PUBLIC MEETING AGENDA

May 26, 2005
9:00 a.m.

Agenda Items to be heard;
05-5-1, 05-5-2, 05-5-3,
05-5-4, 05-5-5

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ELECTRONIC BOARD BOOK

California Environmental Protection Agency

Air Resources Board

LOCATION:
Air Resources Board
Byron Sher Auditorium, Second Floor
1001 I Street
Sacramento, California 95814

PUBLIC MEETING AGENDA

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May 26, 2005
9:00 a.m.

Agenda Item #

05-5-1: Report to the Board on a Health Update: Prenatal Exposure to Polycyclic Aromatic Hydrocarbons and the Development of Respiratory Symptoms in Young Infants

Staff will present the results of a study of pregnant women and their infants exposed to airborne polycyclic aromatic hydrocarbons (PAH), an important component of diesel exhaust. The study found a significant increase in respiratory symptoms in the infants at 12 months of age, as well as some pre-asthma changes in the infants at 24 months of age. The symptoms were most highly correlated with exposure to PAH during pregnancy combined with post-natal environmental tobacco smoke exposure.

05-5-2: Board Meeting to Consider a Research Proposal

"Characterization of Off-Road Equipment Population," Eastern Research Group, Inc., Proposal No. 2584-248.

05-5-3: Public Hearing to Consider Amendments to the ATCM for Stationary Compression Ignition Engines

On March 17, 2005, the Board took emergency action on the Stationary Engine ATCM by removing the requirement that new stationary agriculture engines greater than 50 horsepower (hp) and less than 175 hp meet the appropriate California and federal off-road certification standards for new engines instead of the 0.15 g/bhp-hr PM standard in the ATCM. This action was based on the limited availability of 0.15 g/bhp-hr PM-compliant engines in the greater than 50 hp to 99 hp range and the limited number of manufacturers offering compliant engines in the 100 hp to less than 175 hp range. The proposed revisions to the ATCM would ensure the continued availability of new off-road California- and federal-compliant stationary agriculture pump engines, in all size ranges by all manufacturers, by making the emergency regulatory changes permanent. Staff will also report to the Board on the availability of stationary emergency back-up engines less than 175 hp that comply with the current 0.15 g/bhp-hr PM standard.

05-5-4: Public Meeting to Update the Board on Hydrogen Highway

A summary of the California Stationary Fuel Cell Collaborative (CaSFCC) organization, its activities and accomplishments, will be presented. The presentation will include an overview of fuel cell technologies for stationary power generation, a summary of California programs for encouraging the installation of stationary fuel cells, and highlights of recently funded projects in California. The CaSFCC recently developed a "Roadmap for a Strategic Plan" that includes eight specific tasks that will be developed over the next several months. These tasks will be summarized and next steps identified.

05-5-5: Public Meeting to Update the Board on Compressed Natural Gas and Liquefied Natural Gas in California

This agenda item is to update the Board on natural gas issues that may warrant a modification of the regulatory specifications for compressed natural gas motor vehicle fuel. Staff will provide background and a description of the issues. These issues include statewide natural gas supply and usage, changes in natural gas motor vehicle technology, possible impact on mobile and stationary source emissions, and the possible impact of imported liquefied natural gas on California natural gas quality.

TO SUBMIT WRITTEN COMMENTS ON AN AGENDA ITEM IN ADVANCE OF THE MEETING:

CONTACT THE CLERK OF THE BOARD, 1001 I Street, 23rd Floor, Sacramento, CA 95814 (916) 322-5594
FAX: (916) 322-3928
ARB Homepage: www.arb.ca.gov

To request special accommodation or language needs, please contact the following:

- TTY/TDD/Speech-to-Speech users may dial 7-1-1 for the California Relay Service.
- Assistance for Disability-related accommodations, please go to http://www.arb.ca.gov/html/ada/ada.htm or contact the Air Resources Board ADA Coordinator, at (916) 323-4916.
- Assistance in a language other than English, please go to http://www.arb.ca.gov/as/eeo/languageaccess.htm or contact the Air Resources Board Bilingual Coordinator, at (916) 324-5049.

OPEN SESSION TO PROVIDE AN OPPORTUNITY FOR MEMBERS OF THE PUBLIC TO ADDRESS THE BOARD ON SUBJECT MATTERS WITHIN THE JURISDICTION OF THE BOARD.

THE AGENDA ITEMS LISTED ABOVE MAY BE CONSIDERED IN A DIFFERENT ORDER AT THE BOARD MEETING.

SMOKING IS NOT PERMITTED AT MEETINGS OF THE CALIFORNIA AIR RESOURCES BOARD

California Environmental Protection Agency

Air Resources Board

LOCATION:
Air Resources Board
Byron Sher Auditorium Second Floor
1001 I Street
Sacramento, California 95814

PUBLIC MEETING AGENDA

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May 26, 2005
9:00 a.m.

TITLE 17. CALIFORNIA AIR RESOURCES BOARD

NOTICE OF PUBLIC HEARING TO CONSIDER AMENDMENTS TO THE AIRBORNE TOXIC CONTROL MEASURE FOR STATIONARY COMPRESSION IGNITION ENGINES

The Air Resources Board (ARB or Board) will conduct a public hearing at the time and place noted below to consider amendments to the airborne toxic control measure for stationary compression-ignition engines. This notice summarizes the proposed amendments to the ATCM. The staff report presents the proposed amendments to the ATCM in greater detail.

DATE: May 26, 2005

TIME: 9:00 a.m.

PLACE: California Environmental Protection Agency
Air Resources Board
Byron Sher Auditorium, Second Floor
1001 I Street
Sacramento, California 95814

This item will be considered at a two-day meeting of the ARB, which will commence at 9:00 a.m., May 26, 2005, and may continue at 8:30 a.m., May 27, 2005. This item may not be considered until May 27, 2005. Please consult the agenda for the meeting, which will be available at least 10 days before May 26, 2005, to determine the day on which this item will be considered.

If you have a disability-related accommodation need, please go to http://www.arb.ca.gov/html/ada/ada.htm for assistance or contact the ADA Coordinator at (916) 323-4916. If you are a person who needs assistance in a language other than English, please contact the Bilingual Coordinator at (916) 324-5049. TTY/TDD/Speech-to-Speech users may dial 7-1-1 for the California Relay Service.

INFORMATIVE DIGEST OF PROPOSED ACTION AND POLICY STATEMENT OVERVIEW

Sections Affected: Proposed amendments to title 17, California Code of Regulations (CCR) section 93115.

Background

On February 26, 2004, the Board approved the Stationary Compression Ignition Engine ATCM to reduce diesel particulate matter (PM) emissions from new and in-use stationary diesel engines. Among other provisions, the ATCM contains a 0.15 grams

per brake horsepower-hour (g/bhp-hr) PM standard for new stationary compression ignition agricultural engines. Just prior to the effective date of the standard (January 1, 2005) local air districts and agricultural engine distributors notified ARB of their concern about the availability of compliant agriculture pump engines greater than 50 hp and less than 175 horsepower (hp).

ARB conducted an extensive investigation culminating in the Board taking emergency action at a regularly scheduled Board meeting on March 17, 2005. During the meeting, the Board heard a presentation from ARB staff and testimony from stakeholders within the agricultural industry, agriculture equipment distributors and dealers, engine manufacturers, and others. The testimony confirmed staff's findings that only a limited number of new stationary agricultural pump engines greater than 50 hp and less than 175 hp can meet the 0.15 g/bhp-hr PM standard. The Board took emergency action by removing the requirement that new stationary agricultural engines greater than 50 hp and less than 175 hp meet the 0.15 g/bhp-hr PM standard. Instead, such engines must meet the appropriate California and federal off-road certification standards for new engines. This action was based on the limited availability of 0.15 g/bhp-hr PM-compliant engines in the greater than 50 to less than 100 hp range and the limited number of manufacturers offering compliant engines in the 100 to less than 175 hp range.

The proposed revisions to the ATCM would ensure the continued availability of off-road California- and federal-compliant stationary agricultural pump engines, in all size ranges by all manufacturers, by making the emergency regulatory changes permanent.

Description of the Proposed Regulatory Amendments

For new stationary agriculture diesel pump engines that are greater than 50 hp and less than 175 hp, the proposed amendments require compliance with the current Off-Road Compression Ignition Engine Standards (Title 13 CCR Section 2423) applicable to an engine of the same brake horsepower rating and model year. These standards represent best available control technology for this category of engines.

For new stationary agriculture diesel engines used in other types of agriculture operations or other applications, such as generators, no amendments are being proposed at this time. The ATCM requires that these engines continue to meet the 0.15 g/bhp-hr PM standard, which is more stringent than the current off-road compression ignited engine PM standards.

Additional Provisions under Consideration

As directed by the Board on March 17, 2005, the ARB staff will also consider amendments to the ATCM for other stationary applications using new or in-use diesel engines, such as standby generators. Staff may also propose various clarifying provisions, and make non-substantive and minor editorial changes to the stationary engine ATCM. During the 45-day comment period and leading up to the Board hearing

starting on May 26, 2005, staff plans to collect additional information on this issue. If staff believes that it is appropriate to modify the current staff recommendation, the ARB staff will present proposed changes for the Board's consideration at the hearing. As described below, an additional 15-day comment period will then be provided if the Board approves either the language proposed by ARB staff or a different version.

COMPARABLE FEDERAL REGULATIONS

There are no federal regulations that require these stationary agricultural engines to meet emission standards. There are however federal emission standards for nonroad (off-road) mobile engines. In practice, the same engine models are typically used for both stationary and nonroad applications. Thus, though federal law does not require it, the nonroad standards can be reasonably applied to stationary agricultural engines. The proposed revisions to the ATCM will align the emission standards for stationary agricultural engines with these nonroad standards with which engine manufacturers have demonstrated an ability to comply. These Federal standards are set forth in the United States Code of Federal Regulations Title 40, Chapter 1, Part 89, Subpart B and Part 1039 Subpart B.

AVAILABILITY OF DOCUMENTS AND AGENCY CONTACT PERSONS

The Board staff has prepared a Staff Report: Initial Statement of Reasons (ISOR) for the proposed regulation action, which includes a summary of the environmental and economic impacts of the proposal. The ISOR is entitled, "Staff Report: Initial Statement of Reasons for Proposed Revisions to the Airborne Toxic Control Measure for Stationary Compression Ignition Engines."

Copies of the ISOR and the full text of the proposed regulatory language, in underline and strikeout format to allow for comparison with the existing regulations, may be accessed on the ARB'S web site listed below, or may be obtained from the Public Information Office, Air Resources Board, 1001 I Street, Visitors and Environmental Services Center, 1st Floor, Sacramento, CA 95814, (916) 322-2990 at least 45 days prior to the scheduled hearing which will begin on May 26, 2005.

Upon its completion, the Final Statement of Reasons (FSOR) will be available and copies may be requested from the agency contact persons in this notice, or may be accessed on the web site listed below.

Inquiries concerning the substance of the proposed regulations may be directed to the designated agency contact persons, Tony Andreoni, Manager of the Process Evaluation Section, at (916) 324-6021 or by email at tandreon@arb.ca.gov, or Barbara Cook, Air Pollution Specialist, at (916) 327-1507 or by email at bcook@arb.ca.gov.

Further, the agency representative and designated back-up contacts, to whom nonsubstantive inquiries concerning the proposed administrative action may be

directed, are Artavia Edwards, Manager, Board Administration & Regulatory Coordination Unit, (916) 322-6070, and Amy Whiting, Regulations Coordinator, (916) 322-6533. The Board has compiled a record for this rulemaking action, which includes all the information upon which the proposal is based. This material is available for inspection upon request to the contact persons.

This notice, the ISOR and all subsequent regulatory documents, including the FSOR, when completed, are available on the ARB Internet site for this rulemaking at http://www.arb.ca.gov/regact/statde05/statde05.htm.

COSTS TO PUBLIC AGENCIES AND TO BUSINESSES AND PERSONS AFFECTED

The determinations of the Board's Executive Officer concerning the costs or savings necessarily incurred by public agencies and private persons and businesses in reasonable compliance with the proposed amendments are presented below.

Pursuant to Government Code sections 11346.5(a)(5) and 11346.5(a)(6), the Executive Officer has determined that the proposed regulatory action will not create costs or savings to any state agency or in federal funding to the state, costs or mandate to any local agency or school district whether or not reimbursable by the state pursuant to Part 7 (commencing with section 17500), Division 4, Title 2 of the Government Code, or other nondiscretionary savings to state or local agencies.

The proposed regulatory action will also impose a mandate upon and create costs to local agencies (i.e., local air pollution control and air quality management districts; the "districts"). However, in this case, such administrative costs to the districts are recoverable by fees that are within the districts' authority to assess (see Health and Safety Code sections 42311 and 40510). Therefore, the Executive Officer has determined that the proposed regulatory action imposes no costs on local agencies that are required to be reimbursed by the state pursuant to part 7 (commencing with section 17500), division 4, title 2 of the Government Code, and does not impose a mandate on local agencies that is required to be reimbursed pursuant to Section 6 of Article XIII B of the California Constitution.

In developing this regulatory proposal, the ARB staff evaluated the potential economic impacts on representative private persons and businesses. The ARB is not aware of any cost impacts that a representative private person or business would necessarily incur in reasonable compliance with the proposed action.

The Executive Officer has made an initial determination that the proposed regulatory action will not have a significant statewide adverse economic impact directly affecting businesses, including the ability of California businesses to compete with businesses in other states, or on representative private persons.

In accordance with Government Code section 11346.3, the Executive Officer has determined that the proposed ATCM will not affect the creation or elimination of jobs

within the State of California, the creation of new businesses and the elimination of existing businesses within the State of California, or the expansion of businesses currently doing business within the State of California. A detailed assessment of the economic impacts of the proposed ATCM can be found in the ISOR.

The Executive Officer has also determined, pursuant to title 1, CCR, section 4, that the proposed regulatory amendments will affect small businesses since the proposed amendments may have a beneficial impact on small businesses.

In accordance with H&SC 43013(c), the Executive Officer has determined that the proposed amendments are necessary, cost-effective, and technologically feasible.

Before taking final action on the proposed amendments, the Board must determine that no reasonable alternative considered by the agency or that has otherwise been identified and brought to the attention of the agency would be more effective in carrying out the purpose for which the action is proposed or would be as effective and less burdensome to affected private persons than the proposed amendments.

SUBMITTAL OF COMMENTS

The public may present comments relating to this matter orally or in writing at the hearing, and in writing or by e-mail before the hearing. To be considered by the Board, written submissions must be received **no later than 12:00 noon, May 25, 2005**, and addressed to the following:

Postal mail is to be sent to:

Clerk of the Board
Air Resources Board
1001 I Street, 23rd Floor
Sacramento, California 95814

Electronic mail is to be sent to: statde05@listserv.arb.ca.gov, and received at the ARB **no later than 12:00 noon, May 25, 2005**.

Facsimile submissions are to be transmitted to the Clerk of the Board at (916) 322-3928 and received at the ARB **no later than 12:00 noon, May 25, 2005**.

The Board requests but does not require 30 copies of any written submission. Also the ARB requests that written, facsimile, and e-mail statements be filed at least 10 days prior to the hearing so that ARB staff and Board Members have time to fully consider each comment. The ARB encourages members of the public to bring to the attention of staff in advance of the hearing any suggestions for modification of the proposed regulatory action.

STATUTORY AUTHORITY AND REFERENCES

This regulatory amendment is proposed under the authority granted to the ARB in Health and Safety Code sections 39600, 39601, 39650, 39658, 39659, 39665, 39666, 41511, and 43013. This action is proposed to implement, interpret, or make specific Health and Safety Code sections 39002, 39650, 39658, 39659, 39665, 39666, 40000, 41511, and 43013.

HEARING PROCEDURES

The public hearing will be conducted in accordance with the California Administrative Procedure Act, Title 2, Division 3, Part 1, Chapter 3.5 (commencing with section 11340) of the Government Code.

Following the public hearing, the ARB may adopt the regulatory amendments as originally proposed or with non-substantial or grammatical modifications. The Board may also adopt the amendment language with other modifications if the text as modified is sufficiently related to the originally proposed text that the public was adequately placed on notice that the amendment language as modified could result from the proposed action. In the event that such modifications are made, the full regulatory text, with the modifications clearly indicated, will be made available to the public for written comment at least 15 days before it is adopted.

The public may request a copy of the modified regulatory text from the ARB's Public Information Office, Air Resources Board, 1001 I Street, Visitors and Environmental Services Center, 1st Floor, Sacramento, California 95814, (916) 322-2990.

CALIFORNIA AIR RESOURCES BOARD

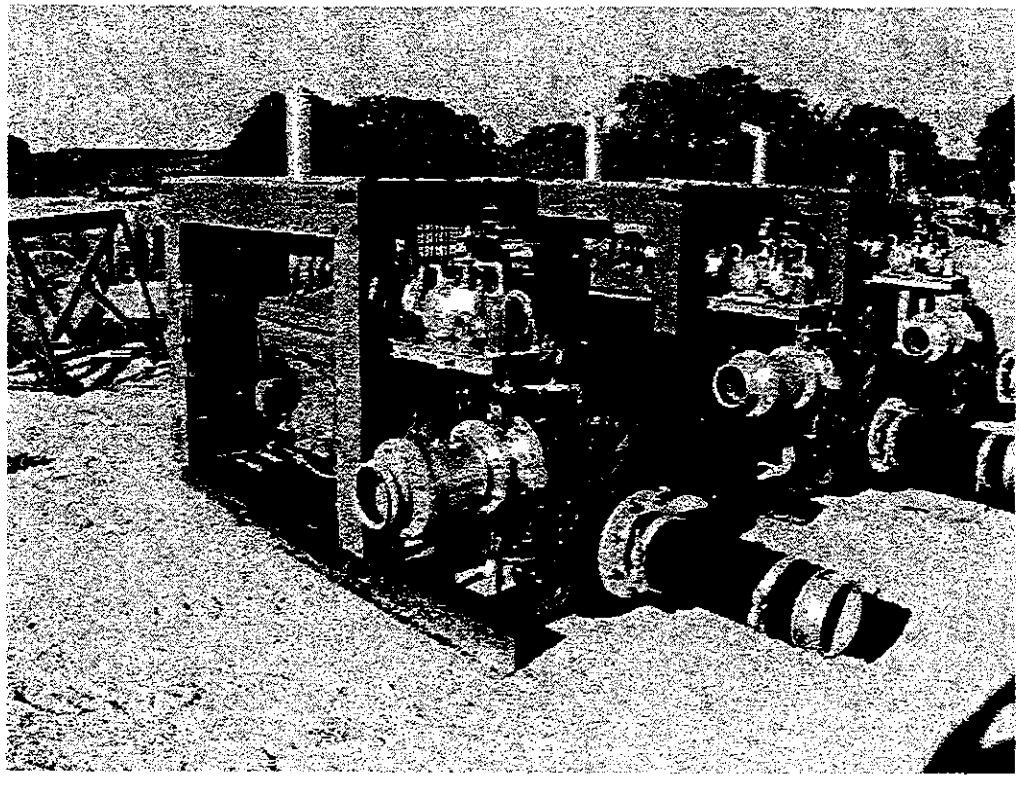
for Catherine Witherspoon
Executive Officer

Date: March 29, 2005

"The energy challenge facing California is real. Every Californian needs to take immediate action to reduce energy consumption. For a list of simple ways you can reduce demand and cut your energy costs, see our Web-site at www.arb.ca.gov."

California Environmental Protection Agency
AIR RESOURCES BOARD

STAFF REPORT: INITIAL STATEMENT OF REASONS FOR PROPOSED REVISIONS TO THE AIRBORNE TOXIC CONTROL MEASURE FOR STATIONARY COMPRESSION IGNITION ENGINES



Stationary Source Division
Emissions Assessment Branch

April 2005

State of California
AIR RESOURCES BOARD

STAFF REPORT: INITIAL STATEMENT OF REASONS FOR PROPOSED RULEMAKING

Public Hearing to Consider

REVISIONS TO THE AIRBORNE TOXIC CONTROL MEASURE FOR STATIONARY COMPRESSION IGNITION ENGINES

To be considered by the Air Resources Board on May 26, 2005, at:

California Environmental Protection Agency
Headquarters Building
1001 "I" Street
The Byron Sher Auditorium
Sacramento, California

Stationary Source Division:
Peter D. Venturini, Chief
Robert D. Barham, Assistant Chief
Emission Assessment Branch:
Dan Donohoue, Chief
Process Evaluation Section:
Tony Andreoni, Manager

State of California
AIR RESOURCES BOARD

PROPOSED REVISIONS TO THE AIRBORNE TOXIC CONTROL MEASURE FOR STATIONARY COMPRESSION IGNITION ENGINES

Executive Summary and
Technical Support Document

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Planning and Technical Support Division

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ACKNOWLEDGEMENTS

We would like to thank the California Air Resources Board Carl Moyer Program staff, San Joaquin Valley Unified Air Pollution Control District, other local air districts, agricultural industry organizations, and agricultural engine manufacturers, distributors, and dealers for providing information used in this Staff Report.

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State of California
AIR RESOURCES BOARD

Staff Report: Initial Statement of Reasons for Proposed Revisions to the Airborne Toxic Control Measure for Stationary Compression Ignition Engines

Executive Summary

I. DISCUSSION OF THE PROPOSED REVISIONS

Why is ARB proposing to revise the Airborne Toxic Control Measure for Stationary Compression Ignition Engines (ATCM)?

On February 26, 2004, the California Air Resources Board (ARB or the Board) approved the Stationary Compression Ignition Engine ATCM to reduce diesel particulate matter (PM) emissions from new and in-use stationary diesel engines. Among other provisions, the ATCM contains a 0.15 grams per brake horsepower-hour (g/bhp-hr) PM standard for new stationary compression ignition agricultural engines. Just prior to the effective date of the standard (January 1, 2005), local air districts and agricultural engine distributors notified ARB of their concern about the availability of compliant agricultural pump engines greater than 50 to less than 175 horsepower (hp).

