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Arnold Schwarzenegger, *Governor*

CALIFORNIA ENERGY COMMISSION

Kenneth Koyama
Principal Author

Dan Fong
Project Manager

Chuck Mizutani
Manager
TRANSPORTATION TECHNOLOGY OFFICE

Rosella Shapiro
Deputy Director
FUELS AND TRANSPORTATION DIVISION

Scott W. Matthews
Acting Executive Director

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Biodiesel

Russell Teall, Biodiesel Industries
Elisa Lynch, Bluewater Network
Dave Smith, British Petroleum
Steve Brisby, California Air Resources Board
Dean Simeroth, California Air Resources Board
Cynthia Cory, California Farm Bureau
Dan Sinks, ConocoPhillips
Randall von Wedel, Cytoculture—Environmental Biotechnology
Dave Williamson, Ecology Center
Bob Clark, Imperial Western Products
Jeff Irvin, ITL Inc.
Steve Howell, MARC-IV Consultants
Scott Hughes, National Biodiesel Board
Teresa Alleman, National Renewable Energy Laboratory
Will Coleman, Renewable Energy Action Project
Kurt Buehler, U.S. Navy
Don Anair, Union of Concerned Scientists
Gina Grey, Western States Petroleum Association
Graham Noyes, World Energy Alternatives
Kumar Plocher, Yokayo Biofuels

Electricity and Hydrogen

Don Eichelberger, Air Products and Chemicals, Inc.
Richard Goodstein, Air Products and Chemicals, Inc.
Jaimie Levin, Alameda Contra-Costa Transit District
Stephen Kukucha, Ballard
Jim Uihlein, British Petroleum
Shannon Baxter, California Environmental Protection Agency
Catherine Dunwoody, California Fuel Cell Partnership
Todd Suckow, California Fuel Cell Partnership
Hank Wedaa, California Hydrogen Business Council
Tim Fullerton, Electric Drive Transportation Association
Gail Hendrickson, Electric Drive Transportation Association
Frank Balog, Ford Motor Company
Dominic DiCicco, Ford Motor Company
Karen Miller, National Hydrogen Association
Jeff Serfass, National Hydrogen Association

Jim Ohi, National Renewable Energy Laboratory
Paul Prokopius, Proton Energy Systems
Art Douwes, Santa Clara Valley Transit Authority
Brad Smith, Shell Hydrogen
Naveen Berry, South Coast Air Quality Management District
Bill Clapper, SunLine Transit Agency
Jonathan Haines, Toyota
Christopher Bordeaux, U.S. Department of Energy
Anthony Eggert, UC Davis/Institute of Transportation Studies
David Friedman, Union of Concerned Scientists
Mike Gorman, UTC Fuel Cells
Erica Herz, UTC Fuel Cells

Ethanol

Ellen Shapiro, Alliance of Automobile Manufacturers
Elisa Lynch, Bluewater Network
Dave Smith, British Petroleum
Steve Brisby, California Air Resources Board
Dean Simeroth, California Air Resources Board
Steven Shaffer, California Department of Food and Agriculture
Matt Summers, California Department of Food and Agriculture
Neil Koehler, California Renewable Fuels Partnership
Tom Koehler, California Renewable Fuels Partnership
Al Jessel, Chevron Oil Company
Loren Beard, DaimlerChrysler
Fred Maloney, DaimlerChrysler
Robert E. Reynolds, Downstream Alternatives Inc.
Art Brickey, First Southwest Company
Mike Ferree, First Southwest Company
Barry Friedman, First Southwest Company
Peg Gutmann, Ford Motor Company
Gary Herwick, General Motors Corporation
Brent Andrews, Interstate Oil Company
James Holland, Kinder Morgan
Phil Lampert, National Ethanol Vehicle Coalition
Roger Listenberger, National Ethanol Vehicle Coalition
Luke Tonachel, National Resources Defense Council
James Peeples, O2 Diesel, Inc.
Scott Dunlop, Pure Fuels Inc.
Steven Paul, Pure Fuels Inc.
Brooke Coleman, Renewable Energy Action Project
Will Coleman, Renewable Energy Action Project
Richard Irwin, Silvas Oil Company
John Silvas, Silvas Oil Company

Dwight Stevenson, Tesoro
Gina Grey, Western State Petroleum Association

Gas to Liquid Fuels

Richard J. Peterson, Alaska Gas-to-Liquids
Adam Schubert, British Petroleum
Dave Smith, British Petroleum
Dean Simeroth, California Air Resources Board
Ed Hardiman, California Department of Transportation
Ed Casey, ConocoPhillips
Doug Smith, ConocoPhillips
Pam Jones, Diesel Technology Forum
Jim Ditch, Long Beach Transit Authority
Teresa Alleman, National Renewable Energy Laboratory
Paul Worhach, Nexant
Gary Grimes, Paramount Refining
John Alvarez, Sasol Chevron
Roger Davies, Shell
Ian Virrels, Shell
Adewale Oshinuga, South Coast Air Quality Management District
Bob Freerks, Syntroleum
John Warzel, Syntroleum
Gina Grey, Western States Petroleum Association
Leigh Noda, World GTL Inc.

Liquefied Petroleum Gas

Greg Gilbert, Autumn Wind Associates
Dean Simeroth, California Air Resources Board
Gary Yee, California Air Resources Board
Jon Van Bogart, Clean Fuels USA
Douglas E. Bergman, ConocoPhillips
Otis W. Dancy, Jr., ConocoPhillips
Bill Platz, Delta Liquid Energy
Steve Moore, Mutual Propane
Brian J. Feehan, Propane Vehicle Council

Natural Gas

Lauren Dunlap, California Natural Gas Vehicle Coalition
Mike Eaves, California Natural Gas Vehicle Coalition
Claus Emmer, Chart Industries
Martin Mahaley, Chart Industries
Mitch Pratt, Clean Energy
Leeore Alpern, Gladstein, Neandross & Associates
Erik Neandross, Gladstein, Neandross & Associates
Tony Estrada, Pacific Gas and Electric Company
Sam Griffith, Pacific Gas and Electric Company
Kent Harris, Pacific Gas and Electric Company
Jan Hull, Trillium

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Introduction

The state's demand for transportation fuels has increased 53 percent in the last 20 years and in the next 20 years, gasoline and diesel demand will increase another 36 percent.[i] California refineries rely increasingly on imported petroleum products to meet this demand. This growing demand and the increasing challenge faced by refineries in meeting this demand will lead to more frequent price volatility and potential economic dislocation. In 2003, the California Energy Commission (Energy Commission) and the California Air Resources Board (CARB) adopted a two-pronged strategy to reduce petroleum demand: promoting improved vehicle efficiency, and increasing the use of alternative fuels. This report discusses the second segment of increasing alternative fuel use in transportation.

The Energy Commission and CARB set a goal that 20 percent of all transportation energy used in 2020 comes from alternative fuels. If California successfully meets this goal, about 4.8 billion gallons of gasoline and diesel will be displaced annually by alternative fuels. Given that current alternative fuel use in 2005 is 6 percent, it will be a challenge to meet this goal within the next 15 years.

The Energy Commission staff and industry stakeholders held a series of meetings to identify the next steps for increasing the use of alternative fuels in California. These stakeholders include alternative fuels producers, vehicle manufacturers, advocacy groups, government agencies, and technology developers. The stakeholders identified key market barriers and developed recommendations to overcome those barriers.

The staff asked the stakeholders for their recommendations that would maximize the potential market share of each alternative fuel discussed in the report. The recommendations received did not include mandates, nor a "hands off and let the market decide" approach. Instead, the stakeholders asked the Energy Commission to facilitate solutions to regulatory barriers or to develop and fund incentive programs. These recommendations will be a challenge to adopt and implement, and the state may need additional suggestions to meet the nonpetroleum fuel goals of 2020.

While some stakeholders believe that their particular alternative fuel can meet the 2020 goal exclusively, the staff believes that no single alternative fuel can reach this goal. Instead, the state will need programs to increase the use of a variety of alternative fuels in more niche applications and in blends with gasoline or diesel. However, even if the state implements all of the recommendations from the stakeholders, it will still be a significant challenge for California to reach the goal of displacing 4.8 billion gallons of gasoline and diesel annually by 2020.

Organization of Report

Seven alternative fuels are discussed in this report:

- biodiesel
- electricity
- ethanol
- gas to liquid fuels (natural gas to diesel fuel)
- hydrogen
- liquefied petroleum gas (propane)
- natural gas

The report discusses the technology status for each fuel, the types of vehicles available, the stakeholders' projections of petroleum displacement, the major market barriers for each fuel, and the steps that the stakeholders noted as important for meeting their market projections. This report only minimally discusses fuel costs, and defers to the costs and benefits analysis report of the *2005 Energy Report*.[ii]

California Leads the Nation with Alternative Fuels

The Energy Commission and other state agencies began programs to introduce alternative fuels to California's transportation system in the early 1980s. The state has made small, but measurable, progress in capturing a portion of the transportation energy market with alternative fuels.

