinv/downloads/GlobalMitigationFullReport.pdf

Wickham, Robert. 2002. Status of Industry Efforts to Replace Halon Fire Extinguishing Agents. Wickham and Associates. March 16. Available at: http://www.epa.gov/ozone/snap/fire/status.pdf.

World Meteorological Association (WMO). 2002. Scientific Assessment of Ozone Depletion: 2002. Global Ozone Research and Monitoring Project - Report No. 47, 498pp., Geneva, 2003.

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY # *C08*
ID NUMBER: *ARB 2-11*
TITLE: *FORESTRY PROTOCOL ENDORSEMENT*
PROPONENT: *STAKEHOLDER SUGGESTION*

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in the 4th quarter of 2007.

Staff recommends this strategy remain on the list as an early action by Board endorsement of the California Climate Action Registry (CCAR) forestry protocols for immediate use to enhance voluntary greenhouse gas emissions reductions. Staff recommends a two-phase process that allows early action by bringing existing sector, project, and certification protocols, developed by CCAR, to the Board for approval in October 2007 and also allows for longer term consideration and review of additional forestry protocol development as determined in the initial public workshop process. Endorsement of sector and project forest protocols would be non-regulatory, because their use would be voluntary.

3. Early Action Description

Forestry is the only sector that *actively removes* greenhouse gases from the atmosphere. The CCAR forestry protocols represent the work of leading experts in the field of forestry and in protocol development, the input of stakeholders and the public over a 4-year public process, and the review by 50 external experts, representing the forest industry, policy and academia. The protocols have been approved by the Board of Forestry (2004) and the CCAR Board (2005). The three protocols together – the sector, project, and certification protocols – are a cohesive and comprehensive set of methodologies for forest carbon accounting, and contain the elements necessary to generate high quality, conservative carbon credits. The first step to effective carbon reduction is accurate carbon accounting.

Unlike other sectors, immediate action in the forest sector does not result in instantaneous greenhouse gas reduction, because forests need time to grow to realize reduction benefits. Therefore, the sooner these voluntary protocols are endorsed, the faster forest projects can be put in place, to establish *future* reductions. The three carbon reduction project types – reforestation, conservation forest management, and avoided development – provide an accounting framework for maximizing carbon sequestration and minimizing carbon loss without compromising the other ecosystem functions forest provide (habitat, structure, nutrient cycling), as well as the suite of other benefits humans depend on from the forests (water storage, soil stability, temperature modification, air and water purification, wood products, recreation). As such, they are ready for use in voluntary measures to reduce carbon emissions in California.

4. Potential Emission Reductions

Because they are critical to accurate carbon accounting, the forestry protocols are required in several of the forest-related Climate Action Team (CAT) strategy implementation plans. A third of carbon reductions through the forest CAT plan depend on application of these forest protocols which equates to a cumulative sequestration of roughly 10 $MMTCO_2eq$ between now and 2020. The CAT-strategy reforestation projects in the year 2020 are expected to result in GHG emissions reduction of 2 MMTCO2eq (CAT, 2007). While there is already interest in the protocols from the private forest sector, the potential emissions reduction from the voluntary use of the protocols could vary depending on a variety of factors, including management activity, site fertility, and available funding. One unpublished industry study suggests a potential increase of 2¼-fold in the pine zone (Steve Brink, California Forestry Association, pers. comm.). Nationally, an additional 100 to 200 Tg C/yr of forest carbon sequestration is achievable, but would require investment in inventory and monitoring, development of technology and practices, and assistance for land managers (Birdsey et al. 2006).

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

Currently, the methodologies for carbon stock assessment require intensive sampling programs to meet the required confidence levels for verification. This is labor and time intensive, and therefore costly. There is currently no better technology/methodology to measure carbon if a high degree of certainty is required in carbon stock assessment. Carbon stock certainty should meet the criteria of other carbon emission estimates in the state (20% of the mean estimate). Smaller landowners may find the cost to implement the sampling and subsequent verification too burdensome to participate. The larger industrial landowners (>30,000 acres) should be able to use forest stocking data from sustained-yield management plans which they are required to submit to California Department of Fire and Forest Protection (CalFire). Data for inventorying large land areas may be accessible from CalFire plot data and USFS Forest Inventory and Analysis plot data.