The ARB staff conducted an extensive investigation and reported to the Board at its regularly scheduled Board meeting on March 17, 2005. During the meeting, the Board heard a presentation from ARB staff and testimony from stakeholders within the agricultural industry, agriculture equipment distributors and dealers, engine manufacturers, and the Engine Manufacturers Association. As a result, the Board unanimously took emergency action to remove the requirement that new stationary agricultural pump engines greater than 50 to less than 175 hp meet the 0.15 g/bhp-hr PM standard. In place of the 0.15 g/bhp-hr PM standard, the Board determined that such engines must meet the appropriate California and federal off-road certification standards for new engines, currently known as "Tier 2" standards. This action was based on the very limited availability of 0.15 g/bhp-hr PM-compliant engines in the greater than 50 to 99 hp range and the limited number of manufacturers offering compliant engines in the 100 to 174 hp range.

The limited availability of small compliant stationary agricultural pump engines, coupled with the limited number of manufacturers offering medium-size compliant engines, could reduce the agricultural community's ability to replace dirtier, older, uncontrolled diesel engines with cleaner diesel engines. Currently, many farmers use financial incentives provided by the Carl Moyer Memorial Air Quality Standards Attainment Program (Carl Moyer Program) and the federal Environmental Quality Incentives Program (EQIP) to voluntarily replace older

engines. These voluntary engine replacements may be slowed by limitations in the number and variety of available stationary agricultural pump engines. In addition, farmers may decide to delay replacement, when faced with a choice of replacing an engine with a larger engine or an engine from an unfamiliar manufacturer. This will reduce the effectiveness of the ATCM and its ability to protect the public from the adverse health effects associated with exposure to diesel PM. Furthermore, adverse consequences would occur if farmers were not able to replace engines that had failed, or to install new engines as needed. Also, equipment dealers would not be able to sell non-compliant engines already in stock or on order.

The emergency amendments became effective on April 4, 2005, but will only apply through August 2, 2005. The proposed revisions to the ATCM would ensure the continued availability of new lower-emitting off-road California- and federal-compliant stationary agricultural pump engines by making the emergency regulatory changes permanent.

What are the proposed revisions to the ATCM?

Staff are proposing that the Board revise the ATCM to require that new stationary agricultural pump engines greater than 50 to less than 175 hp comply with less stringent California and federal new off-road engine certification standards instead of the 0.15 g/bhp-hr PM standard. Staff are also proposing several non-substantive clarifications to the regulatory text. These changes and the rationale for them are presented in Appendix D of this Staff Report. All of staff's proposed revisions are included in Appendix A of this Staff Report.

What actions did ARB take to consult with interested parties?

From January through mid-March 2005, ARB staff requested information and interviewed representatives from agricultural industry groups and engine manufacturers, distributors and dealers. In February, 2005, ARB staff attended the World Agricultural Expo in Tulare, California and initiated discussions about ATCM compliance with numerous agricultural equipment vendors. On March 4, 2005, the agenda for the March 17, 2005 Board meeting announced to the public that the Board would hear staff's proposal regarding emergency regulatory action on the ATCM at the meeting. On March 16, 2005, an electronic mailing to approximately 475 stakeholders (including environmental and citizen groups, agricultural and other industry representatives, and engine manufacturers, distributors, and dealers) provided additional information on the emergency regulatory changes to the ATCM that the Board would be considering at its March 17, 2005 meeting. On March 17, 2005, ARB staff presented its findings and recommendations to the Board and the Board took public testimony on the issue. On March 18, 2005, a follow-up electronic mailing informed stakeholders that: 1) the Board had approved emergency action to change the ATCM, 2) the Office of Administrative Law would review the emergency

regulatory changes, and 3) ARB would initiate a rulemaking to amend the ATCM. Additionally, in the April/May 2005 timeframe, ARB will hold one or more noticed public workshops to further discuss these proposed amendments to the ATCM.

What alternatives to the proposed revisions did ARB consider?

ARB staff also considered: 1) not revising the ATCM, 2) revising the 0.15 g/bhp-hr PM standard only for new stationary agricultural pump engines greater than 50 to 99 hp, 3) revising the 0.15 g/bhp-hr PM standard for a limited duration (i.e., one year), and 4) revising the standards for new stationary emergency standby engines as well as for agricultural pump engines. ARB staff do not believe the first two alternatives are viable based on engine availability and associated concerns regarding technical and economic issues. Staff do not believe that the third option is viable because we do not anticipate that engine manufacturers will increase the number of engine models meeting the 0.15 g/bhp-hr PM standard over the next few years.

Regarding the fourth option, revising new emergency standby engine PM standards, the ARB staff are continuing to gather information regarding the availability of 0.15 g/bhp-hr PM-compliant emergency standby engines and will report its findings to the Board along with any necessary revisions.

What is the environmental impact of the proposed revisions to the ATCM?

As a result of this action, ARB staff do not anticipate any significant adverse environmental impact. Staff estimate that potential PM reductions of approximately 8 tons per year will not occur. This represents a 3 percent less PM emission reduction than potentially would occur if the current inventory of non-certified (pre-1996) agricultural pump engines were replaced with 0.15 g/bhp-hr engines. We believe that the "loss" in emission reductions will not be as great as 8 tons per year for two reasons. First, we will recommend that Carl Moyer Program funding priority be given to stationary agricultural pump engine applications meeting 0.15 g/bhp-hr PM. We believe that this action will motivate engine dealers and farmers to install the lower emitting engines. Second, we believe that the proposed in-use agricultural engine regulations, under development by both the districts and ARB, will help motivate farmers to install the cleanest engine available or replace the existing engine with an electric motor.

Without the proposed action, some potential emission reductions could be lost if farmers elect not to replace their older dirtier engines.[1] If an existing non-certified (pre-1996) engine were to remain in service, the PM emissions would be two to three times greater than an engine meeting the current new off-road engine

[1] The Stationary Compression Ignition Engine ATCM does not require existing agricultural engines to be replaced. However, if an existing engine is replaced, or, if a new engine is installed, it must meet the new stationary agricultural engine standards in the ATCM.

certification standards. Since engine replacement is voluntary, staff can not predict the exact emission and risk reductions that would occur under either the current ATCM or the proposed revisions; however, staff can predict that no increase in current levels of PM emissions and risk will occur as a result of the proposed revisions.

What is the potential health impact of the proposed revisions to the ATCM?

The proposed revisions are not expected to have any significant adverse health impact. As discussed above, there is the potential for not achieving up to 8 tons per year of diesel PM by this action. This would mean that rather than achieving a projected 72 percent reduction in PM emissions from stationary agricultural engines, we would achieve a PM reduction of about 69 percent. For new engines in the greater than 50 to less than 175 hp range, PM emissions under this proposal would be slightly higher than anticipated in the original ATCM. As a result, individuals living near these agricultural pump engines would be exposed to slightly higher levels of diesel PM compared to the exposure anticipated in the original ATCM. Offsetting this potential for increased exposure is the potential that, without this action, higher emitting engines would not be replaced at all. Given the offsetting potential, and the anticipated benefits of recommending Carl Moyer Program funding priority to the lower emitting engines, staff do not anticipate any significant adverse health impacts from this action.

What is the cost impact of the proposed revisions to the ATCM?

ARB does not expect the proposed revisions to result in any increased costs for buyers, sellers, or manufacturers of stationary diesel agricultural pump engines. The revisions are expected to facilitate the transition to cleaner engines and avert potential disruptions in the agricultural engine market and potential cost impacts to farmers and equipment distributors and dealers.

How do the proposed revisions to the ATCM relate to ARB's goals for Environmental Justice?

The proposed revisions to the ATCM are consistent with the environmental justice policy to reduce health risks from toxic air contaminants in all communities, including low-income and minority communities, regardless of location. The proposed revisions would allow farmers to continue to replace older, dirtier, uncontrolled diesel agricultural pump engines greater than 50 to less than 175 hp with cleaner diesel engines, thereby reducing emissions of, and exposure to, diesel PM, an identified toxic air contaminant.

II. RECOMMENDATION

Staff recommend that the Board adopt the ARB's proposed regulatory changes to the ATCM for Stationary Compression Ignition Engines. The proposed revisions

to the ATCM's PM standards for new stationary compression ignition agricultural pump engines greater than 50 to less than 175 hp are necessary to ensure the availability of compliant engines. These revisions would protect public health as well as prevent disruption and economic hardship for farmers and engine distributor/dealers by allowing the replacement of dirtier, older, uncontrolled diesel engines with cleaner diesel engines that meet California and federal new off-road engine certification standards. Staff further recommend that guidance be provided to the local air districts recommending that Carl Moyer Program funding priority be given to stationary agricultural pump engine applications meeting 0.15 g/bhp-hr PM.

In addition, staff recommend that the Board adopt several proposed non-substantive clarifications to the regulatory text (Please see Appendix D of this Staff Report). All of staff's proposed revisions are included in Appendix A of this Staff Report.

State of California
AIR RESOURCES BOARD

Staff Report:
Initial Statement of Reasons for Proposed Revisions to the Airborne Toxic Control Measure for Stationary Compression Ignition Engines

Technical Support Document

I. BACKGROUND

A. OVERVIEW

This report provides the basis for staff's proposed revisions to the Airborne Toxic Control Measure for Stationary Compression Ignition Engines (ATCM) particulate matter (PM) standards for new agricultural pump engines greater than 50 to less than 175 horsepower (hp). As of this writing, the proposed revisions do not address any other applications for compression ignition engines. The report includes information about the current standards, the need for ATCM revision, the proposed revised ATCM standards, regulatory alternatives considered, and potential environmental and economic impacts. In addition, the information and definitions provided in "Staff Report: Initial Statement of Reasons for Proposed Rulemaking - Airborne Toxic Control Measure for Stationary Compression Ignition Engines," September 2003, are hereby incorporated into this report by reference.

B. ATCM FOR STATIONARY COMPRESSION IGNITION ENGINES

At a public hearing on February 26, 2004, the California Air Resources Board (ARB or the Board) adopted the ATCM for Stationary Compression Ignition Engines in accordance with California's Toxic Air Contaminants Program. Among other requirements, the ATCM established best available control technology (BACT)-based PM emission performance standards for new stationary compression ignited engines.

For new stationary agricultural and emergency standby engines greater than 50 hp, the PM standard was set at 0.15 grams per brake horsepower-hour (g/bhp-hr). At the time the standard was adopted, ARB believed that compliant agricultural and emergency standby engines would be available in the horsepower sizes needed because off-road new engine certification test results indicated several engine models of various sizes with exhaust emissions at or below 0.15 g/bhp-hr PM. The ATCM's current 0.15 g/bhp-hr PM standard is identical to the current California and federal off-road certification standards for new compression ignition engines greater than or equal to 175 hp. However, the current ATCM standard is more stringent than the current "Tier 2" California and

federal off-road certification standards for new engines greater than 50 to less than 175 hp. These standards are shown in Table 1-2 of this Staff Report.

Table I-1

California and Federal Off-Road New Compression Ignition Engine Particulate Matter Emission Standards*

Horsepower	Model Year		
	2005-2010 (g/bhp-hr)	2011 (g/bhp-hr)	2012+ (g/bhp-hr)
50-74	0.30	0.30	0.02
75-99	0.30	0.30	0.01
100-174	0.22	0.22	0.01
175-749	0.15	0.01	0.01

*The Board has adopted off-road new compression ignition engine certification standards identical to federal standards for such engines.

Just prior to January 1, 2005, local air districts and engine distributors notified ARB of their concern that 0.15 g/bhp-hr PM-compliant engines greater than 50 to less than 175 hp commonly used in agricultural irrigation pump applications were not available. ARB staff initiated an investigation to evaluate the technical and economic feasibility of the ATCM standard for small- to medium-sized agricultural pump engines. During this investigation, ARB met with dealers and distributors representing the major manufacturers of agricultural pump engines. ARB also reviewed off-road engine certification test data for pump applications and consulted with engine manufacturers and with air districts and organizations representing agricultural businesses. Based on the information gathered, ARB staff determined that there is very limited availability of compliant stationary diesel agricultural pump engines greater than 50 to 99 hp and that the availability of such engines in the 100 to 174 hp range is limited to one or two manufacturers.

Moreover, the availability of 0.15 g/bhp-hr PM-compliant engines greater than 50 to less than 175 hp is likely to be limited until 2012 when California and federal off-road new engine PM certification standards are scheduled to become more stringent as shown in Table I-1. Engine manufacturers preferentially design engines to meet national standards, rather than to meet California ATCM standards because of the relatively small market niche for agricultural pump engines. Additional information on the need for the proposed revisions is presented in Section II of this Staff Report.
(ARB, 2003b; ARB, 2004; ARB, 2005a; ARB, 2005b; CCR, 2004; CFR,2004; FR, 2004)

C. PURPOSE AND AUTHORITY

At its March 17, 2005 meeting, the Board adopted emergency regulatory amendments changing the ATCM's current 0.15 g/bhp-hr PM emission standard for new stationary agricultural pump engines greater than 50 to less than 175 hp to be identical to California and federal new off-road engine certification standards. The emergency amendments became effective on April 4, 2005, but will only apply through August 2, 2005. This Staff Report, including the proposed modified regulation in Appendix A, provides the administrative process necessary to finalize the emergency regulatory changes approved by the Board.

Table I-2 shows the revisions to the ATCM proposed by staff. It is necessary to adopt the proposed revisions to ensure that California farmers can continue to readily obtain, install, and use new stationary agricultural irrigation pump engines greater than 50 to less than 175 hp without undue disruption or economic hardship. Farmers are currently replacing older engines voluntarily using incentives provided by the Carl Moyer Memorial Air Quality Standards Attainment Program (Carl Moyer Program) and the federal Environmental Quality Incentives Program (EQIP). These agricultural pump engine replacements may be slowed by limitations in the number and variety of available engines. In addition, farmers may decide to delay replacement, when faced with a choice of replacing an engine with a larger engine or an engine from an unfamiliar manufacturer.

Table I-2

Proposed Revised Particulate Matter Emission Standards for New Stationary Agricultural Compression Ignition Engines Greater than 50 to Less Than 175 HP

Horsepower	Current ATCM (g/bhp-hr)	Proposed ATCM Revision (g/bhp-hr)	Current Tier 2 California-Federal Off-Road Engine Standards (g/bhp-hr)
>50-74	0.15	0.30	0.30
75-99	0.15	0.30	0.30
100-174	0.15	0.22	0.22

As a result of the proposed revisions, farmers would be allowed to replace older, dirtier, uncontrolled diesel engines with cleaner diesel engines, thereby reducing emissions and public exposure to diesel PM. ARB staff are not proposing revisions to the ATCM's 0.15 g/bhp-hr PM standard for new stationary agricultural pump engines greater than or equal to 175 hp because it is already identical to current California and federal off-road certification standards for new compression ignition engines of that size. Also, the proposed revisions would not change the ATCM's requirement that the PM standards for new stationary

engines of all sizes keep pace with California and federal new off-road engine certification standards as they become more stringent in the 2011/2012 timeframe (See Table I-1).

In addition, staff recommend that the Board adopt proposed non-substantive clarifications to the regulatory text. These changes and the rationale for them are presented in Appendix D of this Staff Report. All of staff's proposed revisions are included in Appendix A of this Staff Report.

D. PUBLIC OUTREACH AND ENVIRONMENTAL JUSTICE

1. Public Outreach

ARB staff conducted public outreach to ensure that affected and interested parties were aware of, and had the opportunity to participate in, the development and review of its regulatory proposals. Prior to the Board's approval of the ATCM on February 26, 2004, the ARB held eight public workshops, two public hearings, and numerous meetings and discussions with representatives of industry groups, environmental organizations, local air districts, and State and federal agencies. For a more detailed summary of public outreach efforts made prior to the rulemaking hearing, please see Section I.D. of "Staff Report: Initial Statement of Reasons for Proposed Rulemaking - Airborne Toxic Control Measure for Stationary Compression Ignition Engines," September 2003.

Based on concerns expressed to ARB about the availability of small- to medium-size new stationary agricultural pump engines, ARB staff requested information and talked with representatives from major agricultural industry groups and engine manufacturers, distributors and dealers. In February, 2005, ARB staff attended the World Agricultural Expo in Tulare, California and initiated discussions about ATCM compliance with numerous agricultural equipment vendors. On March 4, 2005, the agenda for the March 17, 2005 Board meeting announced to the public that the Board would hear staff's proposal regarding emergency action on the ATCM at the meeting. On March 16, 2005, an electronic mailing to approximately 475 stakeholders (including environmental and citizen groups, agricultural and other industry representatives, and engine manufacturers, distributors, and dealers) provided additional information on the emergency regulatory changes to the ATCM that the Board would be considering at its March 17, 2005 meeting. On March 17, 2005, ARB staff presented its findings and recommendations to the Board and the Board took public testimony on the issue. On March 18, 2005, a follow-up electronic mailing informed stakeholders that: 1) the Board had approved emergency action to change the ATCM, 2) the Office of Administrative Law would review the emergency regulatory changes, and 3) ARB would initiate a rulemaking to amend the ATCM. Additionally, in the April/May 2005 timeframe, ARB will hold one or more noticed public workshops to further discuss these proposed amendments to the ATCM.

2. Environmental Justice

The ARB is committed to integrating environmental justice in all of its activities. On December 13, 2001, the Board approved "Policies and Actions for Environmental Justice," which formally established a framework for incorporating environmental justice into the ARB's programs, consistent with the directives of State law. Environmental justice is defined as the fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulation, and policies. These policies apply to all communities in California, but recognize that environmental justice issues have been raised more in the context of low-income and minority communities.

The "Policies and Actions for Environmental Justice" are intended to promote the fair treatment of all Californians and to cover the full spectrum of ARB activities. Underlying these policies is a recognition that the ARB needs to engage community members in a meaningful way as it carries out its activities. People should have the best possible information about the air they breathe and about what is being done to reduce unhealthful air pollution in their communities. The ARB recognizes its obligation to work closely with all communities, environmental and public health organizations, industry, business owners, other agencies, and all other interested parties to successfully implement these policies. (ARB, 2001)

The proposed revisions to the ATCM are consistent with the environmental justice policy to reduce health risks from toxic air contaminants in all communities, including low-income and minority communities, regardless of location. The proposed revisions would allow farmers to continue to replace older, dirtier, uncontrolled diesel agricultural pump engines greater than 50 to less than 175 hp with cleaner diesel engines, thereby reducing emissions of, and exposure to, diesel PM, an identified toxic air contaminant. The amount of diesel PM emission and exposure reduction in low-income, minority, and other communities would depend on the number, use, and replacement rate of such engines in the area.

II. NEED FOR REVISIONS

A. STATIONARY AGRICULTURAL PUMP ENGINE EMISSION INVENTORY

In California, pumping water for the irrigation of crops and to provide water for livestock is the predominant agricultural activity requiring a stationary source of power. Statewide, approximately 80 percent of agricultural pumps are powered by electric motors. Nearly all of the remaining agricultural pumps are powered by compression ignition engines using diesel fuel. For year 2002, ARB staff

estimate approximately 5,300 stationary diesel-fueled agricultural irrigation pump engines emitting about 564 tons per year (TPY) of particulate matter, statewide (See Appendix C of this Staff Report). Using diesel agricultural engine horsepower distribution data from the San Joaquin Valley Unified Air Pollution Control District (SJVUAPCD) and average horsepower for each size category, ARB calculated emissions based on pump engine size as shown in Table II-1. (ARB, 2003a; NASS, 2003; SJVUAPCD, 2005)

Table II-1

Estimated 2002 Total Statewide Stationary Diesel-Fueled Agricultural Pump Engine Particulate Matter Emissions

Horsepower	Number of Engines	Tons Per Year PM
>50-74	100	3
75-99	100	4
100-174	2,000	134
≥175	3,100	423
Total	5,300	564

B. AVAILABILITY OF AGRICULTURAL PUMP ENGINES WITH EXHAUST EMISSIONS AT OR BELOW 0.15 G/BHP-HR PARTICULATE MATTER

Manufacturers design new off-road engines to comply with California and federal new off-road engine certification standards. The availability of 175 hp and greater stationary agricultural pump engines that comply with the ATCM's 0.15 g/bhp-hr PM standard is not an issue because California and federal new off-road engine standards are currently 0.15 g/bhp-hr for engines of that size. However, the ATCM's 0.15 g/bhp-hr PM standard is more stringent than California and federal standards for new off-road compression ignition engines greater than 50 to less than 175 hp.

Tables II-2 and II-3 are based on ARB's review of 2005 off-road compression ignition engine certification testing data and information from major manufacturers of agricultural pump engines. Table II-2 shows that about 10 percent of 50 to 99 hp engines manufactured for the agricultural market test at or below 0.15 g/bhp-hr PM. Table II-3 shows that approximately 50 percent of 100 to 174 hp engines manufactured for the agricultural market test at or below 0.15 g/bhp-hr PM and that 80 percent of these engines are produced by a single manufacturer. Also, although engine models test at or below 0.15 g/bhp-hr PM, they are certified to maintain PM exhaust emission levels at or below 0.30 g/bhp-hr (for 50-99 hp engines) or 0.22 g/bhp-hr (for 100-174 hp engines).

Since manufacturers design engines to comply with national off-road new engine standards, the limited availability of 0.15 g/bhp-hr PM-compliant stationary agricultural pump engines greater than 50 to less than 175 hp is not likely to change until 2012. In 2012, California and federal standards for new off-road engines 50 to 74 hp will change from 0.30 to 0.02 g/bhp-hr; for engines 75 to 99 hp from 0.30 to 0.01 g/bhp-hr; and for engines 100 to 174 hp from 0.22 to 0.01 g/bhp-hr.
(ARB, 2004; ARB, 2005a; ARB, 2005b; CCR, 2004; CFR, 2004; FR,2004)

Table II-2

Agricultural Pump Engine Availability in the 50-99 HP Range

Horsepower	Manufacturer				
	A	B	C	D	E
50-69	2	0	0	*	0
70-89	0	0	0	0	1
90-99	1	2	*	0	1
Total Pump Engines	14	20	5	4	9
Ratio of Compliant to Non-compliant Engines	3/14	2/20	0/5	0/4	2/9
Total A-E Compliant vs. Non-compliant Engines = 7/52					

* No pump engines in the hp range for 2005.