Although California still relies on petroleum fuels for over 90 percent of its transportation energy, it has established the most numerous and diverse network alternative fuel vehicles and refueling stations of any state in the nation. Tables 1 and 2 below show the top 10 states for vehicles and refueling stations.

Table 1
Top Ten States
Population of Alternative Fuel Vehicles

State	Liquefied Petroleum Gas	Natural Gas	Methanol	Ethanol	Electricity	TOTAL
California[a]	21,537	24,990	4,787	9,517	10,670	71,501
Texas	39,279	9,961	162	6,706	82	56,190
New York	6,213	13,100	88	3,723	9,299	32,423
Oklahoma	17,839	3,322	0	1,122	0	22,283
Florida	4,171	4,152	6	7,856	357	16,542
Georgia	4,418	4,484	39	2,076	4,550	15,567
Illinois	5,259	3,120	17	6,916	89	15401
Michigan	4,822	991	48	4,840	1,606	12,307
Colorado	5,611	2,694	3	3,491	126	11,925
Arizona	1.082	7,243	201	1,583	1,662	11,771

Source: Energy Information Agency, http://www.eere.energy.gov/afdc/infrastructure/station_counts.html
[a] For the purpose of this table, these data are for 2002. Elsewhere in the report, updated California data are used.

Table 2
Top Ten States
Alternative Fuel Stations

State	CNG	Ethanol	LPG	Electric	Bio-diesel	Hydrogen	LNG	TOTAL
California[a]	180	2	277	468	14	6	29	977
Texas	34	0	708	2	4	0	2	750
Florida	27	3	111	6	4	0	0	151
Minnesota	3	105	40	0	1	0	0	149
Arizona	30	2	77	26	3	1	8	147
Michigan	15	3	104	2	12	1	0	137
Oklahoma	54	3	78	1	0	0	0	136
Colorado	25	10	75	4	11	0	0	125
Missouri	6	8	106	0	1	0	0	121
Pennsylvania	40	0	75	0	2	0	1	118

Source: Energy Information Agency, http://www.eere.energy.gov/afdc/infrastructure/station_counts.html
[a] For the purpose of this table, these data are for 2002. Elsewhere in the report, updated California data are used.

Biodiesel

Status of Fuels and Technology

Several fleets in California already use biodiesel, a fuel made from vegetable oils, animal fats, and used cooking oils. Although federal fleets in the state have been the leaders with using the fuel, biodiesel has also received grassroots support from several communities. For example, the City of Berkeley held a Biodiesel Film Festival in March 2005.[iii] Table 3 shows a partial listing of fleets in California that use biodiesel.

According to estimates by the National Biodiesel Board, these fleets and others in the state use 4 million gallons of biodiesel per year.[iv] Given that the total U.S. demand for biodiesel is 20 million gallons, California may be one of the largest consumers in the nation.[v]

Biodiesel is typically used in a blend with conventional diesel rather than as 100 percent biodiesel (B100). The stakeholders advocate a 20 percent blend of biodiesel with 80 percent conventional diesel (B20). According to the National Renewable Energy Laboratory, B20 has several advantages:

- It reduces the user cost by blending only 20 percent of this fuel with the lower cost conventional diesel.
- It is considered an alternative fuel under Federal Energy Policy Act requirements.

Table 3
Fleets Using Biodiesel

Category	Fleet
Federal Government	29 Palms
	Travis Air Force Base
	Barstow Marine Corps Station
	Vandenberg Air Force Base
	Port Hueneme
	Channel Islands National Park
Utilities	Pacific Gas and Electric
	Southern California Edison
	San Diego Gas and Electric
Local Governments	City of Berkeley
	County of Alameda
Private Companies	Fetzer Winery
	Thanksgiving Coffee Company
	JR Cardenas Construction

- It reduces emissions of soot, particulates, hydrocarbons, carbon monoxide, and carbon dioxide by more than 10 percent each.
- It is compatible with most engine and fueling system components.[vi]

In addition, B20 recently has received a blender's tax incentive of a penny per percentage point of biodiesel blended with petroleum diesel and a half penny per percentage point of recycled oils such as cooking oils. The Biodiesel Board stated that in mid October 2004, the average price of diesel was $1.53 per gallon and the price of B20 was $1.72. With the tax incentive, the price of B20 would have been $1.52, about the same as petroleum diesel at the time.[vii]

Stakeholder Market Projections

The biodiesel stakeholders estimate that markets will increase with the tax incentives. Under more aggressive scenarios that include expanded tax incentives, stakeholders project substantially higher biodiesel demand in the state, as shown in Table 4.[viii]

Barriers

Most engine manufacturers have provided positive statements about the use of B20 in their heavy duty engines. However, a few, such as Volkswagen, limit biodiesel use to a 5 percent blend or less until they receive greater assurance of fuel quality, material compatibility, and fuel stability. The National Renewable Energy Laboratory is conducting several studies to determine the extent of these problems and measures to mitigate them.[ix]

Table 4
Biodiesel Petroleum Displacement
(million gallons)

Year	Base case	Aggressive
2010	10-30	35-65
2020	40-80	300-700

The stakeholders identified a slight increase in NOx emissions with the use of B20. All other criteria pollutants show significant reductions compared with conventional diesel as shown in Table 5.[x]

Table 5
Emission Impacts from Biodiesel
Compared to Conventional Diesel

	B100	B20
Total Unburned Hydrocarbons	-67%	-20%
Carbon Monoxide	-47%	-12%
Particulate Matter	-48%	-12%
NOx	+10%	+2%

Source: Scott Hughes, Letter to John Geesman, Commissioner, California Energy Commission, March 28, 2003

Although the U.S. Environmental Protection Agency suggests that diesel after treatment technology will help to eliminate any NOx increases from new vehicles, this solution may not apply to diesel vehicles already on the road. Additional testing with fuel additives, fuel formulation, and engine operation strategies may lead to other, broader-based solutions.[xi]

Electricity

Status of Fuel and Technology

The stakeholders for electric transportation technologies have focused on off-road, non-traditional options such as fork lifts and lawn mowers. These specialty vehicles may have better cost effectiveness and regulatory support than on-road battery electric vehicles. Using a diverse group of specialized technologies could significantly help meet the state's petroleum reduction goals and, according to electric transportation stakeholders, displace over 900 million gallons per year. These technologies include the following:

- Plug-in hybrid electric vehicles
- Truck stop electrification and electric transport refrigeration units
- Marine terminal electric technologies
- Off-road electric technologies

The growth of these electric technologies stems from emission regulations that aim for zero emissions. These include anti-idling regulations for trucks in queues; zero emission requirements for new tugs (a small tractor for towing such as those used at airports), tractors, and belt loaders at airports; and indoor emission limits on fork lifts.
In a report prepared for the California Electric Transportation Coalition, the consulting firm TIAX, LLC estimated that the state has about 300,000 electric transportation units not including lawn and gardening equipment.[xii] Table 6 shows the types and population of electric transportation units in the state.

Table 6
Population of Electric Vehicles in California

Technology	2002 Population	Projected 2011 Population
Light-duty EVs, neighborhood electric vehicles, city electric vehicles	3300 - 5700	75,000 – 123,000
Other on-road EVs (plug-in hybrid electric vehicles, shuttles, buses)	54	100 – 6000
Non-road EVs (fork lifts, golf carts, personnel carriers, tow tractors, burden carriers, turf trucks, sweepers/scrubbers, lift trucks, etc.)	286,000 – 296,000	387,000 – 561,000

Source: Tiax, LLC, *Report on the Electric Vehicle Markets, Education, RD&D, and the California Utilities' LEV Programs – Final Report*, for the California Electric Transportation Coalition, March 22, 2002.

Electric vehicles (EVs) using batteries that were built to satisfy California's zero emission vehicle regulations could not substitute for the features and performance of conventional vehicles, and as a result, a self-sustaining market for these electric vehicles has not evolve. None of the major automakers have indicated any plans to further develop and market battery electric vehicles.[xiii]

Plug-In Hybrid Electric Vehicles

One proposal championed by the Electric Power Research Institute (EPRI) and others is the plug-in hybrid EV. These vehicles would be designed to have an electric range of at least 20 miles with their on-board batteries and a gasoline engine to power assist the vehicle on longer trips or on steep grades.[xiv]

A plug-in hybrid EV with a 20-mile all electric range has several benefits. It uses a standard 120-volt plug, not the multi-thousand dollar, higher voltage charger designed

for the EVs of the 1990s. While the plug-in hybrid EV would cost more than a conventional gasoline vehicle or hybrid EV, the electricity used would cost less per mile than gasoline.

However, to date, only a handful of plug-in hybrid electric vehicles are being demonstrated at California utilities, and automakers have shown little interest in developing a line of plug-in hybrid electric vehicles. According to automakers, the plug-in feature of battery electric vehicles was one of the negative characteristics of EVs based on customer feedback from early demonstrations.[xv]

Truck Stop Electrification

Federal law requires drivers of long haul trucks to rest 10 hours for every 11 hours that they drive. Drivers use their truck cabs to sleep for much of the required ten hours and keep the engine idling to operate the cab's heating or air conditioning units for comfort and auxiliary power. Because trucks use a gallon of diesel an hour for every hour of truck idling, engine idling in California uses as much as 45 million gallons of diesel per year.[xvi]

Although CARB has adopted regulations that limit engine idling to no more than five minutes, this regulation only applies to trucks in queues or waiting for their cargo. CARB will review expanding the prohibition to overnight truck idling when truck stop electrification infrastructure becomes more widely available.