6. Technical Feasibility

The carbon accounting techniques used in the forest protocols are standard forest measurement techniques.

7. Additional Considerations

The forestry protocols are designed for small to mid-sized private forest ownerships. There is a need for continued development of forest accounting methodologies to address outstanding issues for: 1) public forest ownerships and for 2) industrial forest private land ownerships. These issues can be addressed within the framework of the existing protocols by defining additional project types beyond the three project types (reforestation, conservation forest management, and avoided deforestation) in the current protocols. For public landowners, issues to resolve include legality of permanent easement transfer, baseline/additionality definition, and carbon offset ownership. By recognizing the need for additional project types in the future, the existing forestry protocols can be moved forward through the public process, endorsed and implementation immediately while the new project types are developed through a longer term public process. This will expedite the availability of the forest protocols for immediate use, while still allowing due consideration to the different needs of the industrial and public forest sector.

Affected Entities: Any forest ownership in California could participate in all forest project types, including state and federal public forests, and private forests. Many non-forest entities might participate in reforestation activities, including local governments, utilities, others.

Trade Associations: California Forestry Association.

Government Agencies Coordination: California Department of Forest and Fire Protection, Board of Forestry, United States Forest Service.

8. Division: Planning and Technical Support Division
Staff Lead: Jeanne Panek
Section Manager: Dale Shimp
Branch Chief: Richard Bode

9. References:

The protocols can be found in their entirety on the California Climate Action Registry website at: http://www.climateregistry.org/PROTOCOLS/FP/

Birdsey, R., K. Pregitzer, and A. Lucier. 2007. Forest Carbon Management in the United States: 1600–2100. J. Environ. Qual. 35:1461–1469.

CAT, Climate Action Team. 2007. Climate Action Team proposed early actions to mitigate climate change in California. Draft for public review. April 2007. www.climatechange.ca.gov/climate_action_team/reports/2007-04-20_CAT_REPORT.PDF

Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

1. Early Actions Strategy Name and Proponent

SUMMARY # *C09*
ID NUMBER: *ARB 2-18 / EJAC-2*
TITLE: *ENFORCEMENT OF FEDERAL BAN ON HFC RELEASE DURING SERVICE/DISMANTLING OF MVACS*
PROPONENT: *2006 CAT REPORT*

2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in 2nd quarter of 2010.

This non-regulatory strategy is expected to be developed in close collaboration with the United States Environmental Protection Agency (US EPA). The strategy is not a stand-alone measure. Rather, it is designed to be implemented in concert with a number of other strategies that staff has identified for mitigating the climate impact of HFCs.

3. Early Action Description

The goal of this non-regulatory strategy is improved compliance with a regulation of US EPA (40 CFR 82.154) that prohibits the venting of certain types of refrigerant, including HFCs, to the atmosphere when MVACS equipment is serviced or dismantled. Venting is avoided by recovering refrigerants with specialized equipment. The recovered refrigerant can be re-used by the owner or transferred to re-processors approved by US EPA.

The main focus of the proposed strategy would be the climate impact abatement of HFCs used in the air-conditioning (A/C) systems of vehicles that are to be dismantled. The current degree of compliance with 40 CFR 82.154 is poorly documented but under review. Per this strategy, better compliance by dismantlers would be obtained via a cooperative program that would be created among ARB's Enforcement Division, appropriate offices in the US EPA, and the environmental protection offices of the counties where dismantling activity is taking place. The specific form of the program has not been determined yet, pending quantification of the avoidable emissions of HFCs. However, the anticipated approach would emphasize enhanced enforcement of existing federal requirements for recovery via audits of activities and documentation.