Table II-3

Agricultural Pump Engine Availability in the 100-174 HP Range

Horsepower	Manufacturer				
	A	B	C	D	E
100-120	0	3	*	0	0
121-140	1	7	0	0	0
141-160	1	7	*	0	1
161-174	4	14	0	1	0
Total Pump Engines	20	37	2	7	4
Ratio of Compliant to Non-compliant Pump Engines	6/20	29/37	0/2	1/7	1/4
Total A-E Compliant vs. Non-compliant Pump Engines = 37/50					

* No pump engines in the hp range for 2005.

C. ISSUES ASSOCIATED WITH LIMITED AVAILABILITY OF COMPLIANT ENGINES

In consultation with the agricultural community and engine manufacturers, distributors, and dealers, ARB staff identified the following critical issues associated with the limited availability of 0.15 g/bhp-hr PM-compliant stationary agricultural pump engines greater than 50 to less than 175 hp:

- Certain existing engines can not be replaced with similar models from the same manufacturer because the appropriate replacement engine does not comply with the 0.15 g/bhp-hr PM standard. Generally, farmers prefer to repower with similar make and model engines based on familiarity with service and maintenance requirements, cost, and/or brand loyalty. These preferences are important because the replacement of older, dirtier diesel engines with new cleaner engines is voluntary and may be slowed or delayed if the engines farmers want are not available.
- Replacing existing engines with engines of different makes, models, or horsepower sizes may result in requiring farmers to purchase engines not specifically suited to the pumping tasks required. Moreover, such replacement may entail burdensome costs to farmers of up to several thousand additional dollars for the replacement engine plus up to several thousand additional dollars for ancillary equipment.
- Carl Moyer Program funding for the replacement of stationary agricultural pump engines greater than 50 to less than 175 hp has been impacted due to the limited availability of engines meeting the 0.15 g/bhp-hr PM standard. Applications for replacement engines not meeting the standard can not be completed.

These issues are expected to result in some farmers not voluntarily replacing pre-1996 uncontrolled stationary diesel agricultural pump engines greater than 50 to less than 175 hp. There are estimated to be about 950 of these pre-1996 engines currently in use. The replacement of older, dirtier, uncontrolled diesel agricultural pump engines with cleaner diesel engines has been actively promoted and supported by the ARB, local air districts, the State Legislature, the United States Environmental Protection Agency, and others for more than five years. Over this time period, engine distributors and dealers indicate from 300 to 500 stationary agricultural pump engines greater than 50 to less than 175 hp have been sold per year. If engine replacement does not proceed, anticipated reductions in emissions of, and exposure to, diesel PM can not be achieved. This will reduce the effectiveness of the original ATCM and its ability to protect the public from the adverse health effects associated with exposure to diesel PM.

Another issue that has created some unintended economic impacts is that a number of dealers were confused about how the ATCM applied to engines

funded under the Carl Moyer Program. Several dealers indicated that they thought that Moyer funded engines did not have to meet the 0.15 g/bhp-hr PM limit. As a result, some California dealers and distributors have several hundred engines on hand or on order that do not meet the 0.15 g/bhp-hr PM standard. Because of this, and the fact that the ATCM did not contain a "sell-through" provision, some dealer/distributors were left with expensive inventories of Tier 2-certified engines that can not be sold in California. The emergency regulation approved by the Board on March 17, 2005, allows dealer/distributors to sell these engines until the emergency regulation expires on August 3, 2005. Given the typical processing time for Carl Moyer and EQIP program applications, it is unlikely that all of these engines will be sold by August 3, 2005. The proposed revisions would address this issue by eliminating the August 3, 2005 deadline for the sale of Tier 2-certified engines. Additional information on the issues associated with limited availability of 0.15 g/bhp-hr PM-compliant engines is provided in Section III.D. and Appendix C of this Staff Report. (ARB, 2005b)

III. PROPOSED REVISIONS

A. SUMMARY

Table III-1 summarizes the proposed revisions to the ATCM. Essentially, ARB staff are proposing that the Board revise the ATCM to require new stationary agricultural pump engines greater than 50 to less than 175 hp to comply with California and federal new off-road engine certification PM standards instead of a 0.15 g/bhp-hr PM standard. Staff are not proposing any revisions to the ATCM's 0.15 g.bhp-hr PM standard for new stationary agricultural pump engines greater than or equal to 175 hp because that standard is already identical to the current California and federal off-road certification standards for new compression ignition engines of that size. The proposed revisions would not change the ATCM's requirement that PM standards for new stationary agricultural pump engines of all sizes keep pace with California and federal new off-road engine standards as they become more stringent in the 2011/2012 timeframe (See Section I, Table I-1, of this Staff Report).

The Board's adoption of these proposed revisions would make permanent the emergency regulatory changes approved by the Board on March 17, 2005.

In addition, staff recommend that the Board adopt several proposed non-substantive clarifications to the regulatory text. These changes and the rationale for them are presented in Appendix D of this Staff Report. All of staff's proposed revisions are included in Appendix A of this Staff Report. (ARB, 2004; CCR, 2004; CFR, 2004; FR, 2004)

Table III-1

Proposed Revised Particulate Matter Emission Standards for New Stationary Agricultural Compression Ignition Engines Greater Than 50 and Less Than 175 HP*

Horsepower	Current ATCM (g/bhp-hr)	Proposed ATCM Revision (g/bhp-hr)	Current Tier 2 California-Federal Off-Road Engine Standards (g/bhp-hr)
>50-74	0.15	0.30	0.30
75-99	0.15	0.30	0.30
100-174	0.15	0.22	0.22

*The Board has adopted off-road new compression ignition engine certification standards identical to federal standards for such engines.

B. EMISSIONS AND RISK ANALYSIS FOR THE PROPOSED REVISIONS

Without the proposed ATCM revisions, ARB staff believe that there will be a limited supply of agricultural pump engines in the greater than 50 to less than 175 hp range, and an associated escalation of the cost for the complying engines due to limited supply. As a result, some farmers that otherwise would have voluntarily replaced their existing stationary agricultural pump engines may not do so. This could result in less PM emission reductions than anticipated under the original ATCM.

Staff are recommending that the ATCM be revised to require stationary agricultural pump engines greater than 50 to less than 175 hp to meet the current Tier 2 California and federal new off-road engine certification standards. This action will result in somewhat less emission reductions compared to what would have occurred if 0.15 g/bhp-hr engines were available. Below, staff compare what these PM emission reductions would be if farmers were to replace uncontrolled engines (model year 1995 and earlier) under each scenario. For this evaluation, staff assumed that farmers would not voluntarily replace model year 1996 and later Tier 1- and Tier 2-certified engines. The Carl Moyer Program, established in 1998, has helped many farmers purchase certified replacement engines and generally requires that these engines be used at least five to seven years.

Using ARB staff's best current estimate of PM emissions from stationary agricultural pump engines (ARB, 2003a) indicates a total for all stationary and portable agricultural pump engines of about 870 tons per year (TPY), statewide. Approximately 35 percent of these are estimated to be portable engines leaving a

total PM estimate from stationary agricultural pump engines of about 560 TPY. Staff apportioned these emissions to the horsepower and control categories using a horsepower-weighted distribution. This distribution is based on extrapolating the distribution of engines developed by the San Joaquin Valley Unified Air Pollution Control District (SJVUAPCD, 2005). This approach gives emissions from uncontrolled engines of 240 TPY. For these uncontrolled engines, Table III-2 gives the baseline emissions and compares the potential PM emission reductions under the existing ATCM to those from the proposed revised ATCM.

Table III-2

Estimated Particulate Matter Emissions Reductions for the Current and Proposed ATCM

Horsepower	Baseline Emissions (TPY)	Current ATCM (TPY reduced)	Proposed Revised ATCM (TPY reduced)	Difference (TPY)
>50-99	3.3	2.8	2.2	0.6
100-174	57	41.4	34.1	7.3
≥175*	179.7	128.8	128.8	0
Total	240	173	165.1	7.9

*The current ATCM's PM standard for agricultural engines greater than or equal to 175 hp would not be changed by the proposed revisions.

The additional PM emission reductions that would result from replacement of all uncontrolled engines with engines that meet the 0.15 g/bhp-hr PM standard instead of engines that meet the current Tier 2 new off-road engine PM standards would be at most eight (8) tons per year. This is about three (3) percent of the baseline PM emissions from uncontrolled stationary agricultural pump engines and about one (1) percent of PM emissions from all stationary agricultural pump engines, statewide.

To evaluate the potential risk to the public from engines emitting PM at the Tier 2 off-road engine standards rather than the ATCM standard, ARB staff performed air quality modeling for engines representative of the greater than 50 to 99 hp and 100 to 174 hp categories. The analysis showed the potential for a small increase in risk. However, offsetting this potential for increased risk is the potential that higher emitting engines would not be replaced at all and the diesel PM emissions and risk from this source would continue unabated. The current ATCM does not require existing stationary agricultural pump engines to be replaced. It requires that if an existing engine is replaced, the replacement engine must meet the new stationary agricultural engine standards in the ATCM. Given the technical and economic issues discussed earlier, retaining the current ATCM's 0.15 g/bhp-hr PM standard for new stationary agriculture pump engines

is likely to reduce voluntary replacement of older engines. As this occurs, the emission and risk reductions anticipated by the current ATCM will be reduced. Since engine replacement is voluntary, staff can not predict the exact emission and risk reductions that would occur under either the current ATCM or the proposed revisions; however, staff can predict that no increase in current levels of PM emissions and risk will occur as a result of the proposed revisions.

C. AVAILABILITY OF EMERGENCY STANDBY ENGINES COMPLYING WITH THE 0.15 G/BHP-HR PARTICULATE MATTER STANDARD

During testimony at the March 17, 2005 Board meeting, the Board was requested to also amend the ATCM's 0.15 g/bhp-hr PM standard for new stationary compression ignition emergency standby engines. Staff intend to investigate this issue and report to the Board at the May 2005 Board meeting.

D. ALTERNATIVES TO THE PROPOSED REVISIONS

ARB staff considered the following four alternatives to the amendments. For each option, staff have identified both technical and economic issues.

1. Do nothing (leave the requirements in the ATCM standing),
2. Revise the requirements of the ATCM only for agricultural pump engines 50 to 99 hp,
3. Revise the 0.15 g/bhp-hr standard for a limited duration (i.e., one year), or
4. Revise the ATCM requirements for new stationary emergency standby engines as well as for agricultural pump engines.

Option 1 – Do not revise the ATCM.

If the ATCM requirements for new stationary agricultural pump engines greater than 50 to less than 175 hp remained in place, some farmers would delay pump engine replacements. If a delay was not feasible, farmers could consider three options for meeting the ATCM standard: purchase a different brand of engine, replace an existing small (greater than 50 to less than 175 hp) uncontrolled engine with a larger engine, or install a diesel particulate filter on a new small engine. Replacing an existing engine with a different make and model engine will be feasible in some, but not all cases. For example, as shown in Tables II-2 and II-3 of this Staff Report, in the 70 to 89 hp range, we found only one complying engine on the market. In several cases (i.e., 50 to 69 hp and 100 to 120 hp) we found only one manufacturer offering complying engines. In addition, replacing an existing engine with a different make and model can require replacement of the pump or other ancillary equipment, significantly increasing the cost.

Replacing existing small stationary diesel agricultural pump engines with larger engines has some significant drawbacks. Most pump engine manufacturers and dealers recommend that an agricultural pump engine be operated under at least a 60 to 70 percent load. Operating at lesser loads, particularly during the initial breaking-in period, may cause excess piston ring wear and oil leakage or "slobber." Oil slobber increases engine wear and decreases engine life. Under certain situations, a larger engine may use more fuel and emit more than a smaller engine. Also, a larger replacement engine would cost from 10 to 35 percent more than a smaller engine and may require that one or more pieces of ancillary equipment be replaced at additional cost.

Farmers could comply by purchasing a diesel particulate filter (DPF) and having it installed on a new engine that did not meet the 0.15 g/bhp-hr PM standard. This option could increase the cost of replacement by 30 to 50 percent. In some instances, using a DPF could double the capital cost of the engine. There would be some additional maintenance costs compared to an engine without a DPF. Currently there are no DPF systems that have received ARB verification for off-road engine agricultural pump applications. For engines equipped with DPFs, periodic testing and inspections may be needed to ensure compliance. Testing and inspection further increase the cost of compliance. Thus, this alternative would substantially increase the costs and regulatory burden for farmers. Based upon these technical and economic issues, staff did not recommend this option.

Option 2 - Revise the ATCM only for agricultural pump engines greater than 50 to 99 horsepower.

The ATCM could be revised to require that new stationary agricultural pump engines meet new off-road engine Tier 2 certification standards rather than the 0.15 g/bhp-hr PM standard only for engines greater than 50 to 99 hp. Staff evaluated the potential change in emissions and risk based on the assumption that the engines most likely to be replaced in the near future would be uncontrolled engines purchased prior to 1996. Stationary agricultural pump engines purchased in California on or after 1996 are more likely to be certified to Tier 1 or Tier 2 California-federal new off-road engine standards. Table III-3 shows our best estimate of the number of uncontrolled engines versus total engines in each of the size ranges.

Table III-3

Estimated Uncontrolled versus Total Statewide Stationary Diesel-Fueled Agricultural Pump Engines

Horsepower	Uncontrolled Engines	Total Engines
> 50 to 99	90	200
100 to 174	860	2,000
≥175	1,300	3,100
Total	2,250*	5,300

*950 uncontrolled engines in the 50 to 174 hp range.

Changing the 0.15 g/bhp-hr PM standard only for the engines in the greater than 50 to 99 horsepower range would address the size category in which the availability of engines capable of meeting the 0.15 g/bhp-hr PM standard is most severely limited. The limitation for engines in the 100 to 174 hp range is less severe because more than half of the engine models are capable of complying with the 0.15 g/bhp-hr PM standard. However, 80 percent of those complying engines are produced by a single manufacturer. While this option might result in lower emissions, if farmers were reluctant to switch to a different manufacturer, replacement of existing higher-emitting engines would likely be delayed. This option is likely to result in higher costs to farmers who did choose to buy engines from a different manufacturer due to the need to replace ancillary equipment. Staff did not propose this option due to concerns about the limited number of manufacturers offering complying engines, the potential for increased costs associated with replacing ancillary equipment, the potential negative economic impact on dealer/distributors who could not sell engines currently in inventory, and the potential for farmers to delay replacing older engines.

Option 3. Revise the ATCM by postponing the 0.15 g/bhp-hr standard for a year.

Under this option, the 0.15 g/bhp-hr PM standard could be receded for a limited duration, for example one year, to allow for additional time for more engine manufacturers to produce 0.15 g/bhp-hr PM-compliant engines. This would be a viable option if staff were confident that engine manufacturers were likely to produce complying engines. However, staff are not confident that this will occur for two reasons. First, the number of stationary agricultural pump engines in the greater than 50 to less than 175 hp range that would be sold in California is very small relative to the total number of engines sold in this horsepower range. This makes it very unlikely that engine manufacturers will produce a California-only 0.15 g/bhp-hr PM-compliant agricultural pump engine. Second, engine manufacturers are faced with meeting more stringent oxides of nitrogen (NOx) standards for these same engines beginning in 2007/2008. In order to meet the lower NOx limits, it is likely that the PM emissions levels for these engines will

increase closer to the allowable certification levels of 0.30 or 0.22 g/bhp-hr. As this occurs, we anticipate that fewer engines will be offered that meet the 0.15 g/bhp-hr PM limit and some of the engines currently meeting that limit will no longer do so. Given these considerations, staff is not proposing this as a viable option.

Option 4 – Revise the ATCM for emergency standby engines as well as for agricultural pump engines.

ARB staff lack information on which to base a recommendation regarding emergency standby engines less than 175 hp. For example, insufficient data is available to estimate the number of emergency standby engines needed to be replaced per year. Moreover, staff have not identified significant technical impediments to replacing an emergency standby engine with one from a different manufacturer. However, staff will continue to gather information on the availability of engines meeting the ATCM requirements for emergency standby and non-pump engines and will report to the Board on this issue at the May 2005 Board meeting.

IV. ECONOMIC IMPACT

The proposed revisions to the ATCM are expected to relieve the potential for cost increases for affected engines. The proposed revisions increase the number and types of engines available to farmers and do not cause shifts in the agricultural engine market or purchase of ancillary equipment. Engine dealers and distributors indicate they have sufficient engines that are certified to meet the current California and federal new off-road engine standards to supply the stationary agricultural pump market.

For dealers that have engines in stock or on order that do not meet the 0.15 g/bhp-hr PM standard of the current ATCM, the revisions will have an economic benefit since they would allow the engines to be sold in California. A potential economic impact on manufacturers unable to produce engines that meet the 0.15 g/bhp-hr PM standard would be averted by adoption of the amendments.

If the proposed revisions to the ATCM are adopted, manufacturers that currently offer 0.15 g/bhp-hr PM engines in the greater than 50 to less than 175 hp range may not sell as many of these engines as they might have if the current ATCM remained in place. This situation would be mitigated to some extent if replacement engines meeting the 0.15 g/bhp-hr PM limit are given priority for incentive funding under the Carl Moyer Program.

The potential impact to state and local governments due to the ATCM has been addressed in "Staff Report Initial Statement of Reasons for Proposed Rulemaking - Airborne Toxic Control Measure for Stationary Compression

Ignition Engines," September 2003. The proposed revisions will not result in any change in costs to state or local governmental agencies previously identified in that rulemaking. (ARB, 2003b; ARB, 2005b)

V. ENVIRONMENTAL IMPACT

On balance, staff believe that the proposed revisions to the Stationary Diesel Engine ATCM will have no adverse environmental impact. The potential increases in PM emissions for engines in the greater than 50 to less than 175 hp range, will be balanced by decreases that will occur due to the greater likelihood that farmers will replace older engines with the more widely-available Tier 2-certified engines.

Statewide, approximately 2,250 uncontrolled (i.e., non-certified) stationary agricultural pump engines operate in California. About 950 of these 2,250 engines are in the greater than 50 to less than 175 hp range. An average PM emission factor for these older engines is 0.7 g/bhp-hr. Replacing these uncontrolled engines with new Tier 2-certified engines or with engines meeting the 0.15 g/bhp-hr PM standard, would achieve a significant reduction in diesel PM. As shown in Table V-1, if all of the estimated 2,250 non-certified engines were replaced with engines meeting the current ATCM, we would achieve a PM emissions reduction of 173 tons per year. If all of the non-certified engines were replaced with engines meeting the proposed revised ATCM, we would achieve a PM emissions reduction of about 165 tons per year.

Table V-1

Estimated Particulate Matter Emissions Reductions for the Current and Proposed ATCM

Horsepower	Baseline Emissions (TPY)	Current ATCM (TPY reduced)	Proposed Revised ATCM (TPY reduced)	Difference (TPY)
>50-99	3.3	2.8	2.2	0.6
100-174	57	41.4	34.1	7.3
≥175*	179.7	128.8	128.8	0
Total	240	173	165.1	7.9

*The current ATCM's PM standard for agricultural engines greater than or equal to 175 hp would not be changed by the proposed revisions.

In the last column in Table V-1, is staffs' estimate of the maximum difference (7.9 tons per year) in PM reduction that could occur under the proposed revised ATCM. This represents about a 3 percent loss in PM emission reductions when one compares projected current and proposed ATCM emission reductions to 2002 baseline emission levels. (ARB, 2003a; SJVUAPCD, 2005)

Offsetting this potential for increased PM emissions, is the potential that without this action higher emitting engines would not be replaced at all. The current ATCM does not require existing stationary agricultural pump engines to be replaced. It requires that if an existing engine is replaced, the replacement engine must meet the new stationary agricultural engine standards in the ATCM. Given the technical and economic issues discussed earlier, retaining the current ATCM's 0.15 g/bhp-hr PM standard for new stationary agriculture pump engines is likely to reduce voluntary replacement of older engines. As this occurs, the emission reductions anticipated by the current ATCM will be reduced. It is not possible for staff to predict how much voluntary replacement may be reduced. However, if about 10 percent of the non-certified engines greater than 50 to less than 175 hp are not replaced because of technical or economic issues, the PM emission reduction "loss" will be more than 8 tons per year.
(ARB, 2003a; SJVUAPCD, 2005).

To maximize the emission reductions achieved by the ATCM, staff recommend that local air districts be encouraged to give Carl Moyer Program incentive funding priority to engines that meet 0.15 g/bhp-hr PM.

40

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APPENDIX A

PROPOSED REVISIONS TO THE AIRBORNE TOXIC CONTROL MEASURE FOR STATIONARY COMPRESSION IGNITION ENGINES

PROPOSED AMENDMENTS TO THE AIRBORNE TOXIC CONTROL MEASURE FOR STATIONARY COMPRESSION ENGINES

Note: The text of the proposed amendments to title 17, California Code of Regulations, section 93115 is shown in underline to indicate additions and ~~strikeout~~ to indicate deletions, compared to the regulatory language as it existed April 3, 2005. Since the emergency amendments that became operative April 4, 2005 are only effective for 120 days, those amendments are not shown. The symbol "* * * * *" means that intervening text not being amended has been omitted.

Amend title 17 California Code of Regulations section 93115 to read as follows:

Section 93115. Airborne Toxic Control Measure for Stationary Compression Ignition (CI) Engines.