Idleaire Technologies Corporation has developed a system that allows truckers to mount a service console on the window of the truck cab to access external cooling or heating as well as other services for an hourly fee. These systems have been strategically placed at 10 truck stops in California, mostly along the Interstate 5 corridor. These truck stops also include other amenities such as restaurants, shops, and shower facilities that add to the commercial success of truck stop electrification.

Other technologies are under development that will allow trucks to plug in their electrical appliances through an off board infrastructure facility known as "shore power," established at rest stops or common truck stops. In addition to cab heating and cooling, shore power will allow trucks to plug in their cargo refrigeration units. Trucks will need to be retrofitted with electrical upgrades to allow them to plug into the power source at a cost of as much as $7,000 per truck. The shore power infrastructure costs about $3,000 per stand.[xvii]

Marine Terminal Electric Technologies

On a typical day in California, 16 container ships arrive at ports in Los Angeles, Long Beach, Oakland, and other locations. While docked, container ships use auxiliary diesel generators to power refrigeration, lighting, computers, etc. (activities commonly referred to as hotelling). The port authorities estimate that 30 million gallons of diesel annually

will be used for hotelling services. To control emissions from these container ships, ports and local air districts have proposed shore-to-ship electrification, known as "cold ironing." Because of California's economy and location, the port authorities expect cargo shipment growth to double over the next 10 years and triple by 2020.[xviii]

Off-Road Electric Technologies

The stakeholders promoting electric transportation technologies have targeted fork lifts, airport ground support equipment, burden and personnel carriers, turf trucks, sweepers, scrubbers, and varnishers for a greater market share of electric technologies. Although the electric versions of these technologies cost more than their internal combustion engine counterparts, regulatory drivers to control both outdoor and indoor emissions will increase the trend of these off-road technologies toward electric technologies.

These off-road electric transportation technologies could help to significantly reduce petroleum demand in the state. Forklifts alone could displace 300 million gallons of gasoline by 2010, with burden carriers, turf trucks, sweepers, scrubbers, and varnishers displacing another 100 million gallons.

Electric lawn mowers and other garden equipment have gained in popularity in recent years. To make them cost effective, local air districts have established programs to swap older gasoline gardening equipment for vouchers for new electric equipment. The available vouchers are generally gone within an hour of the start of these programs.[xix]

Stakeholder Market Projections

The California Electric Transportation Coalition summarized the potential for petroleum displacement from electronic technologies as shown in Table 7 below.

Barriers

The electric transportation stakeholders believe that the state lacks a clear plan to achieve the petroleum reduction goals for the state and therefore proposed a "California Transportation Fuel Strategy and Implementation Plan" that sets out the steps needed, including off-road and non-road petroleum reduction measures. The Energy Commission would develop this plan with input from all stakeholders of all fuels through a technical advisory group.[xx] CalStart/WestStart agreed with this approach, indicating that the Energy Commission is probably in the best position to develop this plan.[xxi]

Table 7
Electricity Technology Petroleum Displacement

Electric Drive Technology	Units	Estimated Petroleum Displaced by 2010 (millions of gallons)
Truck stop electrification	10,000 parking stalls	45
Electric Transport Refrigeration Units	24,000 retrofitted truck refrigeration units	30
Marine Terminal Electric Technologies	Cold ironing at ports of Los Angeles, Long Beach, and Oakland	30
Fork Lifts, Lift Trucks	70,000 to 90,000 trucks	300
Airport Support Equipment	11,100 electric bag and tow tractors	-
Burden Carriers, Turf Trucks	42,800 burden carriers and turf trucks	60
Sweepers, Scrubber, and Varnishers	130,000 vehicles	40
Lawn and Garden Equipment	3.5 million pieces of equipment	110
Plug-in Hybrids	2 million vehicles	300
	TOTAL	915

Source: Dave Modisette, "Electric Transportation Technologies and Equipment" presented at Committee Workshop on Proposed Transportation Energy Efficiency and Alternative Fuels Analyses, California Energy Commission, Sacramento, California, December 20, 2004.

Ethanol

Status of Fuel and Technology

Ethanol is currently the most widely used alternative fuel in California. By virtue of federal regulations requiring minimum oxygen content in gasoline, California gasoline is produced with 5.7 percent by volume of ethanol. This requirement raised California's ethanol usage above 900 million gallons for 2004.

Automobile manufacturers have sold 200,000 fuel flexible vehicles (FFVs) in California that can use a gasoline blend of up to 85 percent ethanol (E85). The 24 different models of FFVs cover nearly all light-duty vehicle market segments from the compact sedan to the minivan to the pickup and sport utility vehicles. Table 8 below shows the FFV models available for sale nationally. This growth of FFV sales seems to be a ready-made potential sales base for E85 if the drivers of these vehicles had access to refueling stations.

The variety of makes and models of FFVs stems from the Corporate Average Fuel Economy (CAFE) credits created through the Alternative Motor Fuels Act of 1988. This Act enables manufacturers to claim a credit of up to 0.9 miles per gallon to add to the corporate average fuel economy of their vehicles sold in the United States. While the act clearly gives manufacturers assistance in meeting their CAFE requirements, it does not ensure use of ethanol.

Table 8
FFV Models

Make	Model	Type
Chrysler	Sebring	Sedan
Dodge	Caravan	Van
Dodge	Grand Caravan	Van
Dodge	Ram Pickup	Pickup
Dodge	Stratus	Sedan
Ford	Explorer	SUV
Ford	Explorer Sport Trac	SUV
Ford	Mercury Mountaineer	SUV
Ford	Mercury Sable	Sedan
Ford	Taurus	Sedan
Ford	Taurus Wagon	Station Wagon
GM	Avalanche	Pickup
GM	Silverado	Pickup
GM	Suburban	SUV
GM	Tahoe	SUV
GM	Sierra	Pickup
GM	Yukon	SUV
GM	Yukon XL	SUV
Mercedes Benz	C240	Sedan
Mercedes Benz	C240 Luxury Wagon	Station Wagon
Mercedes Benz	C320	Sedan
Mercedes Benz	C320 Sport Coupe	Sedan
Mercedes Benz	C320 Sport Sedan	Sedan
Nissan	Titan	Pickup

With only three E85 refueling stations in California, the 200,000 FFVs in the state use gasoline nearly exclusively. In contrast, the rest of the United States has more than 200 E85 stations, mostly located in the Midwest.[xxii] For example, Minnesota adopted aggressive state policies that provided incentives for E85 fueling stations and resulted in over 100 gasoline stations with E85 pumps.

Based on the presentations from the California Renewable Fuels Partnership and Gary Herwick, General Motors Director of Transportation Fuels, the lack of refueling stations for E85 appears to be a lower priority for ethanol stakeholders than other

ethanol-related issues. Instead, the ethanol stakeholders appear to focus on increasing domestic ethanol supply, as well as raising ethanol to a 10 percent blend (E10) in gasoline because of greater near-term market potential than with E85.[xxiii]
Mr. Herwick also stated that future emission requirements will limit the availability of E85 FFVs beyond 2007, because they may have difficulty meeting evaporative emission limits required for partial zero emission vehicles.[xxiv]

Some ethanol supporters have advocated greater use of diesel blended with ethanol, claiming that this fuel in unmodified diesel engines has significantly lower emissions than diesel. Ethanol blended diesel in unmodified engines is in the research and development phase, and its market acceptance depends on resolving uncertainties with materials compatibility, establishing fuel standards, ensuring safety, and developing storage and handling requirements.[xxv] Stakeholders of diesel blended with ethanol believe there will be attractive markets in niche applications in fleets and off road vehicles.

Stakeholder Market Projections

The ethanol stakeholders project significant growth in ethanol as a transportation fuel. Table 9 below shows their projections from a business-as-usual scenario to an aggressive scenario.

Table 9
Ethanol Petroleum Displacement
(millions of gallons)

Year	Reformulated Gasoline - Business as Usual	Reformulated Gasoline - Aggressive Growth	E85 – Business as Usual	E85 – Aggressive Growth	Diesel ethanol blend – Business as Usual	Diesel ethanol blend – Aggressive Growth
2010	879	1543			4	7
2015	830	1639			8	42
2020	890	1757	1000	6000	12	110

Assuming current regulations do not change, an ethanol blend at 5.7 percent will displace about 5 percent of petroleum fuels. If the ethanol industry conducts a marketing campaign for E85 aimed at existing FFV owners, as assumed by Mr. Herwick, another 5 percent could be displaced. To meet growth in E85, though, the stakeholders would have to sponsor a number of E85 fueling stations and to market the fuel.