4. Potential Emission Reductions

Potential emission reductions from dismantling have been estimated to be in the range of 0.1 to 0.6 MMTCO2E in 2010 and 0.1 MMTCO2E in 2020. The potential reductions are lower in the year 2020 because it is assumed that half of the cars going to the dismantlers will have new low-GWP refrigerant in the A/C system instead of HFC-134a as called for in other companion

HFC reduction strategies. Preliminary estimates suggest that the refrigerant bank in EOL vehicles could be as high as 0.5 $MMTCO_2E$ per year. Estimates of annual A/C servicing emissions ranges from 0.3 to 0.6 $MMTCO_2E$. The ARB staff has initiated extramural research to estimate the annual amount of HFC that is available for recovery from vehicle at end-of-life and we will continue to work with the USEPA to develop improved estimates of the portion of the available amount that is being recovered and other parameters.

5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

Some dismantlers may not have the latest compliant hardware for recovering refrigerants or any equipment at all. Each such dismantler who would be prompted to purchase the equipment would have to spend in the neighborhood of $3000 to $4000 per unit. The number of units needed would depend on the size of the operation (vehicle throughput). However, this would be an expense that the dismantler has so far avoided only through failure to comply with the existing federal regulation. Thus, this is not a cost burden associated with the proposed strategy.

The same statements apply to obtaining certification for technicians who use the recovery equipment, but with minimal anticipated costs. Training for the US EPA's certification program is offered by various commercial schools. In addition, the Mobile Air Conditioning Society offers free training (a downloadable pamphlet) and a nominal exam fee, so the necessary expense for operator certification should be minimal.

6. Technical Feasibility

This measure is technically feasible because it is the current federal law, which has been in existence for some time. As such, the equipment exists to recover the refrigerant from automobile A/C systems whether they are being serviced or dismantled. The rigorous enforcement of the federal regulation in California is meant to force vehicle dismantlers to universally use refrigerant-recovery equipment as required by law. The same is true for garages and auto service centers that service MVACS; however, the fraction of such shops that do not have the requisite equipment may be small. It should be noted that recovery procedures and equipment are being revised by industry standard setting bodies to make the process more effective with a higher recovery rates of the refrigerant.

7. Additional Considerations

This strategy involves the enforcement of an existing federal regulation (U.S. EPA- 40 CFR 82.154) that prohibits the venting of refrigerants to the atmosphere when the MVACS is being serviced or dismantled. Some local air districts adopt the federal regulation by reference and others have their own regulation which prohibits the release of refrigerants into the atmosphere. Originally, this item was a strategy in the Climate Action Team Report of March 2006 that ARB intends to pursue as one of suite of measures designed for reducing HFC refrigerant impacts. This strategy involves the creation of a cooperative program among ARB's Enforcement Division, appropriate offices in the U.S. EPA, and local air districts in California. U.S. EPA is currently working on a regulatory impacts assessment that will estimate the emission reductions and costs associated with this type of measure. That work and other on-going activities are expected to yield the necessary additional information for strategy development such as the number of non-compliant dismantlers and shops that perform MVACS servicing in California.

8. Division: Research Division
Staff Lead: Winston Potts
Section Manager: Tao Huai
Branch Chief: Alberto Ayala

9. References:

[1]Vincent, R., *"HFC Reduction Strategy 2-2-5, Enforcement of the Federal Ban on Releasing HFCs During Servicing and Dismantling of MVACS," California Air Resources Board, 2006. As presented in the Climate Action Team Report of March 2006.*

[2]*Air Resources Board, HFC-134a as an Automotive Refrigerant - Background, Emissions and Effects of Potential Controls, August 6, 2004 (www.arb.ca.gov/cc/cc.htm)*

[3] *Karen Thundiyil, USEPA, personal communication, 7/26/07.*

[4] *Improved Mobile Air Conditioning Program (IMAC), "Reducing Refrigerant Emissions at Service and Vehicle End of Life," June 30, 2007*