* * * * *

(d) Definitions

* * * * *

(36) "Initial Start-up Testing" means operating the engine or supported equipment to ensure their proper performance either:

(A) for the first time after ~~initial~~ installation of a ~~new~~ stationary diesel-fueled CI engine at a facility, or

(B) for the first time after installation of emission control equipment on an in-use stationary diesel-fueled CI engine.

* * * * *

(e) Requirements

* * * * *

(2) Operating Requirements and Emission Standards for New and In-Use Stationary Diesel-Fueled CI Engines That Have a Rated Brake Horsepower of Greater than 50 (>50 bhp).

* * * * *

(E) ***Emission Standards for New Stationary Diesel-Fueled CI Engines (> 50 bhp) Used in Agricultural Operations***

1. As of January 1, 2005, except as provided in subsection (c) and subsection (e)(2)(E)2., no person shall sell, purchase, or lease for use in California any stationary diesel-fueled engine to be used in agricultural operations that has a rated brake horsepower greater than 50, or operate any new stationary diesel-fueled engine to be used in agricultural operations that has a rated brake horsepower greater than 50, unless the engine meets all of the following emission performance standards (which are summarized in Table 5.):

* * * * *

TABLE 5: SUMMARY OF THE EMISSION STANDARDS FOR NEW STATIONARY DIESEL-FUELED CI ENGINES > 50 BHP USED IN AGRICULTURAL OPERATIONS (SEE SUBSECTION (e)(2)(E))		
	DIESEL PM	*OTHER POLLUTANTS*
Horsepower Range (hp)	*DIESEL PM STANDARDS (g/bhp-hr)*	*HC, NOx, NMHC+NOx, AND CO STANDARDS (g/bhp-hr)*
Ag Pump Engines >50 to < 99	<0.30[1] OR Off-Road CI Engine Certification Standard for an off-road engine of the same maximum rated power, whichever is more stringent	Off-Road CI Engine Certification Standard for an off-road engine of the same model year and maximum rated power, or Tier 1 standard for an off-road engine of the same maximum rated power.[1]
Ag Pump Engines >99 to < 175	<0.22[1] OR Off-Road CI Engine Certification Standard for an off-road engine of the same maximum rated power, whichever is more stringent	
All other Ag Engines >50	<0.15[1] OR Off-Road CI Engine Certification Standard for an off-road engine of the same maximum rated power, whichever is more stringent.	

1. Prior to January 1, 2008, these limits shall not apply to engines approved for installation prior to January 1, 2005 and funded under State or federal incentive funding programs, as specified in (e)(2)(E)2.

a. Diesel PM Standard:

I. New agricultural stationary diesel-fueled CI pump engines with a maximum rated horsepower greater than 50 but less than or equal to 99 shall emit no more than 0.~~15~~30 g/bhp-hr diesel particulate matter (PM) ~~limit~~ or shall meet the current standards for off-road engines of the same maximum rated power as specified in the Off-Road Compression-Ignition Engine Standards (title 13, CCR, section 2423), whichever is lower; and

II. New agricultural stationary diesel-fueled CI pump engines, with a maximum rated horsepower greater than 99 but less than 175 shall emit no more than 0.22 g/bhp-hr diesel particulate matter (PM) or shall meet the current standards for off-road engines of the same maximum rated power as

specified in the Off-Road Compression-Ignition Engine Standards (title 13, CCR, section 2423), whichever is lower; and

III. Except as provided in subsection (e)(2)(E)1.a.I and (e)(2)(E)1.a.II all new agricultural stationary diesel-fueled CI engines, with a maximum rated horsepower greater than 50, shall emit no more than 0.15 g/bhp-hr diesel PM, or shall meet the current standards for off-road engines of the same maximum rated power as specified in the Off-Road Compression-Ignition Engine Standards (title 13, CCR, section 2423), whichever is lower; and

* * * * *

(3) Emission Standards for New Stationary Diesel-Fueled CI Engines, Less Than or Equal to 50 Brake Horsepower (< 50 bhp).

As of January 1, 2005, except as provided in subsection (c), no ~~owner or operator~~ person shall sell, offer for sale, or lease for use in California any stationary diesel-fueled CI engine that has a rated brake horsepower less than or equal to 50, unless the engine meets the current Off-Road Compression-Ignition Engine Standards (title 13, CCR, section 2423) for PM, NMHC+NOx, and CO for off-road engines of the same maximum rated power. (These requirements are summarized in Table 6.)

TABLE 6 : SUMMARY OF THE EMISSION STANDARDS FOR STATIONARY DIESEL-FUELED CI ENGINES ≤ 50 BHP (SEE SUBSECTION (e)(3))
DIESEL PM STANDARDS, NMHC+NOx, AND CO STANDARDS (g/bhp-hr)
Current Off-Road CI Engine Certification Standard for an off-road engine of the same ~~model year and~~ maximum rated power.

* * * * *

(4) Recordkeeping , Reporting, and Monitoring Requirements

* * * * *

(D) Demonstration of Compliance with Emission Limits

1. Prior to the installation of a new stationary diesel-fueled CI engine at a facility, the owner or operator of the new stationary diesel-fueled CI engine(s) subject to the requirements of section (e)(2)(A)3~~.~~, or (e)(2)(C)1, (e)(2)(E)(1), or (e)(2)(F)1c, shall provide emission data to the District APCO in accordance with the requirements of subsection (h) for purposes of demonstrating compliance.

2. By no later than the earliest applicable compliance date specified in subsections (f) or (g), the owner or operator of an in-use stationary diesel-fueled CI engine(s) subject to the requirements of subsection (e)(2)(B)3.~~,~~ ~~or~~ (e)(2)(D)1, or (e)(2)(F)2.c.,. shall provide emissions and/or operational data to the District APCO in accordance with the requirements of subsection (h) for purposes of demonstrating compliance.

* * * * *

(E) Notification of Non-Compliance

Owners or operators who have determined that they are operating their stationary diesel-fueled engine(s) in violation of the requirements specified in subsections (e)(1) or (e)(2) shall notify the district APCO immediately upon detection of the violation and shall be subject to district enforcement action.

* * * * *

(f) Compliance Schedule for Owners or Operators of Three or Fewer Engines (> 50 bhp) Located within the District

(1) All owners and operators of three or fewer engines located within the District, who will meet the requirements of subsections (e)(2)(B) solely by maintaining or reducing the current annual hours of operation for maintenance and testing, shall be in compliance with the annual hours of operation limits ~~by no later than~~ beginning January 1, 2006.

* * * * *

(g) Compliance Schedule for Owners or Operators of Four or More Engines (> 50bhp) Located within the District

(1) All owners and operators of four or more engines located within the District, who will meet the requirements of subsections (e)(2)(B) solely by maintaining or reducing the current annual hours of operation for maintenance and testing, shall be in compliance with the annual hours of operation limits ~~by no later than~~ beginning January 1, 2006.

* * * * *

(h) Emissions Data

(1) Upon approval by the District APCO or the Executive Officer, the following sources of data may be used in whole or part to meet the emission data requirements of subsections (e)(2)(A) through (e)(2)(~~D~~F):

(A) off-road engine certification test data for the stationary diesel-fueled CI engine,
(B) engine manufacturer test data,
(C) emissions test data from a similar engine, or

(D) emissions test data used in meeting the requirements of the Verification Procedure for the emission control strategy implemented.

(2) *Emissions testing of a stationary diesel-fueled CI engine, for purposes of* showing compliance with the requirements of subsections (e)(2)(A) through (e)(2)(~~E~~F), shall be done in accordance with the methods specified in subsection (i).

* * * * *

NOTE: Authority cited: Sections 39600, 39601, 39650, 39658, 39659, 39665, 39666, 41511, and 43013, Health and Safety Code. Reference: Sections 39002, 39650, 39658, 39659, 39665, 39666, 40000, 41511, and 43013.

APPENDIX B

UPDATED STATEWIDE POPULATION AND EMISSION INVENTORY FOR DIESEL-FUELED AGRICULTURAL IRRIGATION PUMPS

Air Resources Board

Alan C. Lloyd, Ph.D.
Chairman
1001 I Street • P.O. Box 2815 • Sacramento, California 95812 • www.arb.ca.gov

Winston H. Hickox
Agency Secretary

Gray Davis
Governor

MEMORANDUM

TO: Mike Tollstrup, Chief
Project Assessment Branch
Stationary Source Division

FROM: Randy Pasek, Chief
Emission Inventory Branch
Planning and Technical Support Division

DATE: April 30, 2003

SUBJECT: UPDATED STATEWIDE POPULATION AND EMISSION INVENTORY FOR DIESEL-FUELED AGRICULTURAL IRRIGATION PUMPS

With the assistance of local air district staff, we have updated the statewide emission inventory for diesel-fueled agricultural irrigation pumps. As part of this update process, we contacted seventeen air districts with significant irrigated agricultural acreage to obtain their best estimates of the current population and emissions from stationary and mobile diesel-fueled agricultural irrigation pumps. We also worked with district staff to ensure the updated inventory reflects the number of pumps that have been replaced to date under the Carl Moyer Program.

Table 1 provides the statewide population of diesel-fueled agricultural pumps and annual average emissions of ROG, NOx, and PM by region, district, and county. It should be noted that districts estimated to have fewer than 100 agricultural irrigation pumps were not contacted as part of this update and therefore are not reflected in the statewide inventory presented here. We estimate the updated emission inventory presented here represents over 90% of the total statewide population and emissions from diesel-fueled agricultural irrigation pumps. As shown in Table 1, we estimate there are approximately 8,200 diesel-fueled agricultural irrigation pumps statewide that emit 3.3 tons per day (tpd) of ROG, 32.4 tpd of NOx, and 2.4 tpd of PM on an average annual day. Based on discussions with district staff, we estimate that on a statewide basis, 65% of the pumps are stationary while 35% are mobile, with the stationary to mobile split varying considerably from district to district.

Since ROG and NOx emissions from agricultural irrigation pumps are of greatest concern during the summer months due to their role in ozone formation, we have also provided average summer day emissions in Table 2. The summer day emissions were developed from the annual average emissions using a statewide temporal profile that assumes 67% of the agricultural pump emissions occur in the summer months (May through October). As shown in Table 2, agricultural irrigation pumps are estimated to emit 4.3 tpd of ROG, 43.6 tpd of NOx, and 3.2 tpd of PM on an average summer day.

Annual emissions in tons per year from agricultural irrigation pumps can be calculated by multiplying the annual average emissions shown in Table 1 by 365 days. Using this approach, we estimate diesel-fueled agricultural irrigation pumps statewide emit 1,179 tons per year (tpy) of ROG, 11,839 tpy of NOx, and 868 tpy of PM. In estimating annual emissions, do not use the summer emissions provided in Table 2 as these are representative only of the summer months.

If you have any questions regarding the agricultural irrigation pump inventory described in this memorandum, please contact Michael Benjamin of my staff at (916) 323-2915.

cc: Peter Venturini, Chief
SSD

Bob Fletcher, Chief
PTSD

Table 1. Statewide Population and Annual Average Emissions for Diesel-Fueled Agricultural Irrigation Pumps

Region	Air District	County	COUNTY TOTALS ANNUAL AVERAGE EMISSIONS (TPD)					REGION TOTALS ANNUAL AVERAGE EMISSIONS (TPD)			
			POPULATION	ROG	NOx	PM	SOURCE	POPULATION	ROG	NOx	PM
North Central Coast	Monterey Bay Unified APCD	Monterey	450	0.09	0.72	0.05	ADJ-ARB				
North Central Coast	Monterey Bay Unified APCD	Santa Cruz	62	0.01	0.10	0.01	ARB				
North Central Coast	Monterey Bay Unified APCD	San Benito	56	0.01	0.09	0.01	ARB	568	0.12	0.91	0.06
Sacramento Nonattainment	El Dorado County APCD	El Dorado	20	< 0.01	0.05	< 0.01	DIS				
Sacramento Nonattainment	Feather River AQMD	Sutter	181	0.18	2.06	0.15	DIS				
Sacramento Nonattainment	Placer County APCD	Placer	64	0.02	0.21	0.02	DIS				
Sacramento Nonattainment	Sacramento Metropolitan AQMD	Sacramento	122	0.03	0.38	0.03	DIS				
Sacramento Nonattainment	Yolo/Solano AQMD	Solano	134	0.05	0.65	0.05	DIS				
Sacramento Nonattainment	Yolo/Solano AQMD	Yolo	643	0.32	3.64	0.26	DIS	1164	0.60	6.98	0.50
Sacramento Valley Attainment	Butte County AQMD	Butte	163	0.03	0.26	0.02	ARB				
Sacramento Valley Attainment	Colusa County APCD	Colusa	100	0.02	0.16	0.01	ARB				
Sacramento Valley Attainment	Glenn County APCD	Glenn	130	0.03	0.21	0.01	ARB				
Sacramento Valley Attainment	Tehama County APCD	Tehama	200	0.04	0.32	0.02	ADJ-ARB	593	0.12	0.95	0.07
Salton Sea	Imperial County APCD	Imperial	200	0.04	0.32	0.02	ADJ-ARB	200	0.04	0.32	0.02
San Diego	San Diego County APCD	San Diego	75	0.02	0.12	0.01	ADJ-ARB	75	0.02	0.12	0.01
San Francisco	Bay Area AQMD	Alameda	35	0.01	0.06	< 0.01	ARB				
San Francisco	Bay Area AQMD	Contra Costa	44	0.01	0.07	0.01	ARB				
San Francisco	Bay Area AQMD	Marin	17	< 0.01	0.03	< 0.01	ARB				
San Francisco	Bay Area AQMD	Napa	74	0.01	0.12	0.01	ARB				
San Francisco	Bay Area AQMD	San Francisco	0	0.00	0.00	0.00	ARB				
San Francisco	Bay Area AQMD	San Mateo	21	< 0.01	0.03	< 0.01	ARB				
San Francisco	Bay Area AQMD	Santa Clara	82	0.02	0.13	0.01	ARB				
San Francisco	Bay Area AQMD	Solano	0	0.00	0.00	0.00	ARB				
San Francisco	Bay Area AQMD	Sonoma	147	0.03	0.23	0.02	ARB	420	0.08	0.67	0.04
San Joaquin Valley	San Joaquin Valley Unified APCD	Fresno	1415	0.42	5.09	0.39	DIS				
San Joaquin Valley	San Joaquin Valley Unified APCD	Kern	1066	0.44	4.15	0.30	DIS				
San Joaquin Valley	San Joaquin Valley Unified APCD	Kings	525	0.15	1.91	0.16	DIS				
San Joaquin Valley	San Joaquin Valley Unified APCD	Madera	414	0.13	1.48	0.11	DIS				
San Joaquin Valley	San Joaquin Valley Unified APCD	Merced	270	0.10	0.98	0.07	DIS				
San Joaquin Valley	San Joaquin Valley Unified APCD	San Joaquin	413	0.12	1.47	0.11	DIS				
San Joaquin Valley	San Joaquin Valley Unified APCD	Stanislaus	111	0.03	0.40	0.03	DIS				
San Joaquin Valley	San Joaquin Valley Unified APCD	Tulare	286	0.47	1.79	0.08	DIS	4500	1.85	17.25	1.26
South Central Coast	Santa Barbara County APCD	Santa Barbara	100	0.14	1.71	0.12	DIS				
South Central Coast	Ventura County APCD	Ventura	335	0.15	1.87	0.15	DIS	435	0.29	3.57	0.28
South Coast	South Coast AQMD	Los Angeles	54	0.02	0.35	0.02	DIS				
South Coast	South Coast AQMD	Orange	28	0.01	0.18	0.01	DIS				
South Coast	South Coast AQMD	Riverside	139	0.06	0.90	0.06	DIS				
South Coast	South Coast AQMD	San Bernardino	36	0.02	0.23	0.02	DIS	257	0.12	1.67	0.12
	Grand Total (tons/day)		6212	3.23	32.44	2.38		6212	3.22	32.44	2.37

1 Data Source:
DIS = District Estimate
ARB = ARB OFFROAD Model
ADJ-ARB = ARB OFFROAD Model adjusted to reflect district estimate

PTSD 4/23/2003

Table 2. Statewide Population and Summer Emissions for Diesel-Fueled Agricultural Irrigation Pumps

Region	Air District	County	COUNTY TOTALS SUMMER EMISSIONS (TPD) POPULATION	ROG	NOx	PM	SOURCE	REGION TOTALS SUMMER EMISSIONS (TPD) POPULATION	ROG	NOx	PM
North Central Coast	Monterey Bay Unified APCD	Monterey	450	0.12	0.97	0.07	ADJ-ARB				
North Central Coast	Monterey Bay Unified APCD	Santa Cruz	62	0.02	0.13	0.01	ARB				
North Central Coast	Monterey Bay Unified APCD	San Benito	56	0.02	0.12	0.01	ARB	568	0.15	1.22	0.09
Sacramento Nonattainment	El Dorado County APCD	El Dorado	20	0.01	0.07	0.01	DIS				
Sacramento Nonattainment	Feather River AQMD	Sutter	101	0.24	2.77	0.20	DIS				
Sacramento Nonattainment	Placer County APCD	Placer	64	0.02	0.28	0.02	DIS				
Sacramento Nonattainment	Sacramento Metropolitan AQMD	Sacramento	122	0.04	0.51	0.04	DIS				
Sacramento Nonattainment	Yolo/Solano AQMD	Solano	134	0.07	0.87	0.06	DIS				
Sacramento Nonattainment	Yolo/Solano AQMD	Yolo	643	0.43	4.89	0.35	DIS	1164	0.81	9.39	0.68
Sacramento Valley Attainment	Butte County AQMD	Butte	163	0.04	0.35	0.03	ARB				
Sacramento Valley Attainment	Colusa County APCD	Colusa	100	0.03	0.21	0.02	ARB				
Sacramento Valley Attainment	Glenn County APCD	Glenn	130	0.03	0.26	0.02	ARB				
Sacramento Valley Attainment	Tehama County APCD	Tehama	200	0.05	0.43	0.03	ADJ-ARB	593	0.16	1.27	0.09
Salton Sea	Imperial County APCD	Imperial	200	0.05	0.43	0.03	ADJ-ARB	200	0.05	0.43	0.03
San Diego	San Diego County APCD	San Diego	75	0.02	0.16	0.01	ADJ-ARB	75	0.02	0.16	0.01
San Francisco	Bay Area AQMD	Alameda	35	0.01	0.08	0.01	ARB				
San Francisco	Bay Area AQMD	Contra Costa	44	0.01	0.10	0.01	ARB				
San Francisco	Bay Area AQMD	Marin	17	< 0.01	0.04	< 0.01	ARB				
San Francisco	Bay Area AQMD	Napa	74	0.02	0.16	0.01	ARB				
San Francisco	Bay Area AQMD	San Francisco	0	0.00	0.00	0.00	ARB				
San Francisco	Bay Area AQMD	San Mateo	21	0.01	0.05	< 0.01	ARB				
San Francisco	Bay Area AQMD	Santa Clara	82	0.02	0.17	0.01	ARB				
San Francisco	Bay Area AQMD	Solano	0	0.00	0.00	0.00	ARB				
San Francisco	Bay Area AQMD	Sonoma	147	0.04	0.31	0.02	ARB	420	0.11	0.90	0.06
San Joaquin Valley	San Joaquin Valley Unified APCD	Fresno	1415	0.57	6.84	0.53	DIS				
San Joaquin Valley	San Joaquin Valley Unified APCD	Kern	1066	0.59	5.58	0.41	DIS				
San Joaquin Valley	San Joaquin Valley Unified APCD	Kings	525	0.20	2.57	0.22	DIS				
San Joaquin Valley	San Joaquin Valley Unified APCD	Madera	414	0.17	1.99	0.15	DIS				
San Joaquin Valley	San Joaquin Valley Unified APCD	Merced	270	0.13	1.31	0.10	DIS				
San Joaquin Valley	San Joaquin Valley Unified APCD	San Joaquin	413	0.16	1.97	0.15	DIS				
San Joaquin Valley	San Joaquin Valley Unified APCD	Stanislaus	111	0.04	0.54	0.04	DIS				
San Joaquin Valley	San Joaquin Valley Unified APCD	Tulare	286	0.63	2.40	0.11	DIS	4600	2.48	23.20	1.70
South Central Coast	Santa Barbara County APCD	Santa Barbara	100	0.19	2.29	0.17	DIS				
South Central Coast	Ventura County APCD	Ventura	335	0.20	2.51	0.21	DIS	435	0.39	4.81	0.37
South Coast	South Coast AQMD	Los Angeles	64	0.03	0.47	0.03	DIS				
South Coast	South Coast AQMD	Orange	28	0.02	0.25	0.02	DIS				
South Coast	South Coast AQMD	Riverside	139	0.09	1.21	0.09	DIS				
South Coast	South Coast AQMD	San Bernardino	36	0.02	0.30	0.02	DIS	257	0.16	2.24	0.16
	Grand Total (tons/day)		6212	4.34	43.63	9.20		6212	4.34	43.63	9.20

1 Data Source:
DIS = District Estimate
ARB = ARB OFFROAD Model
ADJ-ARB = ARB OFFROAD Model adjusted to reflect district estimate

PTSD 4/23/2003

APPENDIX C

SUMMARY OF CONFIDENTIAL INFORMATION FROM THE AGRICULTURAL INDUSTRY AND ENGINE MANUFACTURERS, DISTRIBUTORS, AND DEALERS

APPENDIX C

SUMMARY OF CONFIDENTIAL INFORMATION FROM THE AGRICULTURAL INDUSTRY AND ENGINE MANUFACTURERS, DISTRIBUTORS, AND DEALERS

The table below summarizes information gathered during development of the *Proposed Revisions to the Airborne Toxic Control Measure for Stationary* Compression Ignition Engines (January through mid-March 2005). Staff greatly appreciate the cooperation of local air districts, agricultural industry organizations, and major agricultural engine manufacturers, distributors, and dealers who provided information about the technical, economic, and practical considerations regarding the initial purchase and replacement of stationary diesel agricultural pump engines.