Barriers

The ethanol stakeholders called for a greater percentage blend of ethanol in gasoline. However, California's air quality agencies advocate a rollback in the oxygen content requirement. Recent studies estimated that ethanol blended in gasoline has increased volatile organic compounds (VOCs) in the South Coast Air Basin between 19 and 25 percent because VOCs can permeate and escape through the "soft" components of a gasoline vehicle, such as rubber hoses.[xxvi] Furthermore, CARB's Predictive Model forecasts an increase in NOx emissions if the ethanol content is greater than 5.7 percent by volume. As a consequence, CARB has asked the federal government to waive the requirement for minimum oxygen content in gasoline due to these projected emission impacts.

The California Renewable Fuels Partnership believes that newer cars will reduce the permeation emissions with the use of better materials.[xxvii] However, the turnover rate of the vehicle population is far too slow to make this a short- or medium-term mitigation measure.

For the E85 FFVs, the stakeholders appear to recognize the need for additional fueling stations in California. Because of the rapid growth of FFVs in the state vehicle population and the potentially lower cost of E85 compared with current gasoline prices, E85 FFVs present a significant opportunity to cost effectively displace petroleum. The 200,000 FFVs today could use over 180 million gallons of E85, a little less than 10 percent of the total demand for gasoline in the state.

Having E85 stations will not be enough to create demand for E85. FFVs are rarely, if ever, marketed as a vehicle that can use ethanol and FFV, and most owners are probably not even aware that they have a vehicle with fuel options. A targeted marketing campaign will need to educate FFV owners on the possibility of using E85 as fueling stations are established.

The proponents for ethanol blended in diesel must overcome several developmental hurdles before the fuel can be widely used. The American Society of Testing Materials has not yet set a fuel specification for this fuel. Engine and vehicle manufacturers have voiced concerns regarding the safety of ethanol blended in diesel, and fuel advocates have conducted testing to control flashpoint and flammability. The manufacturers have also indicated that this fuel will require considerable study of materials compatibility and durability. To help solve these and other issues, an industry consortium has formed to fund testing programs and provide information and data to the public and government agencies. This consortium includes 18 government labs, companies, and ethanol associations.

Gas-to-Liquids Fuel

Status of Fuel and Technology

Gas-to-liquid (GTL) diesel is a synthetic diesel fuel made from natural gas with near-zero sulfur and lower aromatic content, rendering it compatible with existing vehicles and infrastructure. The primary concern, according to the stakeholders, is the economic feasibility of importing a large quantity of this fuel. Half a dozen large-scale production plants are under construction or proposed in Qatar, Malaysia, and Nigeria.[xxviii] While plants have also been proposed in remote locations in the United States,[xxix] natural gas feedstock costs are generally more favorable overseas.

Several studies have concluded that GTL diesel faces relatively minor technical barriers for use in diesel vehicles. In pure form, GTL has poor lubricity (which is mitigated by fuel additives), can be susceptible to oxidation, may have poor cold flow properties, and may have material compatibility problems with some components of diesel engines.[xxx] However, commercial applications of GTL have been in blends with diesel, reducing or eliminating these problems. In this regard, GTL has been called “almost a perfect diesel fuel” by the Alliance of Automobile Manufacturers.[xxxi]

In California, the use of GTL is driven by the need to produce a diesel fuel with a higher cetane level and lower aromatic and sulfur content. CARB has adopted regulations that limit diesel fuel to 10 percent by weight total aromatics (CARB diesel) or require an alternative formulation that produces equivalent emission benefits. Blending GTL with diesel fuel would satisfy CARB’s alternative formulation requirement. Therefore, the staff assumes that GTL in California would only be used as a blend in diesel fuel, not a stand-alone fuel.[xxxii]

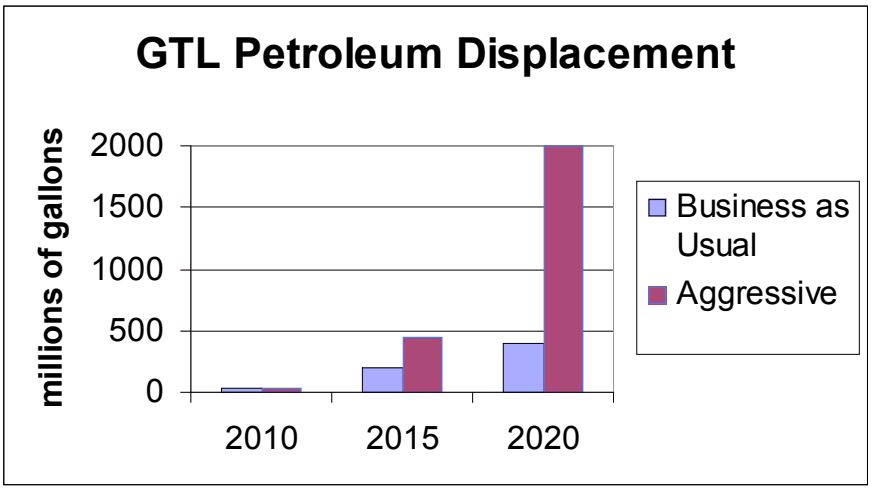
According to the stakeholders, GTL suppliers, who already have significant market demand from Europe, consider California an important potential market if economics are competitive with the European and other world markets. The staff assumed that under a business-as-usual scenario, future growth in diesel demand would be satisfied with conventional diesel. However, if diesel demand grows beyond the business-as-usual scenario, California could become more attractive to GTL suppliers. An influx of light-duty diesel vehicles in the state could substantially increase diesel demand. Several manufacturers produce light-duty diesel vehicles for sale in most of the United States, but not in California, New York, Massachusetts, and Connecticut. In these four states, light-duty diesel vehicles do not meet the states’ emission standards, and cannot be sold. Appendix A lists the 24 models of U.S. diesel cars. In comparison, automobile manufacturers offer more than 400 gasoline models for sale nationally.

Stakeholder Market Projections

The stakeholders believe that GTL will need a fairly aggressive penetration of light-duty diesel vehicles before California becomes an attractive market for the fuel. Under a

business-as-usual scenario, GTL stakeholders believe that new light-duty diesel vehicle sales will reach about 12 percent in the state by 2015. At this level, some GTL imports may begin, but Europe, Australia, and Japan will still be more attractive markets. If light-duty diesel vehicles reach 30 percent of new vehicle sales by 2015, as suggested by the GTL stakeholders, California refiners will need GTL to meet growth in diesel demand. Their projections in GTL growth are shown in Figure 1 below.

Figure 1



Source: Gary Yowell, California Energy Commission, "GTL Working Group Analysis" presented at the Non-Petroleum Fuel Working Groups Conference, California Energy Commission, Sacramento, California, October 12, 2004.

Barriers

Assuming that light-duty diesel vehicles will meet CARB's emission standards, which get more stringent in the next 10 years, automakers will need to sell 200,000 of these vehicles to achieve the 12 percent market penetration by 2015. To meet the 30 percent aggressive scenario espoused by the stakeholders, automakers will need to sell 500,000 vehicles in 2015. These sales goals for California present formidable challenges for the automakers. *Consumer Reports* states that today's car buyer has less than fond memories of diesel cars from the 1970s and that these vehicles "gained a reputation among American consumers as hard-starting, poor-performing, noisy, and dirty."[xxxiii] Consumer surveys show diesel vehicles still have a poor reputation.[xxxiv]

At the national level, though, researchers for the U.S. Department of Energy (DOE) concluded that diesel vehicles will capture a significant share of new vehicle sales despite their poor reputation. Through consumer surveys, DOE projects that by 2012, light-duty diesel will capture about 7 percent of total new vehicle sales nationally. They believe that light-duty diesels and gasoline hybrids will compete head-to-head for those consumers who value fuel economy highly. Greene, et al., project that in the United States, hybrid gasoline vehicles will capture about 15 percent of new vehicle sales by 2012.[xxxv]

Greene, et al., analyzed eight scenarios where diesel and hybrid vehicles came in different configurations and styles. If consumers have a broad choice of makes and models between hybrid and diesel vehicles, diesel vehicles could attract 24 percent of sales, versus 16 percent for hybrids. However, the other scenarios, including their "best guess" scenario, consistently showed hybrid vehicles outselling diesel vehicles by two to one.[xxxvi]

The stakeholders would like a detailed economic feasibility analysis to show the actual potential of GTL as a blending agent in California, the state's market pull, refinery economics in using GTL, and the need for expanded port capacity to import the fuel. This analysis would go a long way toward resolving significant investment uncertainties for wider use of GTL in California and improve its potential contribution to the state's goals for non-petroleum fuels.

Hydrogen

Status of Fuels and Technology

Compared with the other alternative fuels, hydrogen commercialization has the most barriers to overcome. Although the federal and state government, automobile manufacturers, and energy companies are spending billions to accelerate commercialization for hydrogen, the market readiness of the fuel and technology remains years away.

In 2004, the National Academy of Sciences published a report that identified four main challenges for hydrogen:

- Fuel cell technology and hydrogen storage systems are costly and do not meet consumers' performance needs.

- The distribution system and the infrastructure to support hydrogen vehicles will largely need to be built from scratch. With government and multi-party support, 13 hydrogen stations have already been established. In some cases hydrogen is produced at the site of the fueling station; in most other cases, hydrogen is trucked in. This fledgling distribution network partially contributes to the high cost for hydrogen fuel.