Information Requested	Responses
Availability of 0.15 grams per brake horsepower-hour (g/bhp-hr) particulate matter (PM)-compliant new stationary diesel agricultural pump engines >50 to <175 horsepower (hp).	• All major agricultural pump engine manufacturers preferentially design engines to meet federal off-road new engine certification standards. • No agricultural pump engine manufacturer has engines available in all the hp ranges needed to meet the current demand for >50 to <175 hp pump engines. • Very few >50 to 99 hp pump engine models test at ≤0.15 g/bhp-hr PM. Except for one manufacturer, very few 100 to <175 hp engine models test at that level. For further detail about test results, see Tables II-2 and II-3 of this Staff Report. • Engines are certified to meet the federal off-road new engine standards, not to off-road new engine certification test results.
Initial purchase issues.	• Engine dealers work with each farmer to address the farmer's specific pumping task needs and maintenance and economic considerations. • Pump engine size is determined by draw depth, which varies with the water table. • If a larger-than-necessary engine for a particular pumping task is operated at <60 percent load, lugging and poor fuel consumption may result. Also, the cylinder temperature may not get high enough for proper sealing causing oil slobber, excess blow-by, decreased engine life, and increased emissions. Warranty provisions could be affected. • A larger-than-necessary engine is likely to cost $1,500/10-25% more than a smaller engine.

Information Requested	Responses
Repower (replacing existing engine) issues.	• Most/80% of new stationary agricultural pump engines sold are repowers. • Replacing an existing pump engine with one of a different make, model design, or size may require the replacement of one or more significant pieces of ancillary equipment, e.g.: skids, housing, flywheel coupler, gear head, or drive train. A case-by-case evaluation of the circumstances is required to determine what, if any ancillary equipment needs to be replaced. • The estimated additional cost of ancillary equipment is $800-$3,000 or more. For example, a new gear head costs $1,800-$2,100 and its installation would cost an additional $1,500-$1,800. • Currently, the greatest demand for engine replacement is in the 75 to 85 hp size range. • See New Engines Issues, above, for discussion about use of larger-than-necessary engines. • Several local air districts that administer Carl Moyer Program incentive funding for engine replacement do not provide funds for engines more than 25% larger than existing engines, nor for ancillary equipment. • Generally, farmers prefer to repower with similar make and model engines based on service requirements, cost, maintenance requirement familiarity, and/or brand loyalty.

Compliance alternative issues.	• Add-on Control Device:
	  • No add-on devices are verified for stationary agricultural pump engines at present. Their use would require a verification procedure for each make/model, or, case-by-case source testing. Source testing and interpretation can cost $30,000.
	  • Diesel particulate filters (DPFs) may not work on engines operating at <60% load due to low exhaust temperatures.
	  • Generally, engine warranties do not cover any problem that results from the use of an add-on control device, such as a DPF.
	  • Expensive - adds 35-50% or more to the cost of initial purchase or repower.
	• Alternative Test Cycle: Not consistent with federal new off-road engine certification

Information Requested	Responses
Compliance alternative issues (continued).	test requirements. • Emissions Credit for Using California Diesel Fuel: Does not apply since current federal certification test fuel is not sufficiently different from CARB diesel.

Engine stock, purchasing, and timing issues.	• February-May is peak stationary diesel agricultural pump engine purchase and installation season. Farmers must have pump engines by spring planting time.
	• 90-day lead-time required for pump engine orders.
	• Non-complaint engines in stock or on order can not be returned to manufacturers or sold in California. Penalties are imposed for selling outside a distributor's sales territory. Comments regarding non-compliant engine stock:
	  • Constitutes about one-third of one distributor's entire engine inventory valued at $3 million to $7 million.
	  • Completion of dealer-customer contracts for large installations over a period of time have been held up due to uncertainty.
	  • Sales have been suspended on hundreds of pump engines due to uncertainty.
	  • Districts are unable to complete the processing of Carl Moyer Program incentive funding applications for agricultural engine repowers if contracts were not signed by January 1, 2005.

APPENDIX D

PROPOSED CLARIFICATION OF THE REGULATORY TEXT

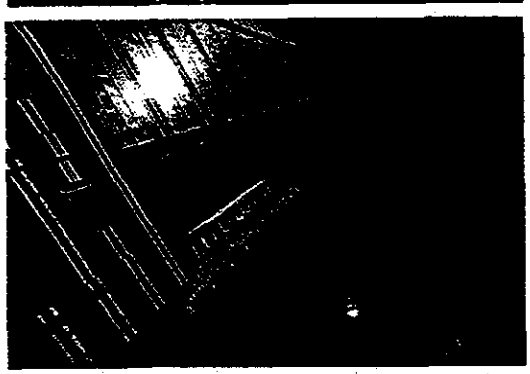
APPENDIX D

Proposed Clarification to the Regulatory Text

Subsection	Description of Change	Rationale for Change
(d)(36)(A)	Remove the word *initial* and *new*.	Clarifies that initial start-up testing could apply to an existing engine as well as a new engine.
(e)(3)	Change the phrase *owner or operator* to *person*.	Clarifies that the requirements of this subsection also apply to engine dealers, distributors, and manufacturers.
(e)(3) Table 6	Removes the phrase *model year and . . .*	Makes the language in the regulation consistent with the language in the table.
(e)(4)(D)1. and 2.	Adds a reference to subsection *(e)(2)(F)1.c.*	Clarifies that new engines in a demand response program must provide data to the District consistent with the requirement for engines not in these programs.
(e)(4)(E)	Adds a reference to subsection *(e)(1)*.	Clarifies that notification of non-compliance applies to fuel requirements as well as engine emissions requirements.
(f)(1) and (g)(1)	Removes the phrase, . . *.by no later than. . .* and replaces it with, . . .*with the annual hours of operation limits beginning . . .*	Clarifies that compliance with the operating hour limits starts January 1, 2006.
(h)(1)	Adds the phrase, . . . or the *Executive Officer . . .* Changes the subsection reference from *(e)(2)(D)* to *(e)(2)(F)*	Clarifies that the ARB as well as the District can approve emission data used to show compliance with the ATCM and clarifies a referencing error.
(h)(2)	Changes the subsection reference from *(e)(2)(E)* to *(e)(2)(F)*	Clarifies a referencing error.

California Hydrogen Blueprint Plan

Volume 1 May 2005



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NETWORK

California Environmental Protection Agency

Acknowledgements

The California Environmental Protection Agency gratefully acknowledges the generous contribution of time and expertise made by members of the Senior Review Committee, the Implementation Advisory Panel, and the Topic Teams (see Appendix B) without whose dedication this plan could not have been produced.

The California Hydrogen Blueprint Plan is submitted to Governor Arnold Schwarzenegger in response to Executive Order S-7-04 by:

- Alan C. Lloyd, Ph.D., Agency Secretary, Cal/EPA
- Shannon Baxter-Clemmons, Ph.D., Special Advisor on Hydrogen and Renewable Energy Programs, Cal/EPA
- Daniel Emmett, Executive Director, Energy Independence Now Coalition

The Plan is presented in two volumes. Volume I contains findings and recommendations to the Governor and the Legislature to begin implementation of the California Hydrogen Highway Network (CA H2 Net). It summarizes what needs to be done to accomplish the goals of Executive Order S-7-04, the estimated costs over the next five years, and recommended next steps. Volume II is a technical report that contains the extensive analysis and findings of the Topic Teams and the Advisory Panel.

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Executive Summary

Background

In the January 6, 2004, State of the State address, Governor Schwarzenegger sent a clear message that California would begin a course toward a sustainable transportation energy future when he spoke the words:

> *I am going to encourage the building of a hydrogen highway to take us to the environmental future...I intend to show the world that economic growth and the environment can coexist.*
>
> *And if you want to see it, then come to California.*

On April 20, 2004, the Governor signed Executive Order S-7-04 calling for the development of the California Hydrogen Blueprint Plan. On the same day he designated the University of California-Davis' hydrogen station as Station #1 of the California Hydrogen Highway Network (CA H2 Net).

Since that time, more than 200 volunteer experts have engaged in the development of the California Hydrogen Blueprint Plan (Blueprint Plan). The volunteers and the organizations they represent are motivated by a shared set of core values that define the vision of a sustainable hydrogen economy for California. These core values are:

- Energy security and national security.
- A healthy environment.
- Economic growth and opportunity for California.

What is the California Hydrogen Highway Network and Why Do We Need It?

The California Hydrogen Highway Network is a State initiative to promote the use of hydrogen as a means of diversifying our sources of transportation energy used while ensuring environmental and economic benefits. To be implemented in phases, the Blueprint Plan outlines a path to 250 hydrogen fueling stations and 20,000 hydrogen-fueled vehicles, which will help set the stage for full-scale commercialization of these technologies.

Hydrogen has the potential to unlock a new energy future for California—a future based on secure, local, and renewable energy sources, accessible and affordable to all Californians, and pollution free. This transition will generate new jobs and new industries and will restore California's control over its energy supply.

Today, as it has been for more than a century, fossil fuels provide a relatively cheap and reliable means to power the vast majority of the world's vehicles. In the last few decades, however, there has been a growing realization that, for at least two reasons, we cannot continue to rely on fossil fuels. First, the supply of

fossil fuels is increasingly insecure. The world is running out of easily accessible petroleum[1] and almost 60 percent of the petroleum imported into the U.S.[2] is from geopolitically unstable areas of the world. Second, the burning of fossil fuels produces pollution that damages human health and generates greenhouse gases that contribute to the unsustainable climate change of the planet.[3]

Hydrogen has the potential to revolutionize the ways we harness the world's energy resources. Hydrogen is both a fuel and an energy carrier. As an emerging transportation fuel, hydrogen is driving innovative new designs of high-efficiency vehicles that offer important environmental and energy diversification benefits. It can be used in fuel cells that are more than twice as efficient as gasoline engines. Fuel cell vehicles (FCVs) have no tailpipe or fueling emissions other than pure water vapor. As an energy carrier, hydrogen can provide electricity where and when needed. Hydrogen can be used in high-efficiency, stationary fuel cells to provide electricity, heating, and cooling for homes and businesses—all with very low environmental impacts.

California is uniquely qualified to play a leadership role in accelerating hydrogen technologies and ensuring that the hydrogen economy moves forward in the smartest way possible. California is already positioned as a world leader in the development and demonstration of hydrogen technologies as evidenced by the California Fuel Cell Partnership, the South Coast Air Quality Management District, the Stationary Fuel Cell Collaborative, the University of California researchers, industries on the cutting edge of technology, and leading national laboratories. A commitment to and an investment in the California Hydrogen Highway Network will help sustain California's leadership position into the future.

Findings and Recommendations

Contained in this Blueprint is a series of findings and recommendations on how to develop the California Hydrogen Highway Network.

Stations

- The development of the California Hydrogen Highway Network should be pursued in three phases. This Blueprint Plan focuses on completion of Phase 1 in the 2010 timeframe.
- Phase 1 calls for deployment of 50 to 100 publicly accessible hydrogen fueling stations sited to provide convenient fueling for hydrogen vehicles. An estimated 2000 hydrogen vehicles can be in operation by 2010 on the way to achieving 20,000 hydrogen vehicles in operation on California's roads and freeways. 20,000 hydrogen vehicles will poise California for full scale commercialization of hydrogen technologies.
- Hydrogen fueling stations should be located in major urban areas near the fleets that are expected to first use hydrogen-fueled vehicles as well as

along major interstates, as much as possible, to facilitate travel between these urban areas.

- An independent review of the California Hydrogen Highway Network effort and the state of hydrogen technologies should be undertaken every two years.

Funding

- Funding to complete the first 100 stations should be provided by the State on a 50/50 match basis with the private sector. The cost to the State for hydrogen infrastructure incentives would be $6.5 million annually for five years.
- Vehicle incentives should be provided by the State during Phase 1. An incentive of $10,000 per vehicle should ensure that 2000 hydrogen-fueled vehicles are operating on California's roads over the next five years. The cost to the State for incentives of both fuel cell and hydrogen internal combustion engine vehicles would be $4.2 million annually for 5 years.
- Cal/EPA should recommend the source of funding and define the return on this investment to the State.

Environmental Goals

- By 2010, the California Hydrogen Highway Network should achieve a 30 percent reduction in greenhouse gas emissions relative to a comparable number of today's fuels and vehicles.
- By 2010, the California Hydrogen Highway Network should utilize at least 20 percent new renewable resources in the production of hydrogen for use in vehicles by 2010 and increase annually thereafter.
- The California Hydrogen Highway Network will be designed to reduce emissions of toxic and smog forming pollutants compared to petroleum-based fuels in use today.

Implementation

- The State should establish policies that help create a business and regulatory climate favorable for establishing a hydrogen infrastructure, including designating hydrogen as a transportation fuel, and streamlining and standardizing the fueling station permitting process.
- The Blueprint Plan was developed through an unprecedented process of partnership and cooperation with stakeholders that should be continued throughout the implementation of the California Hydrogen Highway Network.
- Cal/EPA should initiate and lead an outreach plan to inform the public of the benefits and objectives of the California Hydrogen Highway Network.

The opportunity to lead the world by fostering the birth of the hydrogen economy is before us. By implementing the recommendations in this report, California will open the door to a sustainable transportation energy future. The phased approach and built-in review process recommended in this Blueprint Plan will ensure a thoughtful, prudent path forward and a responsible level of investment.

1.0 Introduction and Background

On April 20, 2004, California began a course towards a sustainable transportation energy future when Governor Arnold Schwarzenegger signed Executive Order S-7-04 creating the California Hydrogen Highway Network.

Today, as it has been for more than a century, the vast majority of the world's vehicles are powered by fossil fuels. They have provided a relatively cheap and reliable means to power our vehicles. In the last few decades, however, there has been a growing realization that, for at least two reasons, we cannot continue to rely on fossil fuels. First, the supply of fossil fuels is increasingly insecure. The world is running out of easily accessible petroleum[4], and almost 60 percent of the petroleum imported into the U.S.[5] is from geopolitically unstable areas of the world. Second, the burning of fossil fuels produces pollution that damages human health and greenhouse gases that contribute to the unsustainable climate change of the planet.[6]

The good news is that there are solutions. Governor Schwarzenegger has offered a bold three-point vision to solve the problem of petroleum dependence.

In the short term, we must conserve fossil fuels as much as possible. The State has initiated a program called "Flex Your Power at the Pump"[7] to encourage all drivers to take steps to conserve fuel. Simple steps such as driving the speed limit, keeping tires fully inflated, and maintaining a responsible air conditioner setting can greatly reduce fuel consumption.

In the mid-term, we must reduce our use of fossil fuels by encouraging the purchase and use of vehicles such as hybrids, plug-in hybrids, electric vehicles and natural gas vehicles that reduce or eliminate the need for fossil fuels. Last year, to promote the importance of this mid-term strategy, legislation[8] was signed that would allow hybrid electric vehicle owners to use the high-occupancy vehicle ("diamond") lanes. Additionally, the State makes fuel efficiency and emissions performance a high priority in its fleet vehicle purchase policy.

In the long term, hydrogen offers the possibility of energy independence and clean, sustainable transportation. Hydrogen is an energy carrier[9] and fuel that can revolutionize human mobility and the ways we harness the world's energy resources. Hydrogen can be used to power vehicles and provide electricity, heating, and cooling for our buildings—all with very low environmental impacts. It can be produced through a variety of processes using a range of feedstocks, including natural gas, methanol, ethanol, biomass, and water. As an emerging transportation fuel, the promise of hydrogen is driving innovative new designs of high-efficiency vehicles that offer important environmental and energy diversification benefits.

1.1 Executive Order S-7-04

In April 2004, the Governor signed Executive Order S-7-04 (Appendix A), which formally launched an important new hydrogen initiative as part of California's energy and environmental plan. This executive order calls for:

- Designation of California's 21 interstate freeways as the "California Hydrogen Highway Network."
- Planning and build-up of a network of hydrogen fueling stations along these roadways and in the urban centers they connect so that by 2010, every Californian will have access to hydrogen fuel.
- Accelerating progress in hydrogen use through public incentives and financing mechanisms, such as general obligation bonds, or revenue bonds with repayment mechanisms; joint power agreements; and partnerships with public and private entities.
- Promoting economic development opportunities resulting from increased utilization of hydrogen for stationary and mobile applications.

1.2 Development of the Blueprint Plan

Cal/EPA led a collaborative process to develop a Blueprint Plan to implement the California Hydrogen Highway Network (CA H2 Net). To manage this effort, Cal/EPA established an Executive Order Team[10] (EO Team), chaired by the Cal/EPA Secretary. The EO Team respectfully accepted the counsel of a Senior Review Committee consisting of senior State government officials, and an Implementation Advisory Panel consisting of high-level representatives from industry, California State agencies, federal and local government agencies, academia, and public advocacy groups.[11] The Advisory Panel worked closely with the EO Team and the Topic Teams to provide the basis for the recommendations and Action Plan to implement the CA H2 Net.

Volunteer experts provided invaluable and detailed technical, financial and policy inputs that helped shape the Blueprint Plan. These volunteers represented a wide array of government agencies, private industry, academia, and environmental organizations. More than 200 individuals served on five separate "Topic Teams": Rollout Strategy, Societal Benefits, Economy, Implementation, and Public Education[12]. Each of the Topic Teams submitted an independent report to the EO Team—all are publicly available.[13]

Over the course of about six months, the five Topic Teams, Advisory Panel and EO Team worked together to develop the basis for the Blueprint Plan. The five Topic Teams performed detailed analyses, solicited input and vetted their findings at public meetings, and presented key conclusions to the Advisory Panel. The Advisory Panel guided the work of the Topic Teams based on their wisdom and experience. The EO Team shaped the recommendations in the California Hydrogen Blueprint Plan based on a series of agreed upon statements from the Panel that were supported by the findings of the Topic Teams.

The California Hydrogen Blueprint Plan is a two-volume document accompanied by five independent reports from the Topic Teams. Volume I contains the EO Team's recommendations to begin implementation of the CA H2 Net. Volume I summarizes an Action Plan, the estimated costs to the State over the next five years, and recommended next steps. Volume II contains key findings of the Topic Teams and the corresponding counsel of the Advisory Panel in support of the recommendations in Volume I.

The Blueprint Plan will be updated every two years in accordance with Executive Order S-7-04. The updates will be critical to ensure that the CA H2 Net promotes an accelerated and intelligent transition to a hydrogen economy.

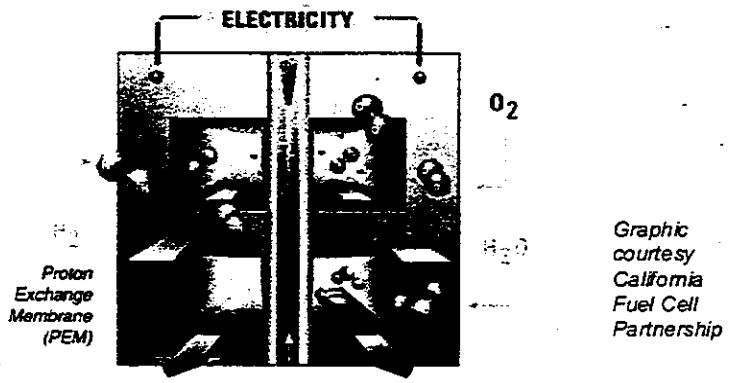
1.3 Basic Description of Hydrogen and its Uses

Hydrogen is the simplest and lightest element. Although hydrogen is all around us and accounts for 75 percent of the entire universe's mass,[14] on Earth it is found only in combination with other elements. For example, hydrogen readily bonds with oxygen to make water, and with carbon to make organic matter. Before it can be used as a fuel, hydrogen must be separated from these other elements. The process to "produce" hydrogen requires energy, just as it takes energy to make other transportation fuels like gasoline and to compress natural gas. For example, hydrogen can be produced from molecules called hydrocarbons by applying heat. This "reforming" process is currently used to make hydrogen from natural gas and is the cheapest method of hydrogen production. An electrical current can also be used to separate water into its components of oxygen and hydrogen in a process called electrolysis. In addition, certain types of algae and bacteria use sunlight as their energy source and give off hydrogen under certain conditions.[15] Hydrogen gas exists in the form of two tightly bound hydrogen atoms (H_2).

Today, hydrogen is primarily used for industrial processes such as ammonia manufacturing and petroleum refining. It has also been widely used in NASA's space program as fuel for the space shuttles, and in fuel cells that provide heat, electricity and drinking water for astronauts.

A fuel cell is an elegant and simple device that produces a direct and continuous current of electricity using an electrochemical reaction between hydrogen and oxygen. All of the world's major automobile manufacturers are developing hydrogen fuel cell vehicles because of the incredible potential fuel cells hold as a commercially viable, clean and efficient power source. Stationary applications of fuel cell systems can be used to generate environmentally friendly electricity and usable heat. In both applications of fuel cells, California is likely to be the earliest U.S. market for commercialization. Figure 1 illustrates how a PEM fuel cell converts hydrogen and oxygen into electricity.

Proton exchange membrane (PEM) fuel cells are the type most commonly used for automotive applications.



When hydrogen enters a PEM fuel cell, its electrons and protons are separated. A membrane in the cell selectively allows the protons to pass through, while the electrons are routed to provide the electricity to power the motor that propels the vehicle. On the other side of the membrane, the hydrogen combines with oxygen from the air to form water and heat.

Figure 1—Basic Operation of a Proton Exchange Membrane (PEM) Fuel Cell

Fuel cell vehicles are in fact electric vehicles (EVs). Like battery-powered EVs, fuel cell vehicles use efficient and fast response electric-drive systems. However, instead of electrons being stored in the chemicals in the battery, the electrons are released in the fuel cell by way of a reaction between hydrogen and oxygen. Fuel cells can be thought of as batteries that never lose their charge – hydrogen can be continuously supplied from an external fuel tank, and oxygen can be extracted from air. The simplicity of fuel cells impart many desirable attributes to fuel cell vehicles including zero emissions, fuel economy that is twice as high as most internal combustion engines that we drive today. However, consumers will desire a driving range and refueling times comparable to gasoline vehicles.