- To capture the benefits of hydrogen production from renewable sources, cost reductions have to occur, probably by technological breakthroughs. The National Academy of Sciences suggests greater research and development of photobiological, photochemical, and thin-film solar processes.

- The National Academy of Sciences believes that coal will ultimately be used in cost-competitive hydrogen production. If hydrogen fuel for transportation spreads nationally, coal will be the energy source for hydrogen production. This will require

advancements in carbon dioxide sequestration to avoid contributing to emissions of greenhouse gases.[xxxvii]

Despite these challenges, policy makers have established hydrogen goals from the President's State-of-the-Union speech ("the first car driven by a child born today could be powered by fuel cells"[xxxviii]) to the Governor's Hydrogen Highway ("to support and catalyze a rapid transition to a clean, hydrogen transportation economy in California"[xxxix]). As a result of these and other actions, no less than 20 states have active and funded programs for fuel cell vehicles.[xl]

Table 10 shows a list of fuel cell vehicles that are used only for testing and demonstration. Very few organizations outside of the manufacturer actually use these vehicles currently, but in the next two years fleet operators will get their chance at experiencing hydrogen fuel and related technologies.

Table 10
Hydrogen Vehicles

Original Equipment Maker	Model	Type
Anuvu	Clean Urban Vehicle	Fuel Cell
BMW	Clean Energy	ICE
DaimlerChrysler	NECAR 4	Fuel Cell
DaimlerChrysler	F-Cell	Fuel Cell
Ford	Focus	Fuel Cell
Ford	Model U	ICE
GM	Sequel	Fuel Cell
GM	Hydro Gen 3	Fuel Cell
Honda	FCX-V4	Fuel Cell
Hyundai	Tucson.	Fuel Cell
Hyundai	Santa Fe	Fuel Cell
John Deere	Commercial Work Vehicle	Fuel Cell
Nissan	Xterra	Fuel Cell
Toyota	FCH-4	Fuel Cell
Volkswagen	Touran Hymotion	Fuel Cell

California also has hydrogen demonstrations with buses at several locations. These are listed in Table 11 below.

Table 11
Hydrogen Buses in California

Location	Bus Type	Number of Buses
AC Transit	Hydrogen Fuel Cell	3
Santa Clara Valley Transit Authority	Hydrogen Fuel Cell	3
SunLine	Hydrogen Natural Gas Blend	2
SunLine	Hydrogen Hybrid Electric	1
SunLine	Hydrogen Fuel Cell	1
UC Davis	Hydrogen Natural Gas Blend	3

Although General Motors has publicly stated that they plan to begin selling hydrogen vehicles in 2010, in most cases the projected commercialized sales of fuel cell vehicles would not occur until the technology develops further.[xli] DOE plans to oversee an extensive research and development program ranging from more efficient production of hydrogen, to improved hydrogen storage systems, to reduced fuel cell stack costs. By 2015, DOE hopes to achieve several technology goals:

- Reach 5000 hours of fuel cell durability, which is about equivalent to the service life of a vehicle.
- Reduce fuel cell stack costs to $30 per kilowatt, which is equivalent to a gasoline engine cost.
- Reduce hydrogen production costs from natural gas to $1.50 per gasoline gallon equivalent (gge).
- Reduce hydrogen delivery costs to $1 per gge.
- Adopt codes and standards that maximize safety practices and equipment while minimizing costs.
- Improve on-board storage to enable a 300-mile driving range.[xlii]

To reach these goals, DOE will need to see at least an order of magnitude improvement from current technology. Although its budget fluctuates from year to year, it plans to spend $1.2 billion over the next 5 years on research and development to accelerate the rate of technology development. DOE will probably need further funding to reach the goals of 2015.

While DOE funds research and development, California's programs have emphasized the implementation phase of the hydrogen economy. The state and local governments have spent several million dollars sponsoring demonstrations of hydrogen vehicles, establishing hydrogen fueling stations, conducting training for emergency responders, and raising the level of awareness of the general public of hydrogen. The state also has not precluded hydrogen fuel use in internal combustion engines.

The California Hydrogen Highway Network Initiative is intended to catalyze a rapid transition to a clean hydrogen transportation economy in the state, reducing our

dependence on foreign oil and protecting our citizens from harmful emissions. The Governor ordered a Blueprint Plan (Plan) to guide the state for the transition.[xliii] The Plan sets up a phased introduction over the next several years of fueling stations, vehicles, and other potential hydrogen uses as shown in Table 12. The Plan does not specify the targeted year for each Phase nor the estimated costs of this program.

Table 12
Phased Introduction of Hydrogen

Application	Phase I	Phase II	Phase III
Fueling Stations	50-100	250	250
Light Duty Hydrogen Vehicles from Major Manufacturers	2,000	10,000	20,000
Heavy Duty Hydrogen Vehicles	10	100	300
Stationary and Off Road Applications (distributed generation, building, fork lifts)	5	60	400

The Plan will emphasize a public-private partnership to broaden the number of hydrogen fueling stations and vehicles in California, with new stations expected to expand around existing hydrogen fueling stations and concentrate in urban centers. The Plan suggests that the state identify anchor fleets and one in particular – government fleets – as early adopters. To capture progress in technology development, the Plan will be updated every two years. The plan sets goals of reducing greenhouse gas emissions by 30 percent and at least 20 percent of the hydrogen fuel comes from renewable resources.

Stakeholder Market Projections

The stakeholders made no projections about hydrogen fuels during the proceedings for the 2005 Energy Report because the Blueprint Plan was under development at the same time. Since the Plan does not set time based goals for achieving its three phases, the staff assumed that the state will reach Phase I in 2010, Phase II in 2015, and Phase III in 2020. Table 13 shows the staff estimates for petroleum displacement in these three phases.

Table 13
Hydrogen Fuel Projection
(gallons of gasoline displaced)

Year	Light Duty	Heavy Duty[a]	Other[b]	TOTAL
2010	800,000[c]	12,000	7,500	819,500
2015	4,800,000[d]	120,000	90,000	5,010,000
2020	12,000,000[e]	360,000	600,000	12,960,000

[a] 30,000 miles per year @ 2 miles per gasoline gallon equivalent (mpgge).
[b] 3,000 hours per year @ 0.5 gge per hour.
[c] 10,000 miles per year @ 25 mpgge.
[d] 12,000 miles per year @ 25 mpgge.
[e] 15,000 miles per year @ 25 mpgge.

Barriers

The pace of technology development for hydrogen production, fuel cell technology, and fuel storage may be difficult to speed up. Several groups and individuals suggest that California will need major technological and scientific breakthroughs to increase efficiency, reduce costs, and raise vehicle performance. All of the demonstration vehicles operating in 2005 have much less range than a conventional gasoline vehicle and the reliability of the fuel cell stacks have yet to be proven.[xliv]

Many of these needed breakthroughs relate to the progress of technology development for fuel cells. However, a more near-term technology may be hydrogen in internal combustion engines. Hydrogen use in internal combustion engines needs less technological advancement than vehicles powered by hydrogen fuel cells and is much closer to known technologies for natural gas and gasoline engines. While these vehicles may not have all of the emission benefits of fuel cell vehicles, they can be placed into vehicle demonstrations in the near-term. In addition, hydrogen in blends with natural gas has been demonstrated in buses and has reduced emissions without reducing performance.[xlv]

A more difficult problem is the cost of hydrogen from renewable sources. Natural gas is the short-term source of hydrogen, but California prefers renewables as the feedstock or power source for hydrogen production. However, renewables, like fuel cell technology, will need significant technological breakthroughs to be a viable option. DOE set its reduction cost goal for hydrogen produced from renewables at up to $10 per gasoline gallon equivalent by 2015. In the same time period, DOE set its production cost goal for hydrogen produced from natural gas at $1.50 per gasoline gallon equivalent.[xlvi] For renewables to compete with natural gas as a hydrogen feedstock or production power source, therefore, costs must be reduced by a factor of seven.

The distribution of hydrogen fuel is another major barrier. The Blueprint Plan envisions up to 250 refueling stations in California to support 20,000 hydroelectric vehicles. This will require significant funding and considerable planning to site these stations. The Blueprint Plan does not include coal or nuclear as options for producing hydrogen.[xlvii] In contrast, DOE plans to sponsor research and development for hydrogen from both coal with carbon capture and sequestration and nuclear through their Nuclear Hydrogen Initiative. DOE projects hydrogen costs from coal and nuclear processes to be less than hydrogen from renewables over the next 10 years.[xlviii]

Liquid Propane Gas/Propane

Status of Fuel and Technology

Since 1999, the world population of liquefied petroleum gas (LPG) vehicles has grown about 20 percent per year to over 8 million vehicles in 2004. In contrast, the California LPG vehicle population has decreased over that same period to 22,000 vehicles in 2004 from 33,000 in 1999.[xlix] Only one manufacturer has an engine certified for LPG operation currently, the Cummins B Gas Plus Propane, which is used in shuttle buses and street sweepers.

This trend is reflected nationally, where the population of LPG vehicles has also declined since 1999,[l] reflecting the lack of available vehicles for sale and the limited market of vehicle conversions.[li] The decline in vehicles and sales is shown in Figures 2 and 3 below.

Aftermarket conversions have filled in somewhat for the lack of LPG vehicles from original equipment manufacturers in California. According to Bill Platz from Clean Fuel USA, conversions for the GM 8.1 and GM 6.0 liter engines may be available for school buses, shuttle buses, vans, and pickups.[lii] Outside of California, several more companies offer conversion packages for a broader range of engines. However, these companies have found California's procedure to certify the conversion packages onerous and expensive.[liii] To meet CARB's certification procedure, companies must show that the conversions will not degrade the emissions from the vehicle for 150,000 miles.

Figure 2

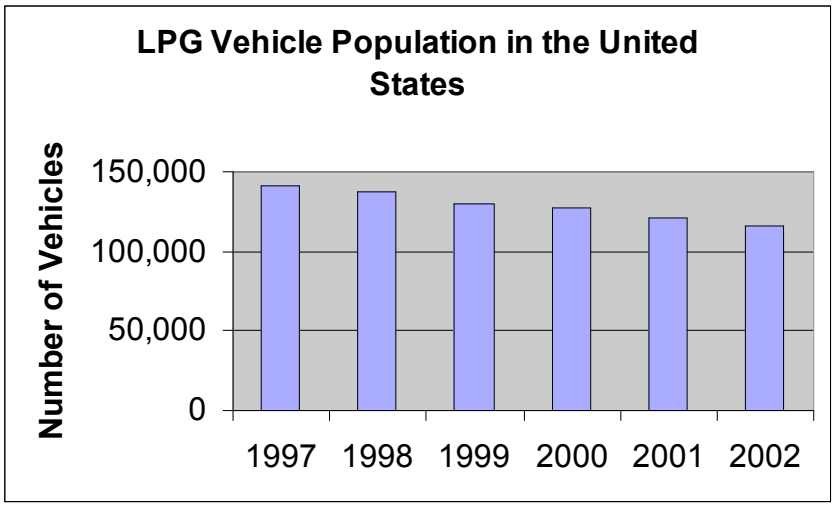
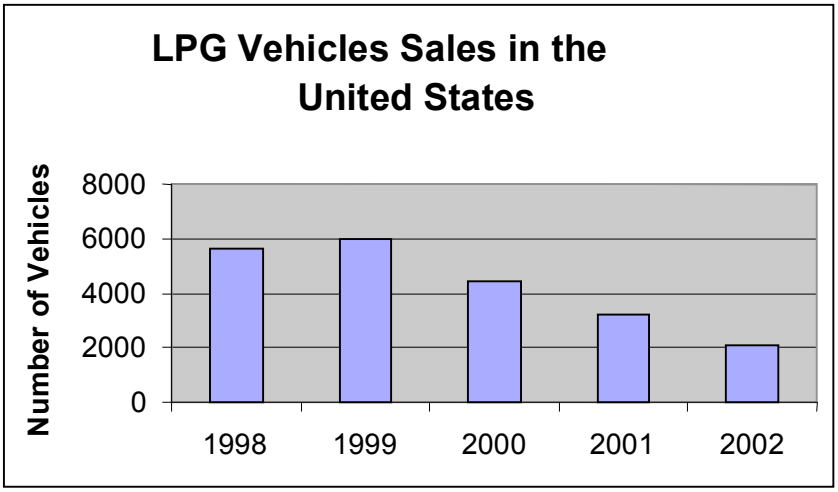


Figure 3



Source: Energy Information Agency, US Department of Transportation, http://www.eia.doe.gov/cneaf/alternate/page/datatables/atf114-20.html

The California Department of Transportation operates 1600 bi-fuel Ford F150 pickups, but according to Clean Fuel USA, only a handful of these vehicles actually fuel with LPG. With a combination of state and private funds, the LPG industry has expanded the number of fueling stations available for these vehicles. Figure 4 shows the locations of some of the LPG refueling sites in California.

Figure 4

CFUSA California Locations

LPG has made significant inroads in the forklift markets. By 2001, LPG forklifts captured about 85 percent of the national forklift demand.[liv] However, since 2001, gasoline and electric forklift manufacturers have challenged this market dominance. The LPG industry claims a major victory in modifying proposed CARB emission regulations that would have required zero emission forklifts; CARB settled on establishing an emission standard for forklifts that continues to permit the lowest emitting LPG forklifts. According to the National Petroleum Gas Association, California has 32,000 LPG forklifts and represents a successful application of this technology and fuel.[lv]

Stakeholder Market Projections

The LPG stakeholders projected that 250,000 LPG vehicles could be in place by 2020 and displace 300 million gallons of gasoline. Their big caveat, though, is that different California agencies have different goals, and they see no coordination in promoting alternative fuel vehicles.[lvi] In addition the dwindling availability of vehicles and conversion packages point to a bleak future for propane, except for propane forklifts that also face stiff competition with electric forklifts.

Barriers

California's LPG stakeholders have stated that they do not believe the automobile manufacturers will offer LPG vehicles in their product line. Instead, stakeholders want to rely on vehicle conversions to reverse the downward trend in the state's LPG vehicle population. The stakeholders believe that conversion companies would like to enter the

California markets, but these companies believe that the certification procedures for these conversions kits are cost prohibitive and financially risky.[lvii]

The stakeholders propose that state agencies coordinate their policies. For example, according to the stakeholders despite the Energy Commission's policies on petroleum reduction, CARB has put up a roadblock through the certification process for retrofit of aftermarket conversion packages. LPG stakeholders suggested developing new procedures that would be more affordable to potential conversion companies, while not compromising emission standards.

Natural Gas

Status of Fuel and Technology

Natural gas vehicles in California have captured a small but significant share of the transportation market. Based on recent data from the California Department of Motor Vehicles, over 30,000 natural gas vehicles currently are driven on the state's roadways. Table 14 lists the variety of natural gas vehicles.

Table 14
Natural Gas Vehicle Population

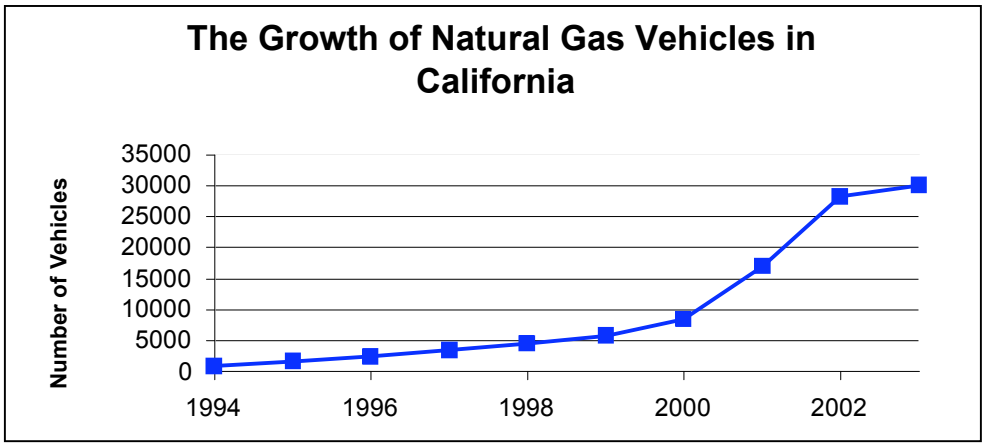
Vehicle Type	Number of Natural Gas Vehicles
Car – Subcompact	1,176
Car – Compact	17,802
Car – Midsize	367
Car – Large	1,011
Van – Compact	199
Van – STD	606
Van - 8501-10,000	1,106
Pickup – STD	3,198
Pickup - 8501-10,000	168
Bus	3,919
Conventional Cab	38
Dump Trucks	34
Garbage Trucks	239
Other	163
Total	30,026

Source: DMV Database 2002

According to the California Natural Gas Vehicle Coalition (Coalition), these vehicles displace 70 to 75 million gallons of petroleum fuel per year. The Coalition further claims that petroleum fuel displacement from natural gas has grown at 25 to 33 percent per year since 1994.[lviii] As shown in Figure 5, the average growth rate for natural gas

vehicles over the last 10 years has been about 50 percent which suggests that this growth rate is accurate.