Figure 2 illustrates the basic operation of a hydrogen fuel cell vehicle powered by a proton exchange membrane (PEM) fuel cell, which is the type being developed for automotive applications. While today's prototype fuel cell automobiles appear similar to conventional vehicles on the outside, the drive train components and their layout can be quite different. The challenge most cited by experts as a potential shortcoming of hydrogen vehicles for consumers is the storage of enough fuel so that a hydrogen vehicle's range is similar to that of a traditional internal combustion engine vehicle.

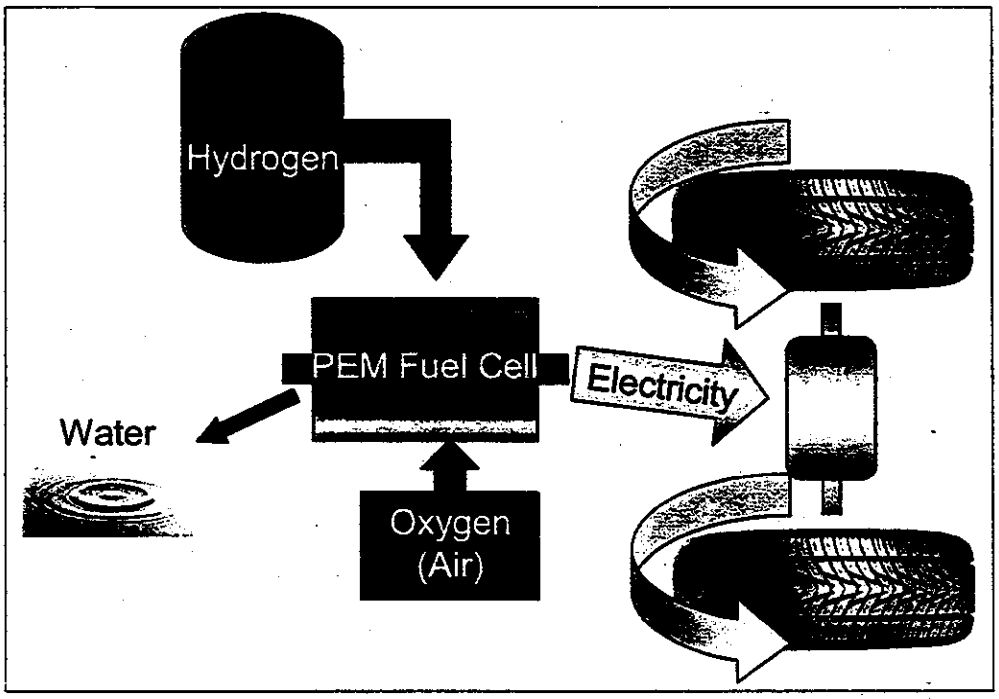


Figure 2—Basic Operation of a Hydrogen Fuel Cell for Automobiles

Hydrogen can also be used to power vehicles with internal combustion engines (ICEs), much as natural gas is currently used. At least two major automobile companies are working to develop and commercialize hydrogen ICE vehicles. Hydrogen ICE vehicles face the same hydrogen storage issues as fuel cell vehicles. Presently the cost of a hydrogen ICE vehicle is less than 25 percent of a hydrogen fuel cell vehicle. Compared to gasoline ICEs, hydrogen ICEs offer better mileage, do not consume fossil fuels and have extremely low emissions.[16]

2.0 Why Hydrogen?

The CA H2 Net Blueprint Plan has identified a number of significant benefits associated with implementing a hydrogen highway network. Hydrogen can greatly reduce our dependence on petroleum, provide numerous environmental and public health benefits, and create economic opportunities including new jobs in California.

2.1 Energy Diversity and Security Benefits

2.1.1 Hydrogen is an Integral Part of California's Long-Term Energy Strategy

California's transportation sector is nearly 100 percent dependent on gasoline and conventional diesel, both of which are nonrenewable and in finite supply.

Demand for these fuels in California alone has grown nearly 50 percent in just the last 20 years and will continue to grow. At the beginning of this decade, California had a population of 33.8 million people, driving 24 million registered vehicles, and consuming more than 17 billion gallons per year of gasoline and diesel fuel. By 2020, it is projected that 45.5 million Californians will operate 31.5 million vehicles consuming about 24 billion gallons of gasoline and diesel fuel.[17]

California's petroleum refining capacity has not kept pace with this demand. In fact, since the mid-1990s, in-state refining capacity has decreased nearly 20 percent, and California has shifted from being a net exporter of petroleum to a net importer.[18] During this period, a combination of refinery outages, marine and distribution constraints and other factors has led to volatile gasoline and diesel prices.

Several options are available to reduce the demand for petroleum transportation fuels. Conservation through the production of more fuel efficient motor vehicles is an effective means of reducing demand for petroleum. Encouraging greater use of available, non-petroleum fuels, such as natural gas and synthetic diesel fuel, can also reduce petroleum demand. Together, these near-term approaches may be able to keep the demand for petroleum fuels from increasing above current levels over the next two decades. Beyond the near-term, greater use of non-petroleum fuels will be necessary to meet the ever growing demand for clean transportation. A detailed assessment by the California Energy Commission and the Air Resources Board showed that, from an environmental and economic standpoint, hydrogen fuel cell vehicles provide an attractive long-term approach for continuing to reduce California's petroleum dependence.[19]

Figure 3 illustrates the impact of near-term measures to reduce California's dependence on petroleum. The petroleum reduction goal cannot continue to be met with near-term remedies after 2035 without additional actions. The increase in petroleum demand after 2035 is due to California's growing population and increased vehicle usage.

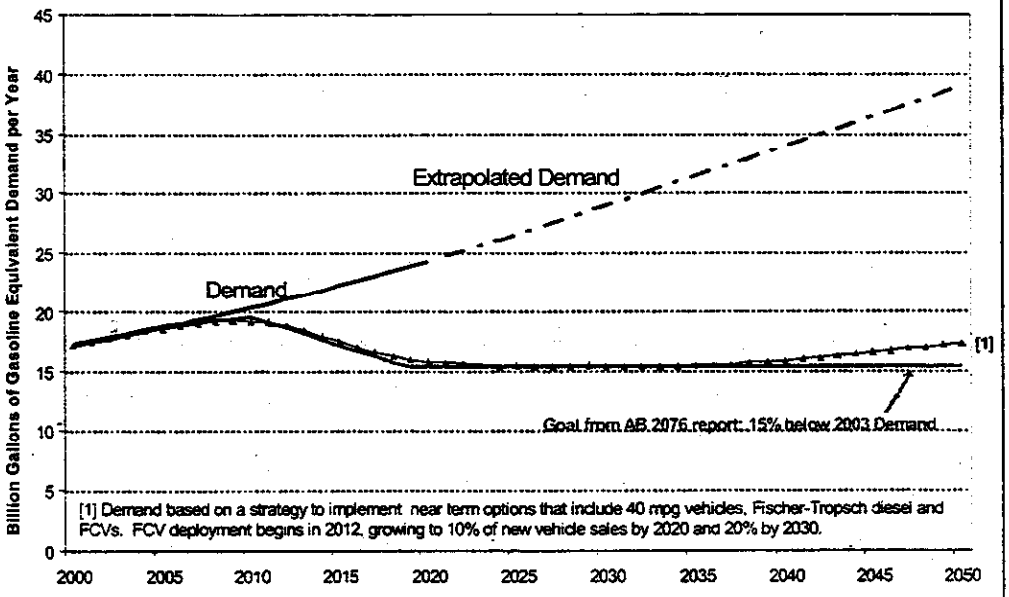


Figure 3—Growth in Demand for On-road Petroleum Fuels[20]

2.1.2 Hydrogen Can Diversify and Stabilize California's Energy Supply

Hydrogen can diversify and stabilize California's energy sector and the supply of transportation energy. Hydrogen occupies a unique niche at the confluence of transportation, electricity, and heating energy. For example, hydrogen "energy stations" are electricity production units that can also provide heating, cooling and power for homes and businesses, while producing enough additional hydrogen that can be used to fuel vehicles.

Hydrogen is an energy carrier so it can be used to store, move and deliver energy in a usable form to consumers. In this manner, hydrogen can be used to store renewable energy that is intermittent in nature for times periods when the demand exceeds the electricity supplied by the renewable resource.

2.1.3 Hydrogen Can Be Produced From Renewable Resources

An infrastructure based on hydrogen and renewable resources is inherently sustainable in nature. The term "renewable resources" (or simply "renewables") refers to resources such as wind, solar, geothermal, and waste resources such as biomass. All of these types of renewable resources are available in California and can be used to produce hydrogen. Hydrogen produced from renewable resources can have no emissions of any pollutants, and reduce reliance on limited resources such as oil and natural gas. Further, to the extent California takes the lead in developing technology to produce hydrogen from renewable resources, our state

is in an attractive long-term economic position as demand for such technology is expected to grow significantly worldwide.

2.2 Environmental Benefits

To make a fair comparison of the full environmental impacts of various motor vehicle types requires characterization of the "source-to-wheel"[21] emissions. Figure 4 illustrates the steps included in the source to wheel emission calculations.

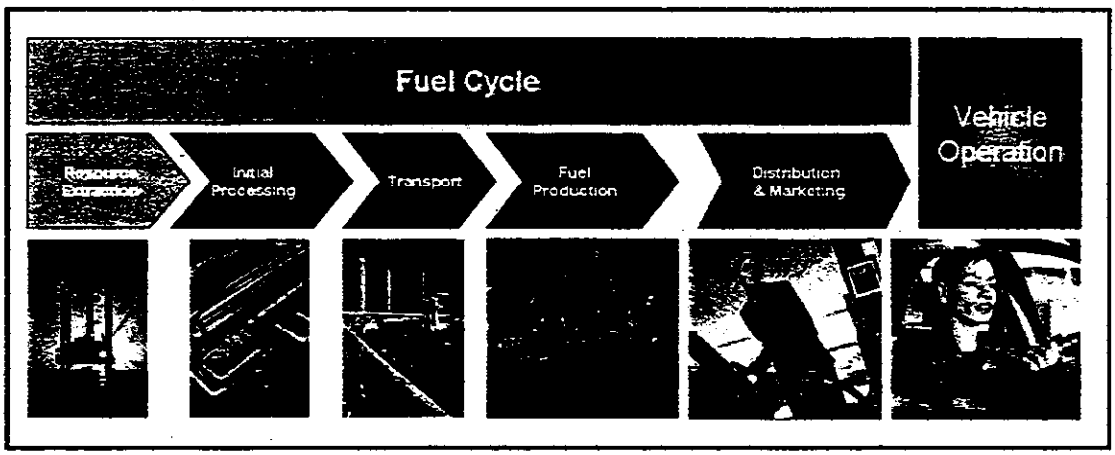


Figure 4—Emissions Illustration (Source-to-Wheel)[22]

The source-to-wheel analysis includes the steps in the fuel cycle and the end use of the fuel. The steps include extraction and processing of the fuel, transport of the fuel to the point of use, any additional processing that is needed, fueling the vehicle and vehicle operation. Based on this type of analysis, the environment benefits of using hydrogen to power vehicles or generate electricity fall into two major categories 1) reduction of smog forming and toxic emissions, and 2) reduction of greenhouse gas emissions.

2.2.1 Hydrogen Can Reduce Smog-forming and Toxic Emissions

The use of hydrogen as a transportation fuel can result in lower emissions of criteria pollutants when compared to those from petroleum fuels. The smog-forming and toxic emissions benefits are dependent on the systems and materials used to produce and consume hydrogen. If hydrogen is produced using electrolysis and the electricity is derived from renewable resources then the source-to-wheel emissions are zero—the entire fuel cycle is sustainable. Relative to gasoline refining, particulate matter emissions can be higher if hydrogen is generated by electrolysis dependent on electricity derived from coal. For the entire source-to-wheel analysis, hydrogen vehicle emissions of oxides of nitrogen, volatile organic compounds and carbon monoxide are less than gasoline or diesel, while the relative comparison for particulate matter depends on how the hydrogen is produced.

Distribution emissions in the hydrogen fuel cycle are only important if the hydrogen is produced in a central plant and has to be distributed by gasoline and diesel trucks. Distribution emissions are zero if the hydrogen is produced where it is used (called distributed generation) or if the hydrogen is transported from a central location by a zero emission vehicle.

Fueling emissions are never a factor in the hydrogen fuel cycle because any hydrogen that escapes during fueling is nontoxic, unlike emissions from petroleum-based fuels.

Tailpipe emissions are zero if hydrogen is used in a fuel cell vehicle. The only emission is water. The emissions consist of only near-zero amounts of oxides of nitrogen in a hydrogen combustion engine.

In contrast, California's 24 million gasoline- and diesel-fueled vehicles directly or indirectly cause a variety of serious pollution problems in our state. Adverse environmental impacts occur during virtually every step associated with using these vehicles: from the beginning of the fuel production phase to the tailpipe. The refining of petroleum into gasoline and diesel fuel results in emissions of reactive organic compounds, including toxic compounds, oxides of nitrogen and particulate matter. Refineries are typically one of the largest stationary sources of emissions in California. The distribution of gasoline from the refinery to the retail service station results in fuel evaporation emissions at every point of transfer, including transfer to the car. Burning petroleum fuels in vehicles results in emissions of volatile organic compounds, some of which are toxic, oxides of nitrogen, carbon monoxide, and particulate matter.

This discussion points to the importance of producing hydrogen in the most environmentally sound manner. Zero emitting options are available such as solar/electrolysis, which can result in zero emissions for the entire fuel cycle.

2.2.2 Hydrogen Can Reduce Greenhouse Gas Emissions

As with smog-forming emissions, the fuel cycle greenhouse gas (GHG) emissions of hydrogen vehicles depend on the method of hydrogen production. In this case emissions also depend on what type of vehicle uses the hydrogen, because fuel cell vehicles are more efficient than combustion vehicles that burn hydrogen. And both hydrogen fuel cell and ICE vehicles are more efficient than conventional gasoline vehicles.

Shown in Figure 5 are the results of an analysis of the fuel cycle greenhouse gas emissions of hydrogen compared to gasoline, for both fuel cell and hydrogen internal combustion engine (ICE) vehicles. Notable is that production of hydrogen from renewable-based electricity results in near zero emissions. Reforming of natural gas also results in lower fuel cycle greenhouse gas emissions. However, production of hydrogen using grid electrolysis results in greater greenhouse gas emissions than gasoline. Again this points out the importance of developing the CA H2 Net using the lowest emitting technologies for producing hydrogen.

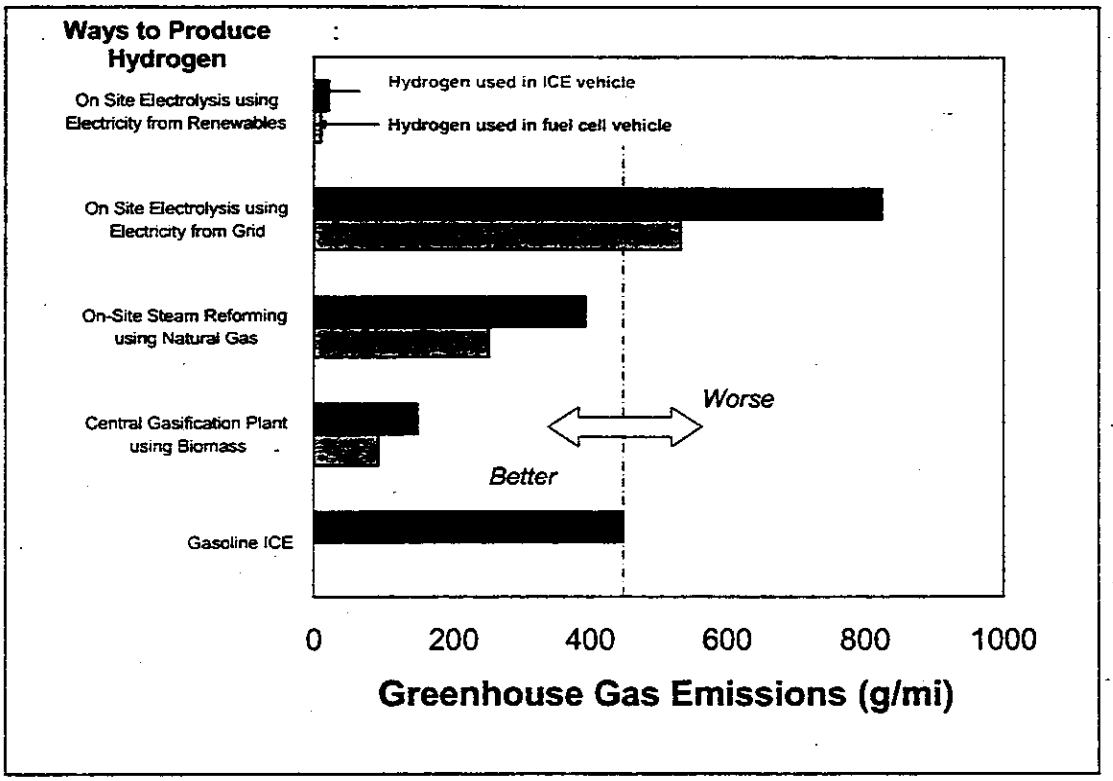


Figure 5—Source-to-Wheel Greenhouse Gas Emissions[23]

2.3 Economic Development Benefits

California has a long history of being at the forefront of emerging high-technology industries. State officials have recognized that these industries can create jobs as technologies develop and flourish in the world marketplace. More than 100 companies are working on prototype hydrogen-related technologies in California; examples include hydrogen production systems, fuel cells, hydrogen storage systems, and safety-related devices. Many companies have initiated similar efforts in other states. If California continues to lead in creating demand for hydrogen fueling stations and products, companies with related technologies are more likely to choose our state to locate new technology centers and manufacturing facilities. Expansion of hydrogen-related research, development and demonstration efforts will help generate new jobs, businesses, and industries in California.

2.4 Educational Benefits

Just as California is home to the world's leading businesses and industries, so too is it home to some of the world's finest universities. The University of California (UC) and California State University (CalState) systems have well-established programs related to the development of the hydrogen economy and its attendant technologies. California's universities have been at the forefront in engineering vehicle systems; fuels development, production, and distribution; emissions

testing; traffic modeling and infrastructure development; and more. They are also among a cadre of early-adopters and testers of hydrogen technologies and will be essential components to the early-phase rollout of the CA H2 Net. Integrating the UC and CalState systems into the development of the CA H2 Net will help sustain their vital role in the developing hydrogen economy, as well as serve to attract the world's best researchers and educators in the field.

3.0 Key Findings of the Blueprint Plan

The key findings of the Blueprint Plan outline an approach that is thoughtful and prudent. The Advisory Panel suggested several crucial points to the development of the CA H2 Net such as gradually building up the numbers of hydrogen stations and vehicles in phases, regularly reviewing the progress of the CA H2 Net, setting renewable content and GHG emissions goals for the hydrogen production, leveraging existing alternative fuel activities and building partnerships that are inclusive of government, industry, academia and advocacy groups. The EO Team has incorporated the wise suggestions of the Advisory Panel and included necessary legislative and funding needed to sustain California's leadership.

3.1 *Points of Consensus from the Advisory Panel*

Members of the Advisory Panel represented a diverse group of private- and public-sector stakeholders having many interests in the commercialization of hydrogen fuel and hydrogen-fueled products. They were asked to provide guidance to the Topic Teams and the EO Team. Given the Panel's diverse make up, it is significant that members were able to reach agreement on a broad range of issue areas, including:

- The CA H2 Net will continue to put California, its businesses, and universities in a world-class leadership position for the successful introduction of hydrogen technologies.
- The CA H2 Net should use a long-term, multi-phased, sustainable approach to develop hydrogen technologies.
- The CA H2 Net program will make use of existing alternative fuels (e.g. such as natural gas and ethanol) and emerging near and mid-term technologies to expand hydrogen use.
- Investment in hydrogen infrastructure is manageable.
- The CA H2 Net program should investigate a variety of hydrogen production options.
- Hydrogen vehicle introduction will depend on technology and cost readiness as well as consumer acceptance.

- Government fleets, private fleets and "early adopters" should be encouraged to purchase hydrogen vehicles based on technology and cost readiness.
- The CA H2 Net should include energy station concepts.
- The CA H2 Net should achieve a 30 percent reduction in GHG emissions relative to comparable uses of today's fuels and technologies, and utilize 20 percent renewable resources in the production of hydrogen for use in vehicles by 2010.
- The CA H2 Net will best be accomplished by fostering public-private partnerships.

3.2 A Multi-Phase Approach: Short-Term Plan With a Focus on Long-Term Objectives

A key conclusion reached by the EO Team as well as the Advisory Panel was that the transition to hydrogen fuel in California will best be accomplished through a phased approach over several years. The successive phases will include building up the number of hydrogen fueling stations as more hydrogen-fueled vehicles and products are deployed. The overall approach will require a long-term commitment that should begin now with Phase 1. Regularly scheduled assessments of the CA H2 Net progress will help ensure success while deploying 250 hydrogen fueling stations in California, as envisioned in Executive Order S-07-04.

California is using and will continue to employ a station build up philosophy. The California station build up philosophy states that the fueling stations will initially be clustered in urban areas with a few stations distributed between the areas to link them. In California, the stations will initially be located in the San Francisco Bay Area—Sacramento regions and the Los Angeles—San Diego regions. In this way consumers can freely travel within these urban areas and commute between the two. This approach will give the majority of Californians the opportunity to easily use hydrogen cars. Table 1 provides an overview of the three recommended phases. This is followed by a description of Phase 1 and a brief overview for Phases 2 and 3.

Table 1—Estimated Numbers of Hydrogen Products and Stations by Phase

Type of Hydrogen-Fueled Vehicle or Product	Number of Units Targeted / Estimated for Deployment (by Phase)		
	Phase 1: 50 to 100 Stations	Phase 2: 250 Stations (w/ Initial Lower Usage)	Phase 3: 250 Stations (w/ Expanded Usage)
Light-duty FCVs and ICEVs from major manufacturers.	2,000	10,000	20,000
Heavy-duty FCVs or ICEVs.	10	100	300
Stationary and off-road vehicle applications.	5	60	400
FCV = Fuel Cell Vehicle	ICEV = Internal Combustion Engine Vehicle		

3.2.1 Description of Phase 1

The goal for Phase 1 is to establish a network of 50 to 100 stations in California. Currently there are 39 stations that are either existing or planned for completion in the next two years. Therefore, the efforts of Phase 1 will focus on building up to 61 additional hydrogen stations in California. By 2010, this will result in a statewide network of 50 to 100 hydrogen fueling stations that will be located in a manner to maximize hydrogen usage ("throughput," or volume dispensed). The number of stations is necessary to establish a network broad enough to support many small fleets.

Phase 1 stations will primarily serve fleet vehicles rather than the general motoring public. Early Phase 1 hydrogen vehicles are likely to be placed within fleets owned and operated by the State of California, other government agencies, and private companies and individuals with vested interests in hydrogen vehicles. Phase 1 progress and results will be reviewed every two years to assess the progress of vehicle and energy station manufacturers.

The number of stations sited will depend on the introduction rate of hydrogen-fueled vehicles. The numbers and locations of stations in Phase 1 are intended to fuel up to 2,000 light-duty vehicles and 10 heavy-duty vehicles. The number of vehicles is based on estimates provided by members of the California Fuel Cell Partnership and individual manufacturers. In addition, the California Stationary Fuel Cell Collaborative estimates that five "energy stations" with stationary fuel cells will be deployed during Phase 1. Energy stations are a single unit that includes a stationary power source, such as a fuel cell, and a hydrogen fueling station.

For illustration purposes, Phase 1 placement of fueling stations in Northern and Southern California was mapped in Figures 6 and 7. The Northern California map (Figure 6) shows nine existing or currently planned hydrogen stations (red dots), and ten additional stations (black dots) as they might be sited in the Bay Area and Sacramento in Phase 1 of the CA H2 Net. The Southern California Map (Figure 7) shows 21 existing or currently planned stations in the Los Angeles area and 10 additional stations as they might be sited in Phase 1. Together, these two maps illustrate a minimum 50-station network for the major population centers of Northern and Southern California. An additional 50 stations in Phase 1 would be placed in locations that need support for hydrogen-fueled vehicles and to link the urban areas to construct a fueling network. The station network that includes a concentration of stations in urban areas and a limited number of stations to link those urban centers will allow vehicles to roam between the urban areas without being limited by a vehicle's range.

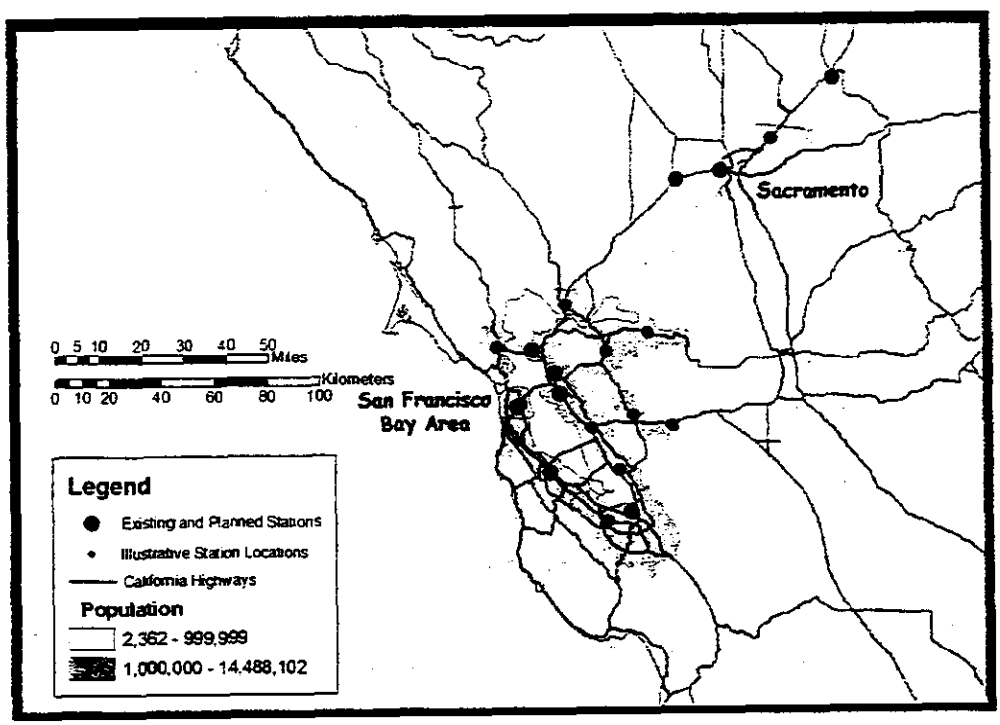


Figure 6—Example of Phase 1 stations in Northern California based on population density and existing gasoline stations[24]

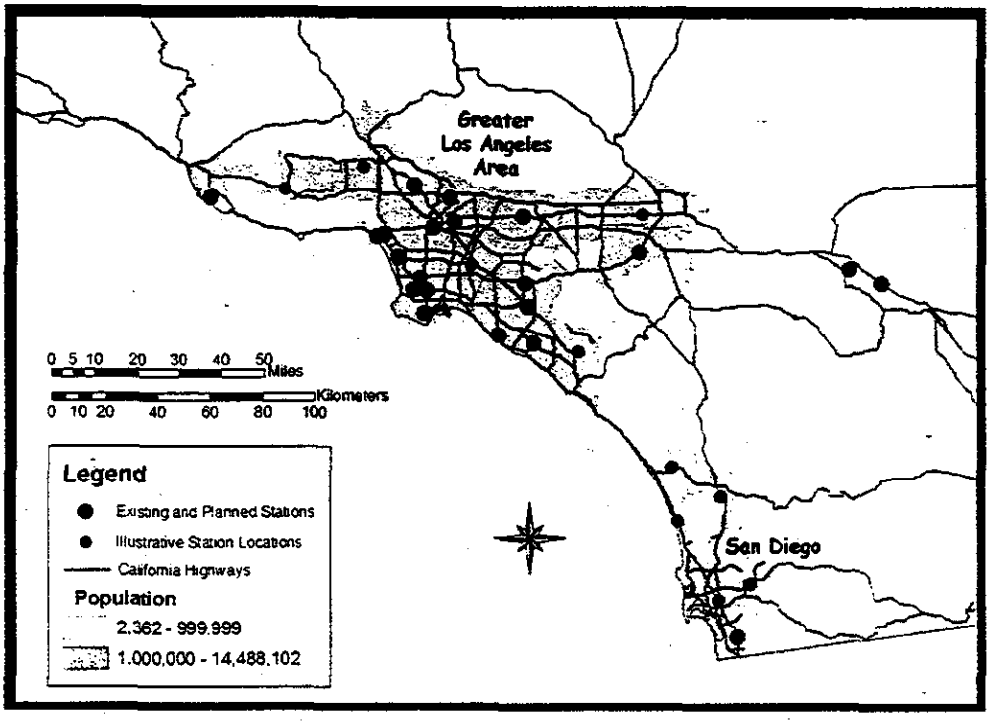


Figure 7—Example of Phase 1 stations in Southern California based on population density and existing gasoline stations[25]

The Phase 1 stations will utilize a mix of hydrogen-production technologies that can be evaluated in real-world use by energy companies to assess commercial viability. Some of the Phase 1 hydrogen stations will include energy stations. Energy stations that are powered by hydrogen or a hydrogen-containing fuel, such as natural gas, can provide fuel to hydrogen vehicles and electrical power to the grid or to nearby buildings.

To the maximum extent possible, renewable energy sources will be used to produce the hydrogen. Specific criteria for achieving environmental benefits are discussed in detail in Volume II.

3.2.2 Description of Phases 2 and 3

Embarking on Phase 2 is contingent on the completion of Phase 1 and the results of the biennial assessments. A network of 250 hydrogen stations and 10,000 hydrogen vehicles marks the exit gate for Phase 2. The vehicle-to-station ratio is similar to that in Phase 1, but with expanded numbers of vehicles in broader applications, and an expansion in energy station deployments. Also in the Phase 2 time frame, hydrogen home fueling stations (similar to home fueling now being commercialized for natural gas vehicles) may begin to play an enabling role for the CA H2 Net. These may even be small-scale residential energy stations that allow homeowners to fuel their vehicles while also powering, heating or cooling their homes.

In Phase 3, the number of stations is anticipated to remain constant while the number of hydrogen end uses increase. End uses of hydrogen include cars, buses and off-road applications. The number of vehicles is expected to double from Phase 2 to Phase 3 to equal a total of 20,000 cars. The higher ratio of vehicles to stations (80:1) is indicative of a doubling in "capacity utilization" (percentage of a station's total available hydrogen that is used) for the total station network. Phase 3 also assumes an expanded role for energy stations. Early stage development of all hydrogen stations will focus on regional network clusters in key Northern and Southern California urban areas, but these regional clusters will ultimately be bridged to form a comprehensive state network.

As the statewide network of hydrogen stations is built up in Phases 2 and 3, strategic stations that link large urban centers will play a more prominent role in the CA H2 Net. A statewide bridging network is envisioned that will focus on station deployments along Interstates 5, 10, 15, and 80.

3.3 *Early Risks Must Be Shared*

Implementation of hydrogen transportation and a hydrogen economy are not without challenges. For example, today's prototype hydrogen cars have high costs and technology limitations that can hinder commercialization. Cost, durability and hydrogen storage systems are among the biggest challenges. The investment by auto manufactures and the U.S. Department of Energy to solve these challenges demonstrates that there is a collective belief that they will be overcome. The CA H2 Net is an important part of making California the place to demonstrate and advance the vehicle technology so that we realize the cumulative benefits as quickly as possible.

The current pace to develop hydrogen-fueled vehicles and products is still hindered by the need to solve the so-called "chicken-or-egg" question: which should come first, commercialization of vehicles that run on hydrogen, or building of fueling stations that dispense it? Who should take the initial risk with expanded investments—hydrogen producers or vehicle manufacturers? What is the appropriate role of the government? Past experience in California with clean, alternative fuels leads to a clear conclusion: the early risks must be shared.

The benefits associated with hydrogen have prompted government organizations and private companies across the globe to pursue hydrogen technologies and build hydrogen stations. Nowhere is progress more impressive than in California. Private industry has invested heavily in California and learned many valuable lessons. The State must take advantage of industry experience and where possible, maximize future investments.

For example, the state should take advantage of the experiences station owners have shared regarding siting hydrogen and CNG stations to date. The average "public access" hydrogen station can easily take up to eighteen months to permit. In contrast, gasoline stations usually take only 12 to 14 months to establish yet require three more permits than hydrogen stations. The State may be able to

reduce the time to establish hydrogen stations by adopting a statewide uniform permitting process and regulatory approvals of hydrogen stations.

The simplification of the permitting process should be based on the adoption and consistent implementation of regulations, codes and standards for fire, life, and safety. These types of measures that the State can adopt will expedite the safe and effective deployment of stations by clearly defining the environment within which station developers must operate.

The State has a responsibility to implement as many non-financial incentives as possible but should also financially invest in our future if it is to be sustainable. We must invest financially now if we are to see the California environment and economy grow together.

3.4 Investment in Hydrogen

Today 11 hydrogen fueling stations are operating in Southern California and 5 in Northern California that support early demonstration programs. Most stations are not presently accessible to the public. Figure 8 illustrates the location of the hydrogen stations present in California.

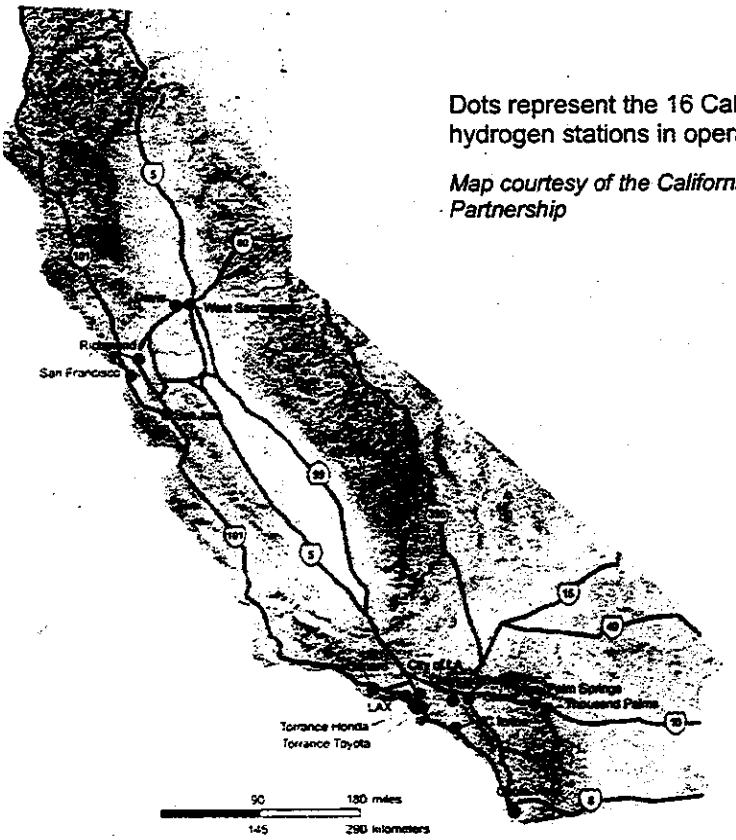


Figure 8—Map of hydrogen stations in California.[26]

Plans are underway to expand the number of stations to 39 within the next two years. As part of this expansion, the South Coast Air Quality Management District is partially funding construction of 14 new stations in the Los Angeles area. The U.S. Department of Energy is providing a 50 percent cost share for 19 new hydrogen fueling stations. Several members of the private sector are planning a few new energy stations as part of the emerging distributed energy generation market.

All major vehicle manufacturers are investing heavily in fuel cell vehicle technology development. So far almost 90 prototype fuel cell vehicles have been placed on California's roads as part of demonstrations (e.g. University of California, the cities of Los Angeles and San Francisco, and the California Fuel Cell Partnership) to date. The number of fuel cell vehicles is expected to increase to as many as 300 within the next three years, and could increase to about 1,200 by 2010. Seven fuel cell transit buses have been ordered and will begin operating this year.

Hydrogen internal combustion engine vehicles (H2ICEs) have been developed by companies such as BMW and Ford. In addition, companies such as Quantum Technologies and the Hydrogen Car Company are producing after-market H2ICEs, which could supplement the market provided they can meet certain certification standards. If mass-produced, H2ICE vehicles could serve as a lower cost (compared to fuel cell vehicles) bridging technology to introduce the public to hydrogen, while expanding the demand for hydrogen fuel from the CA H2 Net. It is estimated that as much as $2 billion has been expended or committed towards hydrogen vehicles and fueling infrastructure in California through these existing programs.[27] Funding for these efforts is being cost shared through two primary sources: the R&D dollars of private companies that have vested interests in hydrogen (for example, automobile manufacturers and energy companies), and their government partners, including state agencies.

3.4.1 Funding Required to Expand Fueling Stations and Vehicles

The CA H2 Net is based on a phased approach in which fueling stations need to be available to serve hydrogen vehicles as they emerge from prototype demonstrations to commercial production. To allow hydrogen vehicles to operate freely within and between major urban areas of California, 50 to 100 stations are needed by 2010. Between now and then, the number of hydrogen vehicles will be growing, however it will be well into the next decade before enough vehicles will be on the road to fully utilize each station and provide an adequate return on investment to the station owner. Yet without a widely distributed network of stations now, growth in the number of hydrogen vehicles will be hindered due to lack of fuel availability. This situation ("which comes first, the stations or vehicles?") suggests a role for government to share risk and help launch these new hydrogen industries whose success will benefit all Californians. Experience with the fuel station demonstration programs sponsored by the U.S. Department

of Energy suggests a 50/50 cost share with energy providers will stimulate private sector investment in the expansion of the CA H2 Net to 100 stations.

On the vehicle side, hydrogen vehicles are not yet cost competitive with conventional vehicles. Reductions in cost must occur through continued research, development and demonstration before hydrogen vehicles become commercially available. For a FCV to be cost competitive with conventional vehicles, automakers must be able to produce fuel cell power at $50 per kilowatt. Due to significant investment in R&D by government and industry over the last several decades, the cost of fuel cell power has dropped from over $500,000 per kilowatt to less than $500 per kilowatt today.[28] While this is significant progress, the cost of fuel cell power must still come down by a factor of ten. Companies that are working on the H2ICE technology believe their vehicles will be cost competitive sooner with conventional vehicles than fuel cells. The cost differential is already less than a factor of ten between H2ICE and gasoline ICE.

Clearly, costs are decreasing as fuel cell technologies are refined with an eye toward commercialization. However, costs are expected to remain relatively high for the 1,200 fuel cell vehicles envisioned in Phase 1. The vehicle manufacturers are expected to absorb much of these costs when placing vehicles into demonstration programs, as they have done to date.

However, many other states and countries have expressed interest in participating in fuel cell vehicle demonstration programs, both because of public interest and the hope that the home of future production of fuel cell products may occur where substantial vehicle demonstrations and infrastructure have taken root. Thus there is a competition emerging to acquire the fuel cell vehicles that will become available during the rest of this decade. Competing programs around the world are drawing the resources and attention of vehicle manufactures in many different directions.

The location of the California Fuel Cell Partnership, the University of California's and California State University's transportation and technology programs, and the U.S. DOE demonstrations in our state will help continue to draw vehicles here, as will the CA H2 Net. However, to help assure a growing number of fuel cell vehicles are placed in California to utilize the fueling network, vehicle incentives are needed. Based on the state's experience with incentives for battery electric vehicles ($5,000 to $10,000 per vehicle), and taking into consideration the higher cost of fuel cell vehicles at this stage of development, a $10,000 incentive per fuel cell vehicle is believed necessary to encourage vehicle manufactures to place additional fuel cell vehicles in California fleets.

Vehicle manufacturers could also produce lower cost hydrogen vehicles that use conventional internal combustion engines. While these vehicles are less efficient and lack some of the performance attributes of a fuel cell vehicle they still achieve emissions and petroleum reduction benefits compared to conventional vehicles. And while the incremental cost of a hydrogen ICE vehicle is estimated at $20,000 per vehicle, a $10,000 per vehicle incentive is believed sufficient to stimulate production.[29]

Fuel cells can also be utilized in other applications ranging from stationary power generation to forklifts. Because of low volumes, technology development often lags for these types of applications. Incentive funds are often needed to initiate development and demonstration. State incentives proved essential to initiating the purchase of seven fuel cell transit buses. It is expected that incentives, used as a highly leveraged cost-share, would be effective in developing markets for heavy duty on-road and off-road applications for hydrogen fuel cells and hydrogen combustion engines.

3.4.2 Estimated Costs for Phase 1

The estimated cost for the State's share of implementing Phase 1 of the CA H2 Net is presented in Table 2. About half of the funds would be used to help build new hydrogen fueling stations, with the other half providing vehicle incentives. The total cost is $53.5 million spread out over five fiscal years, or about $11 million per year. The private sector is committed to the other 50 percent of the investment needed to make this program successful. Energy companies have expressed enthusiasm about participating in the CA H2 Net, especially with the coordinated, phased and thoughtful process laid out by the Blueprint Plan. Auto manufacturers have expressed the need for vehicle incentives to bring together a balance of investment between carmaker, government and fleets users. As mentioned before, cost-sharing of both stations and vehicles will draw hydrogen activity to California in the face of growing world-wide demand for demonstration projects.

Table 2—Estimated State Cost to Implement Phase 1 of CA H2 Net over 5 years

Elements of Phase 1	Total Estimated Costs (millions)	Estimated Cost Share for State (millions)
11 additional stations (note 1).	$11.0	$5.5
Next 50 stations (note 2).	$54.0	$27.0
Incentives for 1,000 light-duty fuel cell vehicles (note 3).		$10.0
Incentives for incremental cost of 800 light-duty hydrogen ICE vehicles (note 4)		$8.0
Demonstration of new applications for hydrogen fuel cells (note 5)		$3.0
Total Estimated Phase 1 Cost for State of California		$53.5

Table Notes:

1. An estimated 39 hydrogen stations are built or being planned through existing programs. 11 additional stations are needed to achieve the lower-end Phase 1 goal of 50 stations.
2. 50 additional stations will be needed to achieve the upper-end Phase 1 goal of 100 stations.
3. Industry is providing 200-300 light-duty fuel cell vehicles as part of existing industry and government programs. Incentives are needed under Phase 1 to encourage placement of an additional 1000 vehicles in California.
4. Production of lower cost vehicles that burn hydrogen in conventional engines can occur with appropriate incentives, allowing a more rapid build-up to take advantage of the CA H2 Net.
5. Funding needed to cost share development of new applications of fuel cells in transit buses, shuttle buses, and off-road equipment.

The state share of the next 11 fueling stations would be $5.5 million, based on a 50/50 cost share with energy providers (approximately $500,000 per station). The average cost of each of the next 50 stations will be about the same—slightly more than $1 million per station—yielding a state cost share of $27 million. The number of stations to be built beyond the first 50 would be determined during the regular program progress reviews, and the state's contribution could be spread out over 5 years.