Figure 5

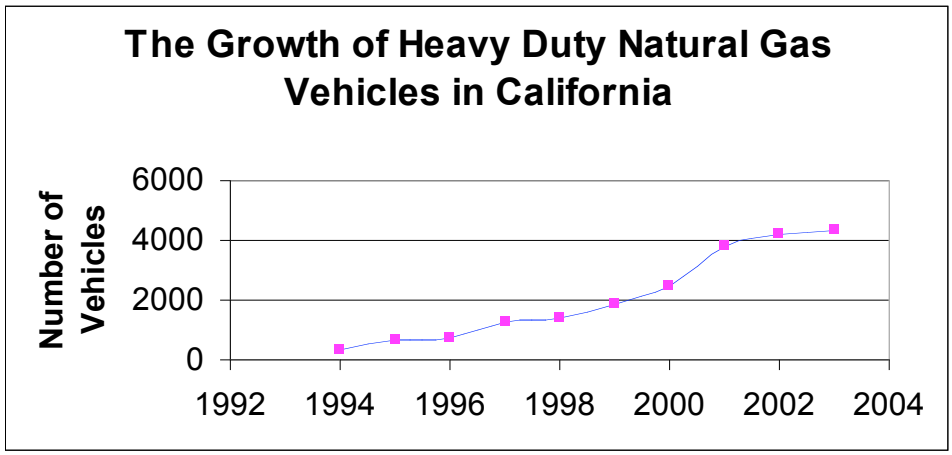


Source: DMV Database 2002.

However, because Ford has stopped production of its natural gas vehicles, the growth rate will fall significantly. Currently, only General Motors and Honda have light-duty natural gas vehicles available in the 2005 model year. Although several European automobile manufacturers offer natural gas light-duty vehicles for the European market,[lix] currently none plan to modify the vehicles for sale in the United States.

The number of heavy-duty natural gas vehicles has also increased over the same period. Figure 6 shows the growth trend over the last 10 years. Unlike light-duty vehicles, dozens of heavy-duty vehicles are still available for order, and several natural gas engines still have emission benefits over their diesel counterparts.

Figure 6



Source: DMV Database 2002.

Most of the technology development activities focus on emissions and efficiency improvements to heavy-duty natural gas engines. The National Renewable Energy Laboratory (NREL) has co-funded projects to improve emissions from heavy-duty natural gas engines to meet future national emissions standards well before the standards are in place. The goal of the NREL program is to develop production natural gas engines that meet future emission standards and have high commercial value. NREL's projects include engines designed for transit buses and garbage trucks, vehicles in which natural gas has made significant market penetration.

Stakeholder Market Projections

The Coalition made very aggressive forecasts of natural gas use in transportation for the state. With appropriate incentives, policies, and regulations in place by 2020, natural gas could displace 10 percent of petroleum use in transportation. To meet this goal, the Coalition projects that 100,000 heavy-duty and 2 million light-duty natural gas vehicles will need to operate in the state.[lx]

Gladstein, Neandross, and Associates, administrators of the Interstate Clean Transportation Corridor Program, suggested that even more petroleum displacement can occur in heavy-duty vehicles. Their projection is based on the potential for producing liquefied natural gas (LNG) using in-state feedstocks such as landfill gas, stranded gas, and digester gas. They believe that in-state LNG can fuel more than 120,000 heavy-duty trucks every year.[lxi] Although Gladstein, et al., used the maximum estimates of the LNG production from these sources, actual LNG production will be subject to local conditions and site-specific economics.

Stakeholder Recommendations for State and Industry Actions

The Coalition proposed a "California Energy Policy Act" to implement programs to displace petroleum and reduce greenhouse gas emissions. The proposed act would require the state to purchase alternative fuel vehicles and use the alternate fuel, develop a petroleum reduction incentive program modeled after the Carl Moyer emission reduction program, and resurrect a state-sponsored research and development program for transportation. The act would allocate at least $130 million for all of these programs, but the Coalition did not identify a funding source.[lxii]

Gladstein, et. al. recommended greater development of in-state natural gas resources to produce LNG and suggested a substantial $700 million program. Table 15 shows their preliminary analysis of potential LNG production.

Table 15
Potential LNG Production in California
(million gallons per day)

Source	Production Capacity
Landfill Gas	5
Stranded Gas	1
Digester Gas	1
TOTAL	7

Source: Eric Neandross, Gladstein, Neandross, & Assoc., "LNG for HDVs," presented at the Non-Petroleum Fuel Working Groups Conference, California Energy Commission, Sacramento, California, October 12, 2004.

Barriers

One of the biggest hurdles for achieving greater market penetration of natural gas vehicles is the decision by several automobile manufacturers to stop producing natural gas vehicles. The Coalition believes that public policy uncertainty made manufacturers decide not to offer natural gas vehicle offerings. This may mean that natural gas vehicles would need long-term government incentives to expand their market share. Mike Eaves from the Coalition stated, "Variable or changing policies do absolutely nothing to boost confidence in manufacturers of sustaining production for long periods of time."[lxiii]

The Coalition also believes that a major policy transformation needs to take place that emphasizes petroleum reduction rather than emissions. Because of improvements in overall emissions control technology for gasoline vehicles, the natural gas edge in vehicles will likely diminish in five years. However, natural gas should still play an important role because of its broad applications in both light- and heavy-duty vehicles.

The Coalition recommends that the goals set forth in *Reducing California's Petroleum Dependence* should be codified. This step will help ensure stability in state policies and give manufacturers confidence that these goals are not "just a two-year whim."[lxiv]

The staff, however does not share the opinion of the Coalition regarding how much stable state policies influence vehicle manufacturing decisions. In discussions with some original equipment manufacturers, the staff determined that the automakers based their decisions to stop producing natural gas vehicles more on the potential market for these vehicles rather than on the availability of incentives or regulations.

Summary of Petroleum Displacement Potential in 2020

Stakeholders were asked to make their best projections of petroleum displacement from alternative fuel use by 2020. As noted above, market success for these fuels

depends on overcoming critical barriers. The stakeholders' projections are summarized in Table 16.

Table 16
Summary Projections for 2020
(millions of gallons)

Alternative Fuel	Petroleum Displacement
Biodiesel	80
E85	1,000
Electricity	915
Ethanol in diesel blends	12
Ethanol in RFG	890
GTL	400
Hydrogen	13
LPG	300
Natural Gas	1,700
TOTAL	5,310
Goal for 2020	4,800

Assuming that the stakeholders are correct in their projections, California can meet the 20 percent goal with room to spare. However, several of these projections rely on assumptions that may be a stretch under a business-as-usual scenario.

- Biodiesel seems to have created a successful market application with the help of federal policies and recent tax incentives. While engine manufacturers have expressed some concerns in gaining full acceptance of B20, the barriers do not appear insurmountable.

- Stakeholders for ethanol must deal with three issues before this fuel can displace significantly more petroleum.

  - E85 assumes the establishment of refueling stations and some market acceptance by consumers of E85. With the number of FFVs expected to grow, California may have a ready market for E85. However, the stakeholders have not made this a priority at least in the Energy Commission's stakeholder meetings and workshops.

  - Ethanol in diesel blends, like biodiesel, has not gained acceptance by engine manufacturers, and unlike biodiesel, ethanol blends have additional hurdles to resolve safety and material compatibility concerns.

  - The question for ethanol in gasoline is whether air quality agencies will accept a higher blend up to 10 percent. CARB and South Coast Air Quality Management District agencies are requesting the exact opposite, asking the federal government for a waiver of the oxygenate requirements.

- The stakeholders for electric transportation may have carved out potentially successful niche applications. These appear to be near-term applications which may require infrastructure development but not major technological development. Several applications have already become commercial, although market penetration may accelerate with additional incentives.

- Gas-to-liquid diesel fuel use in California appears to have one of the most difficult market thresholds to cross. Since imports of GTL will require a large, sustained demand, the stakeholders expect light-duty diesel to create this new demand. In addition, with demand in Europe taking nearly all GTL produced, California may not be able to generate the demand or command the price for the fuel. Instead, the economics for diesel fuel in California favor meeting any projected increase in diesel demand with other petroleum sources rather than imported GTL.

- While hydrogen will have the least demand of the alternative fuels, even this amount will depend upon the progress of technology development.

- LPG suppliers will need to create demand with very few vehicles available and little prospects of gaining the interest of vehicle manufacturers.

- Natural gas has made significant in-roads in certain applications and may have become the fuel of choice with transit agencies and municipal garbage agencies. Other applications, such as parcel delivery and other medium-duty fleets also use natural gas vehicles as their standard. Still, the stakeholders have proposed a large light-duty natural gas vehicle population in the state by 2020 despite the trend from manufacturers reducing and even eliminating natural gas vehicle models.

As a result of these uncertainties, the stakeholders' projections for non-petroleum fuel use in alternative fuel vehicles (AFVs) are optimistic. Energy Commission staff believes that ethanol in diesel blends is in the early stages of research and development, GTL will probably have its major fuel market in Europe, and few if any vehicles will be available for LPG and light-duty diesel.

However, the alternative projection does not assume E85 projections will be zero, despite the current lack of refueling stations, in the hopes that the industry will find the market potential enticing enough to set up an infrastructure network.

Stakeholder Recommendations

The stakeholders suggested several common steps to promote their own alternative fuel and meet their projections of fuel use. In making these recommendations, none of the stakeholders made an especially bold proposal, such as a mandate for all fleets in California to use alternative fuels, nor did any say that the market will determine the success or failure of the alternative fuels and that action is unnecessary. Table 17 below summarizes some of the recommendations from the stakeholders.