Only a few hundred fuel cell vehicles are planned for demonstrations in California to date. Fuel cell vehicle incentives of $10 million would help ensure California can grow its hydrogen vehicle fleet on a path consistent with development of the fuel station network. One thousand additional fuel cell vehicles would be placed in fleets that would continue their operation for the vehicles' useful life. In addition to rapidly increasing the number of operational hydrogen vehicles, 800 hydrogen ICE vehicles would be offered subsidies. A $10,000 per vehicle subsidy is considered sufficient to acquire both types of vehicles for use in California.

Three million dollars is suggested to provide incentives for new applications for fuel cell vehicles, such as heavy duty and off-road vehicles. The incentive amount per vehicle would depend on the application. The concept is similar to the California Energy Commission electricity program (Public Interest Energy Research Program or PIER) which awards funds for projects whose success can help improve the operation and efficiency of infrastructure.

These estimated Phase 1 costs are justified by the benefits discussed in this report. These costs appear to be well within the range of funding currently associated with clean air programs in California.[30] One finding of the CA H2 Net Blueprint Plan is that private industry cannot justify investing this magnitude of private capital "based on expected returns over the near term...given the immaturity of the market, projections of product availability, and the time needed to develop (significant) throughput at hydrogen fueling stations."[31] Without government cost sharing through the CA H2 Net, Phase 1 is unlikely to be implemented.

The biennial review process will be used to assess technological and commercial readiness for both vehicles and fueling stations. This will allow the State to make informed decisions regarding incremental funding allocations for Phase 1, as well as whether or not to fund subsequent phases.

3.4.3 Estimated Costs for Phases 2 and 3

The costs to implement Phases 2 and 3 will depend on the success achieved during Phase 1. Assuming the upper limit of 100 stations is achieved for Phase 1, an additional 150 stations will be targeted for completion by the end of Phase 2. The cost of adding these additional 150 hydrogen fueling stations is estimated at approximately $76 million, reflecting a lower per-station cost as volumes increase and fueling technologies mature. Whether or not California will need to share these costs will depend on how industry views the risks and returns associated with this level of investment.

Similarly, it is not clear that vehicle incentives will be required in these later phases. Technical successes in on-board storage, fuel cell costs and durability could obviate the need for incentives. Volume II of this Blueprint Plan includes detailed discussions of the various options that may provide the funding for the implementation of the CA H2 Net. The pros and cons of each funding mechanism are also discussed. Some of those options include (but are not limited to); market-based mechanisms, subsidies, non-profits & reinforcing mechanisms.

3.4.4 The Competition[32]

California is not the only state to recognize the benefits of hydrogen and work to bring the industry home. At least thirteen states either have funding mechanisms in place or proposed that are available for hydrogen projects and most states have University researchers working on hydrogen related technologies. The Colorado Fuel Cell Research Center has leveraged $2 million in public funding to develop a project worth over $12 million. Florida presently has proposed legislation worth

over $15 million in funding and tax credits for hydrogen projects. Minnesota has a legislative proposal worth $6 million in bonds that would be used to build a wind-to hydrogen project. Even a smaller state like Hawaii has been investing in hydrogen since 1983.

The competition to become the home of the hydrogen revolution is steep. California has got to take decisive action under Governor Schwarzenegger's leadership to secure the hub of the next technology revolution.

4.0 California Hydrogen Blueprint Action Plan

The EO Team came to a number of conclusions in the form of an Action Plan that will support and accelerate the realization of the benefits of the California Hydrogen Highway Network. To capitalize on the commitment of auto manufactures to build hydrogen vehicles and the interest of energy companies to help build hydrogen fueling stations, now is the time for the State of California to provide leadership. The Action Plan follows:

- **The Governor's budget should propose the funds for Phase 1 of the CA H2 Net.** A network of up to 100 hydrogen fueling stations allowing up to 2000 hydrogen vehicles to operate freely within the state can occur with financial participation by the state. 50/50 cost sharing of fueling stations and incentives to increase the number of hydrogen vehicles placed in California can be realized with a $10.7 million dollar annual investment for 5 years.

- **Site stations, build the CA H2 Net, and procure vehicles in cooperation with stakeholders by forming a public/private partnership.** Successful implementation of Phase 1 requires cooperation and partnership with other stakeholders interested in the benefits of hydrogen. A partnership with energy providers will provide funding and expertise to build fueling stations and market the fuel. A partnership with vehicle providers will place vehicles in appropriate fleets and help assure successful operation. A partnership with other government agencies will maximize the resources needed to implement the CA H2 Net, including addressing codes and standards, siting stations, and coordinating with fire marshals and safety personnel. A public-private partnership should be defined and led by Cal/EPA.

- **Adhere to environmental goals during implementation of the CA H2 Net.** Implementation of the CA H2 Net should achieve the goals recommended by the Advisory Panel of producing hydrogen from renewable sources and reducing greenhouse gases and other pollutants relative to conventional fuels.

- **Establish policies to support the use of hydrogen.** New policies should:
  - Establish hydrogen as a "transportation fuel"
  - Direct the California Department of Food and Agriculture's Division of Measurement Standards to develop specifications for hydrogen transportation fuel
  - Designate the State Fire Marshal's Office as the lead agency responsible for adopting hydrogen codes and standards, coordinating local authorities having jurisdiction and their permitting processes, and training emergency first responders to address hydrogen incidents.
- **Initiate an outreach plan.** An outreach plan to inform the public of the benefits and objectives of the CA H2 Net should be initiated.

These recommendations, along with many specific and detailed action items developed by the Advisory Panel and Topic Teams are discussed in detail in Volume II. The Action Plan provides a clear direction for implementing a successful CA H2 Net that will be the foundation for successful commercialization of a hydrogen-based economy in California.

Acronyms

CA	California
CA H2 Net	California Hydrogen Highway Network
Cal/EPA	California Environmental Protection Agency
EO	Executive Order
EO Team	Executive Order Team
EV	Electric Vehicle
FCV	Fuel Cell Vehicle
GHG	Greenhouse Gas
H2	Hydrogen
ICE	Internal Combustion Engine
ICEV	Internal Combustion Engine Vehicle
NASA	National Aeronautics and Space Administration
PEM	Proton Exchange Membrane
PIER	Public Interest Energy Research Program
PM_{10}	Particulate Matter $\leq$ 10 microns in diameter
R&D	Research and Development
U.S. DOE	United States Department of Energy

Appendix A—Executive Order S-7-04

EXECUTIVE DEPARTMENT

STATE OF CALIFORNIA

EXECUTIVE ORDER S-7-04
by the
Governor of the State of California

WHEREAS, hydrogen, a non-carbon energy carrier which can be made from clean renewable energy, is ideally suited to address global, regional and local energy and environmental challenges; and

WHEREAS, the State of California is a world leader in renewable energy production, efficiency and conservation, clean air and emission controls, environmental goals and planning, as well as creating, promoting and commercializing new technologies and industries; and

WHEREAS, hydrogen-powered vehicles and infrastructure can lead to energy independence; offer zero or near-zero smog-forming emissions; reduce health problems due to motor vehicle-related air pollution; reduce water pollution from oil and gasoline leaks; lower global warming pollution; improve fuel economy; quieter and smoother operation; as well as provide economic and workforce benefits to help California meet current and future energy needs; and

WHEREAS, the economic feasibility of a hydrogen infrastructure is enhanced by building hydrogen energy stations that power vehicles as well as supply electricity for California's power needs; and

WHEREAS, air pollution can cause or aggravate a wide range of serious health problems including cancer, birth defects, respiratory illnesses such as asthma and emphysema, heart and blood ailments, nervous system toxicity and early death; and

WHEREAS, children are more acutely affected by air pollution and have a higher incidence of harm from dirty air; and

WHEREAS, health problems caused by air pollution result in direct and indirect costs of hundreds of billions of dollars per year in California; and

WHEREAS, even after years of improvements in vehicle emissions technologies and effective emissions regulation, California has some of the worst air quality in the country; and

WHEREAS, much of the State of California does not meet state or federal health-based air quality standards, is at risk of not meeting federal air quality "attainment" status and may thereby lose billions of dollars in federal funds; and

WHEREAS, California is committed to Environmental Justice to ensure a clean and sustainable environment for all Californians; and

WHEREAS, the California Legislature has taken a leadership role to address petroleum dependence by passing AB 2076, which resulted in a report by the California Energy Commission (CEC) and the Air Resources Board (ARB) that found: California's oil refining capacity has not been able to keep up with growing demand for fossil fuel; the state faces a future of increasing petroleum dependence, supply disruptions, and rapid and frequent price volatility; without major efforts to reduce petroleum dependence, meeting future petroleum needs would require that California accept major expansion of refining capacity, delivery infrastructure and increased dependence on foreign energy supplies; and

WHEREAS, California is the home to the California Fuel Cell Partnership, a unique collaborative of eight auto manufacturers, four energy supply companies, two fuel cell technology companies, and seven government agencies, seeking to advance practical environmental transportation solutions with new fuel cell vehicle and hydrogen infrastructure technologies. The California Fuel Cell Partnership is the first public private partnership to test fuel cell vehicles under real day-to-day driving conditions; and

WHEREAS, California is also the home of the California Stationary Fuel Cell Collaborative, a public-private organization that includes 16 government agencies, two public electric utilities, the University of California, as well as major fuel cell technology companies, end users, energy supply companies, local government agencies and municipalities, research institutions, and developers; and

WHEREAS, state government organizations have been leading both research and commercial advances in energy and transportation technologies; and

WHEREAS, local governments and regional government agencies also are taking a leadership role to advance hydrogen and fuel cell vehicle technologies; and

WHEREAS, many of California's prestigious universities, national laboratories, and research institutions are leaders in advancing hydrogen, fuel cells, renewable energy, advanced vehicle systems and infrastructure technology through commercialization strategies and partnerships; and

WHEREAS, several studies have estimated that hundreds of thousands of manufacturing and support services jobs will be created when fuel cells gain market shares in the power and vehicle markets, and California is poised to receive many of these jobs and related investment and export opportunities because of its educated workforce and robust automotive and fuel sectors; and

WHEREAS, auto manufacturers have publicly announced their intention to commercially market "tens of thousands" of hydrogen and fuel cell vehicles within this decade, providing that a hydrogen infrastructure is available; and

WHEREAS, California has one of the nation's largest public fleets and the largest private sector vehicle market in the United States and has set a precedent of pushing for vehicle emissions reductions and clean vehicle technologies; and

WHEREAS, California's commitment to clean energy surpasses that of any other state, and California offers the best opportunity to hasten the commercialization of hydrogen and fuel cell technologies.

NOW, THEREFORE, I, ARNOLD SCHWARZENEGGER, Governor of the State of California, by virtue of the power vested in me by the Constitution and statutes of the State of California, do hereby issue this order effective immediately:

IT IS ORDERED that the State of California is committed to achieving a clean energy and transportation future based on the rapid commercialization of hydrogen and fuel cell technologies; and

BE IT FURTHER ORDERED that California's 21 interstate freeways shall be designated as the "California Hydrogen Highway Network" and the California Environmental Protection Agency and all other relevant state agencies including but not limited to State and Consumer Services; Department of Finance; Business, Transportation and Housing; Education; Health and Human Services; and Resources, shall work with state legislators and key stakeholders, including local and regional government organizations, educators, energy providers, automakers, fuel cell products suppliers, financing entities, non-governmental organizations, and community based organizations including those representing Environmental Justice communities to implement this Executive Order, plan and build a network of hydrogen fueling stations along these roadways and in the urban centers that they connect, so that by 2010, every Californian will have access to hydrogen fuel, with a significant and increasing percentage produced from clean, renewable sources; and

BE IT FURTHER ORDERED that the California Environmental Protection Agency, in concert with the State Legislature, and in consultation with the California Energy Resources Conservation and Development Commission and other relevant state and local agencies, develop a California Hydrogen Economy Blueprint Plan for the rapid transition to a hydrogen economy in California due January 1, 2005, and to be updated bi-annually thereafter containing recommendations to the Governor and the State Legislature and shall include, but not be limited to, the following:

Accelerating progress in hydrogen use, including public incentives and financing mechanisms such as general obligation bonds, or revenue bonds with repayment mechanisms; joint power agreements, procurement agreements, competitive master contracts, and partnerships with public and private entities; a review of immediate financing opportunities via the California Alternative Energy and Advanced Transportation Financing Authority (CAEATFA).

Promoting environmental benefits (including global climate change) and economic development opportunities resulting from increased utilization of hydrogen for stationary and mobile applications; policy strategies to ensure hydrogen generation results in the lowest possible emissions of greenhouse gases and other air pollutants.

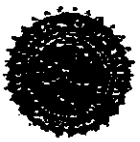
BE IT FURTHER ORDERED that the State of California will commit to achieving the following by 2010:

The state will commit to negotiate with auto makers and fuel cell manufacturers to ensure that hydrogen-powered cars, buses, trucks, and generators become commercially available for purchase by California consumers, businesses and agencies including state, regional and local; and

- California's state vehicle fleet shall include an increasing number of clean, hydrogen-powered vehicles when possible to be purchased during the normal course of fleet replacement; and
- Safety standards, building codes and emergency response procedures for hydrogen fueling installations and operation of hydrogen-powered vehicles shall be in place and permit agencies, building inspectors and emergency responders shall receive appropriate training; and

- Appropriate incentives shall be provided to encourage the purchase of hydrogen-powered vehicles and to encourage the development of renewable sources of energy for hydrogen production; and

I FURTHER DIRECT that as soon as hereafter possible, this order shall be filed with the Office of the Secretary of State and that widespread publicity and notice be given to this order.



IN WITNESS WHEREOF I have here unto set my hand and caused the Great Seal of the State of California to be affixed this the twentieth day of April 2004.

/s/ Arnold Schwarzenegger

Governor of California

Appendix B—List of Contributors

Senior Review Committee

Terry Tamminen[1]
Cabinet Secretary
Governor's Office

Alan Lloyd, Ph.D.[2]
Agency Secretary
California Environmental
Protection Agency

Mike Chrisman
Agency Secretary
Resources Agency

Sunne Wright McPeak
Agency Secretary
Business, Transportation and
Housing Agency

Tom Campbell
Director
Department of Finance

A.G. Kawamura
Agency Secretary
California Department of Food
and Agriculture

Tom Torlakson
Senator
California State Senate

Jenny Oropeza
Assemblymember
California State Assembly

Fred Aguiar
Agency Secretary,
State and Consumer Services
Agency

Ruben Grijalva
Chief
Office of the State Fire Marshal

1 Severed as Agency Secretary of Cal/EPA at the time the California Hydrogen Highway Network was first initiated.

2 Served as Chairman of the Air Resources Board at the time the California Hydrogen Highway Network was first initiated.

Implementation Advisory Panel

Terry Tamminen
Cabinet Secretary
Governor's Office

Dr. Alan Lloyd
Agency Secretary
California EPA

James D. Boyd
Commissioner
California Energy Commission

Brian Smith
Deputy Director, CalTrans

Cynthia Verdugo-Peralta
Governor Appointee
South Coast AQMD
Representing all 35 California
Air Pollution Control Districts

Donald L. Paul, Ph.D.
Vice President and Chief
Technology Officer
ChevronTexaco Corporation

Gary Petersen
Board Chairman, BioConverter

Ed Kjaer
Director of Electric
Transportation
Southern California Edison

Richard M. Morrow
Vice President, Southern
California Gas Company

Dr. Gerhard Schmidt
Vice President of Research and
Advanced Engineering
Ford Motor Company

Ben Knight
Vice President
Honda R & D North America,
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Dr. Christoph Huss
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Steve Chalk
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Jon Slangerup
President & CEO
Stuart Energy Systems

Jason Mark
Director
Clean Vehicles Program
Union of Concerned Scientists

Roland Hwang
Senior Policy Analyst
Natural Resource Defense
Council

Al Weversted
Director for Mobile Emissions
and Fuel Economy
General Motors
Representing the California Fuel
Cell Partnership

Dr. Scott Samuelson
Professor, National Fuel Cell
Research Center (NFCRC)
Representing the California
Stationary Fuel Cell
Collaborative

Luis Arteaga
Executive Director
Latino Issues Forum

Jeffrey Lockett
California Area Manager
Air Products and Chemicals, Inc.

Topic Team (Managers and Co-chairs)

Rollout Strategy

Matt Miyasato—Team Manager
South Coast AQMD

Eileen Tutt—Team Manager
California Air Resources Board

Cynthia Verdugo-Peralta, Co-Chair
South Coast AQMD

Wolfgang Weiss, Co-Chair
DaimlerChrysler

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Shell Hydrogen

Implementation Team

Rick Margolin-Team Manager
Energy Independence Now Coalition

Bill Chernicoff, Co-Chair
U. S. Department of Transportation

Andrei Tchouvelv, Co-Chair
Stuart Energy

Chris Sloane, Co-Chair
General Motors

Economy

Fereidun Feizollahi—Team Manager
California Air Resources Board

Michael Eaves, Co-Chair
Natural Gas Vehicle Coalition

Chip Schroeder, Co-Chair
Distributed Energy Systems

Public Education

Melissa Meuser—Team Manager
California Air Resources Board

Bob Hayden, Co-Chair
California Fuel Cell Partnership

Don Hardesty, Co-Chair
DOE/Sandia National Laboratory

Dick Schoen, Co-Chair
Solar Integrated Technologies

Societal Benefits

Eileen Tutt—Team Manager
California Air Resources Board

Stefan Unnasch, Co-Chair
TIAX

Jack Kitowski, Co-Chair
California Air Resources Board

Endnotes

[1] This is an increasingly recurring theme in the petroleum industry as evidenced by: "ChevronTexaco Warns of Global Bidding War," by Deepa Babington, Reuters, February 15, 2005; "Shell cuts oil reserves again as profits soar," by Tom Bergin, Reuters, February 3, 2005; "Shell, Exxon Tap 'High Cost' Oil Sands, Gas as Reserves Dwindle," Bloomberg, February 18, 2005.

[2] "Crude Oil and Total Petroleum Imports Top 15 Countries", United States Department of Energy—Energy Information Administration, February 23, 2003.

[3] Intergovernmental Panel on Climate Change, 2001. Third Assessment Report of the Intergovernmental Panel on Climate Change.

[4] This is an increasingly recurring theme in the petroleum industry as evidenced by: "ChevronTexaco Warns of Global Bidding War," by Deepa Babington, Reuters, February 15, 2005; "Shell cuts oil reserves again as profits soar," by Tom Bergin, Reuters, February 3, 2005; "Shell, Exxon Tap 'High Cost' Oil Sands, Gas as Reserves Dwindle," Bloomberg, February 18, 2005.

[5] "Crude Oil and Total Petroleum Imports Top 15 Countries", United States Department of Energy—Energy Information Administration, February 23, 2003.

[6] Intergovernmental Panel on Climate Change, 2001. Third Assessment Report of the Intergovernmental Panel on Climate Change.

[7] www.fypower.org/save_gasoline/.

[8] California AB 2628 proposed by Assemblymember Fran Pavley in 2004.

[9] An "energy carrier" stores, moves, and delivers energy in a useable form to consumers.

[10] Executive Order Team members are Alan C. Lloyd, PhD, Cal/EPA Secretary; Shannon Baxter Clemmons, Cal/EPA Special Advisor on Hydrogen and Renewables; and Daniel Emmett, Energy Independence Coalition's Executive Director. Cabinet Secretary Terry Tamminen led the effort in 2004 when he was Cal/EPA Secretary.

[11] The individual members of the Advisory Panel are acknowledged on the inside front cover of this report and are listed in Appendix B.

[12] The Topic Team members are individually listed at the beginning of Volume II of the California Hydrogen Blueprint Plan. The Topic Team leaders and co-chairs are listed in Appendix B.

[13] Reports are available at www.hydrogenhighway.ca.gov.

[14] California Energy Commission, *Energy Story: Chapter 20*; is available online at www.energyquest.ca.gov/story/chapter20.html.

[15] Ibid.

[16] Equivalent to the Air Resources Board's Low Emission Vehicle rating of SULEV.

[17] California Energy Commission, California Air Resources Board; *Reducing California's Petroleum Dependence, Joint Agency Report*; August 2003 (Publication Number P600-03-005f).

[18] Ibid.
[19] Ibid.
[20] Ibid.
[21] This report uses the term "Source-to-Wheel" rather than "Well-to-Wheel" that is more commonly known. Source-to-Wheel is a more accurate term to describe hydrogen production since well to wheel denotes oil well to vehicle wheel.
[22] Images illustrate fuel cycle for petroleum fuel production.
[23] Hydrogen production methods depicted in this figure represent the high and low ends of emissions impacts. This figure is representative of light-duty vehicles only.
[24] These maps are meant to illustrate station placements rather than show actual station locations. These maps show a combination of actual and hypothetical placements for planned and yet to be planned sites. Only 30 of the currently estimated 39 existing stations are shown. Many of the currently planned station sites are confidential.
[25] Ibid.
[26] Up-to-date information on the specifics of the hydrogen stations in California can be found at www.cafcp.org/fuel-vehl_map.html.
[27] This is an educated guess based on input from Advisory Panel members and individuals familiar with various programs in California.
[28] U.S. Department of Energy (www.fossil.energy.gov/programs/powersystems/fuelcells/) and Automotive News, "GM: Sequel Fuel Cell Vehicle Not Ready for Mass Production," by Jason Stein, January 09, 2005 (www.autonews.com/news.cms?newsId=11110).
[29] One auto manufacturer pursing Hydrogen ICE development has indicated that at commercial production levels, the current incremental cost of the technology is estimated to be $20,000. Very low volume production, contemplated in the first phase of this program would have higher incremental costs.
[30] For example, the Governor recently signed AB 923, which expands California's Carl Moyer Program. Up to $140 million per year of incentive funding is now available to help reduce diesel-related emissions, including funding that was provided in the fiscal year 2004-2005 budget (SB1107).
[31] See Economy Topic Team report in Volume II of this report.
[32] More information on hydrogen initiatives in other states can be found at www.energyindependencenow.org/factsheets.html

No written material available at time of electronic book creation.