Table 17
Stakeholder Recommendations

	Biodiesel	Electricity	Ethanol	GTL	Hydrogen	LPG	Natural Gas
Adopt Clear State Policy for Petroleum Reduction	•	•					•
Facilitate with Other Agencies on Regulatory Barriers			•	•		•	
Fund Additional Research and Development					•		•
Government Fleet Purchase of AFVs and Use of the Fuel		•			•	•	
Incentives or a Moyer Type Program	•	•	•			•	•
Lack of Available Products from OEMs				•		•	•
Provide Infrastructure Support				•		•	
Set Fuel Specification	•		•	•			

The summarized recommendations may vary somewhat from stakeholder to stakeholder, but each addresses perceived barriers faced by their own alternative fuel.

- The stakeholders suggest that adopting a clear state policy will help develop future government actions to achieve petroleum reduction goals. One stakeholder recommended codifying these goals, and another stakeholder suggested reversing a long line of "ineffective policies," such as the federal Energy Policy Act (EPAct).[lxv]

- As noted above in the ethanol and LPG sections, perceived regulatory barriers prevent these alternative fuels from capturing greater market shares. The stakeholders have asked the Energy Commission to help resolve these problems, but to date, solutions remain uncertain although the staff plans to remain involved in these negotiations. For the LPG issue, a further step could be to help conversion companies meet the certification requirements rather than trying to change the existing regulations.

- Interestingly, very few stakeholders suggested increasing state funding for research and development. Although improvements to the alternative fuel vehicle technology, fuel delivery system, and infrastructure are still needed to improve performance and reduce costs, other organizations fund research and development to a much larger degree than the state could provide. In addition, while California has a history of

funding successful demonstration projects such as school buses and refueling stations, the stakeholders did not emphasize this phase of commercialization.

- Stakeholders suggested that government lead by example and incorporate AFV's into their own fleets. Government at all levels has already made significant commitments to purchasing AFVs and establishing refueling stations.

  EPAct requires the state to purchase 75 percent of its new car fleets as alternative fuel vehicles. The state motor pool includes natural gas sedans and pickups as well as ethanol FFVs. Still, the state could make a better effort at using alternative fuel rather than gasoline in these bi-fuel vehicles.

  While EPAct does not require local governments to purchase AFVs,[lxvi] several local governments have already made a significant switch to alternative fuels. The Fleet Rules from the South Coast Air Quality Management District compels local governments in the South Coast Air Basin to use alternative fuel vehicles in their bus and garbage truck fleets. In addition, several local governments annually request funding from the DOE's Clean Cities program to purchase AFVs.

  The stakeholders may express dissatisfaction with the pace of government purchases of AFVs, but without a doubt, a sizeable portion of state and local governments are making a concerted effort to use alternative fuels. Future AFV purchases may be a function of available funding for both the vehicle and the refueling station, but not a lack of commitment to alternative fuels.

- The most common suggestion was a program for petroleum reduction, like the Carl Moyer Memorial Air Quality Standards Attainment Program for lower emissions. Instead of providing incentives for cost effective emission reduction projects, the Energy Commission would administer a parallel program to provide incentives for petroleum reduction. Only one of the stakeholders suggested a funding source for this type of program – a penny a gallon tax on gasoline, which could generate $160 million annually.[lxvii]

  The Carl Moyer program has effectively accelerated the penetration of lower emission heavy-duty vehicles into the state. Because CARB authorized the local air quality agencies to administer the program, the focus has been on local issues. The local air quality agencies can identify target fleets for lower emission heavy-duty vehicles far more readily than CARB. In addition, since cost effectiveness is the primary criterion for determining what projects get funded, local agencies have achieved the most emission reductions from available funding. As a result, this program has received great support and a permanent funding source.[lxviii]

  A similar program for petroleum reduction could work in concert with the Carl Moyer program. Since the Carl Moyer program funds the most cost effective projects, alternative fuel projects will not be very high on the list. However, if a petroleum reduction program is designed properly, alternative fuel projects may get more

favorable treatment; the two incentive programs need not overlap in funding projects.

- As noted in the sections for LPG and natural gas, the automobile manufacturers have stopped or reduced production of their propane and natural gas vehicles. Unfortunately, the state has been less than successful in trying to persuade these manufacturers to reverse this decision. When Ford announced that it no longer would produce light-duty natural gas vehicles, several government organizations led by the chair of the South Coast Air Quality Management District met with Ford management. Their efforts may have extended production one more year, but Ford eventually pulled these vehicles from its production plans.

- Some stakeholders recommended helping with infrastructure development, although this proposal did not appear frequently in their presentations and testimonies. The staff believes that California may have reached a point where the number of refueling stations for some alternative fuels adequately supports the population of AFVs. The Energy Commission administered the infrastructure portion of the Moyer program in its first two years, but the Legislature declined to fund any infrastructure projects in subsequent years. Since then, the staff has not heard requests for resurrecting the Moyer infrastructure program. The South Coast's Mobile Source Air Pollution Reduction Review Committee has experienced a similar reduction in interest for infrastructure funds.[lxix] Still, to meet the petroleum reduction goals, the state may need refueling stations for E85 light-duty vehicles.

- Some of the stakeholders made a technical recommendation to adopt and accept fuel specifications for biodiesel, ethanol blended diesel, and GTL. The producers of these fuels have taken the necessary steps of meeting the requirements of the American Society of Testing Materials.

Staff Findings and Options for Policy

The Energy Commission's goal of displacing 20 percent of petroleum fuels with non-petroleum fuels by 2020 will be difficult to meet. The stakeholders for the seven alternative fuels have given us a road map to improve the marketability of these fuels, but this road map includes significant challenges. The staff recommends that the Energy Commission consider the following:

- Request funding to develop and implement a Carl Moyer-like program for petroleum displacement.

- Invite the ethanol industry to help develop a program to establish E85 refueling stations, along with a marketing program to inform eligible consumers of the potential for fueling their FFVs with E85 while saving money at the same time.

- Assist in resolving air quality issues related to increasing ethanol blends up to 10 percent of gasoline.

- Develop a program with the LPG and natural gas stakeholders that could help conversion companies comply with California certification procedures.

- Encourage the continued development of hydrogen, but suggest lowering expectations to match the pace of technological development.

- Assist biodiesel and GTL to gain a foothold in California's diesel market as a blend fuel.

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Acronyms

AFV	Alternative Fuel Vehicle
B20	20 percent biodiesel-diesel blend
B100	100 percent biodiesel
CAFE	Corporate Average Fuel Economy
CARB	California Air Resources Board
DOE	Department of Energy
E85	85 percent ethanol 15 percent gasoline blend
Energy Commission	California Energy Commission
EPAct	Energy Policy Act
EPRI	Electric Power Research Institute
EV	Electric Vehicle
FFV	Fuel Flexible Vehicle
GM	General Motors
GTL	Gas to Liquids
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
NGV	Natural Gas Vehicle
NOx	Nitrogen Oxide
NREL	National Renewable Energy Laboratory
SUV	Sports Utility Vehicle
VOCs	Volatile Organic Compounds

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Appendix

Light-Duty Diesel Vehicles Available in the United States

Vehicle	Engine
Audi Q7 Diesel SUV	(Coming in 2007)
Chevrolet Silverado 2500HD	Duramax Turbo Diesel 6600 V8
Chevrolet Silverado 3500	Duramax Turbo Diesel 6600 V8
Dodge Ram 2500 Regular /Quad Cab	5.9 Liter I-6 High-Output Cummins Turbo Diesel
Dodge Ram 3500 Regular /Quad Cab	5.9 Liter I-6 High-Output Cummins Turbo Diesel
Dodge Ram Hybrid	(Coming in 2006)
Ford F-250 XL, XLT, Lariat	6 Liter PowerStroke Turbo Diesel V-8
Ford F-350 XL, XLT, Lariat	6 Liter PowerStroke Turbo Diesel V-8
Ford E-Series XLT Wagon	7.3 Liter V-8 PowerStroke Diesel
Hummer H1	6.5 Liter V8 Turbo-charged Diesel
2005 Jeep Liberty CRD (Coming Soon)	2.8-liter four-cylinder (diesel)
H1 Alpha (coming in 2005)	6.6-liter Duramax turbo diesel engine
Mercedes-Benz E320 CDI	3,222-CC turbocharged 24-valve inline-6
Mercedes-Benz C-Class diesel sedan (Coming Soon)	V-6 diesel engine
Mercedes-Benz ML350 (Coming in 2006)	3.7-liter V-6
Mercedes-Benz ML500 (Coming in 2006)	V-8
Mercedes-Benz Sprinter passenger van	2.7 Liter 5-cylinder Mercedes-Benz common rail direct injection diesel
Volkswagen Beetle	1.9 Liter I-4 Turbo-charged Diesel
Volkswagen Golf	1.9 Liter I-4 Turbo-charged Diesel
Volkswagen Jetta	1.9 Liter I-4 Turbo-charged Diesel
Volkswagen Jetta Wagon	1.9 Liter I-4 Turbo-charged Diesel
Volkswagen Touareg	V10 TDI
Volkswagen Passat TDi Sedan	2.0 Liter I-4 Turbo-charged Diesel
Volkswagen Passat Wagon GL TDI	2.0 Liter I-4 Turbo-charged Diesel