

SUMMARY OF BOARD ITEM

ITEM # 03-6-6: PUBLIC HEARING TO CONSIDER APPROVAL OF THE GOAL AND RECOMMENDATIONS FOR REDUCING CALIFORNIA'S DEPENDENCE ON PETROLEUM

STAFF RECOMMENDATION: Staff recommends the Board approve the goal and recommendations for reducing California's dependence on petroleum contained in the staff report entitled Reducing California's Petroleum Dependence, July 2003. This report has been prepared as directed by Assembly Bill 2076, Shelley, Chapter 936, Statutes of 2000.

DISCUSSION: AB 2076 directs the Air Resources Board (ARB) and the California Energy Commission (CEC) to develop and adopt recommendations for the Governor and the Legislature on a strategy to reduce California's dependence on petroleum. This directive is the outgrowth of increasing concern regarding the effects of petroleum dependence on California's environment and economy. Such effects include the impact of higher fuel prices on the cost of transportation and the cost of production throughout the economy, the vulnerability associated with heavy reliance on foreign imports that are subject to external disruptions and geopolitical instability, and the environmental consequences of petroleum-related emissions of greenhouse gases and smog-forming pollutants.

The staff evaluated a number of options to reduce petroleum use in California, focusing most directly on fuel efficiency and fuel substitution options. For each option staff estimated the reduction in petroleum demand, and the associated costs and benefits.

The most dramatic reduction in petroleum usage is achieved by improving vehicle fuel efficiency. In most cases, this reduction can be realized at a net cost savings to society.

Although improving vehicle fuel efficiency provides the most dramatic near- and mid-term reduction in petroleum usage at the least cost, the benefits begin

to diminish in the long-term as population growth overwhelms the petroleum reduction effects and petroleum usage begins to increase. To reverse this trend, a non-petroleum fuels element is essential to the long-term effectiveness of a petroleum reduction strategy. Most of the non-petroleum fuel options, however, have a direct net cost. These costs are largely a result of the higher cost of the fuel compared to the staff's projected price for gasoline and diesel (\$1.64 per gallon). If the price of gasoline and diesel should rise to the \$2.00 to \$2.50 per gallon range on a sustained basis, staff's analysis shows that most of the non-petroleum options would have positive net societal benefits provided that the price of the non-petroleum fuel did not rise concurrently.

Over the course of the past two years, the staff of the CEC and ARB have developed a petroleum reduction goal of 15 percent below 2003 levels of petroleum usage by 2020, maintained for the foreseeable future, and recommendations to support the goal. The goal and recommendations follow from extensive staff work to evaluate petroleum reduction options and numerous public workshops and meetings with stakeholders. The goal reflects ambitious but achievable levels of reduction in petroleum usage through the combined effects of improved vehicle efficiency and the use of non-petroleum fuels. The recommendations to support the goal are as follows:

- 1) The Governor and Legislature should adopt the recommended statewide goal of reducing demand for on-road gasoline and diesel to 15 percent below the 2003 demand level by 2020 and maintaining that level for the foreseeable future.
- 2) The Governor and Legislature should work with the California delegation and other states to establish national fuel economy standards that double the fuel efficiency of new cars, light trucks, and sport-utility vehicles.
- 3) The Governor and the Legislature should establish a goal to increase the use of non-petroleum fuels to 20 percent of on-road fuel consumption by 2020 and to 30 percent by 2030.

SUMMARY AND IMPACTS:

Adoption of the goal and recommendations is a first step in ensuring a significant decrease in petroleum dependence in our State, thus helping to protect this State from the adverse effects associated with near total dependence on petroleum in the transportation sector. Reducing the State's petroleum dependence would provide significant environmental benefits at little or no cost to society. When approved, the proposed goal and recommendations would have no adverse effects on the California economy. According to ARB and CEC analysis of the costs and benefits associated with the strategy considered to meet the goal, neither the goal nor the recommendations would result in a net societal cost. Further, to determine the effects of petroleum reduction strategies on the California economy, the Environmental-Dynamic Revenue Analysis Model (E-DRAM) was used. That analysis concludes that the statewide economic impacts are small for any of the strategies considered.

Please note that the goal in Recommendation #1 (15 percent below 2003 demand) assumes that the federal government doubles the current Corporate Average Fuel Economy (CAFE) standard. Should the federal government fail to implement a CAFE standard that doubles the fuel efficiency of new cars, it would be necessary to reassess the goal in Recommendation #1.

Reducing California's Petroleum Dependence

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CALIFORNIA
ENERGY
COMMISSION

CALIFORNIA
AIR RESOURCES
BOARD

JOINT AGENCY DRAFT REPORT

JULY 2003
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Gray Davis, Governor

**CALIFORNIA
AIR RESOURCES
BOARD**

Chuck Shulock
Eileen Tutt
Paul Wuebben
Principal Authors

Tom Cackette,
Chief Deputy Executive Officer

**CALIFORNIA
ENERGY
COMMISSION**

TRANSPORTATION COMMITTEE

James D. Boyd,
Presiding Member

John L. Geesman,
Second Member

Gerry Bemis
Susan Brown
Dan Fong
Sherry Stoner
Principal Authors

Susan Brown
Manager
**TRANSPORTATION
TECHNOLOGY OFFICE**

Scott W. Matthews
Deputy Director
**TRANSPORTATION ENERGY
DIVISION**

Robert L. Therikelsen
Executive Director

Disclaimer

This report was prepared by the California Energy Commission and the California Air Resources Board. Opinions, conclusions and findings expressed in this report are those of the authors. The report does not represent the official position of the Energy Commission or the Air Resources Board until adopted and approved at a public meeting.

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Energy Commission Contributing Staff

Gerry Bemis
Dan Fong
Melissa Jones
Chris Kavalec
Elizabeth Parkhurst
Mike Smith
Leigh Stamets
Sherry Stoner

Air Resources Board Contributing Staff

Chuck Shulock
Eileen Tutt
Paul Wuebben

Management

Tom Cackette, Chief Deputy Executive Officer, Air Resources Board
Scott W. Matthews, Deputy Director, Transportation Energy Division, Energy Commission
Susan Brown, Manager, Transportation Technology Office, Energy Commission

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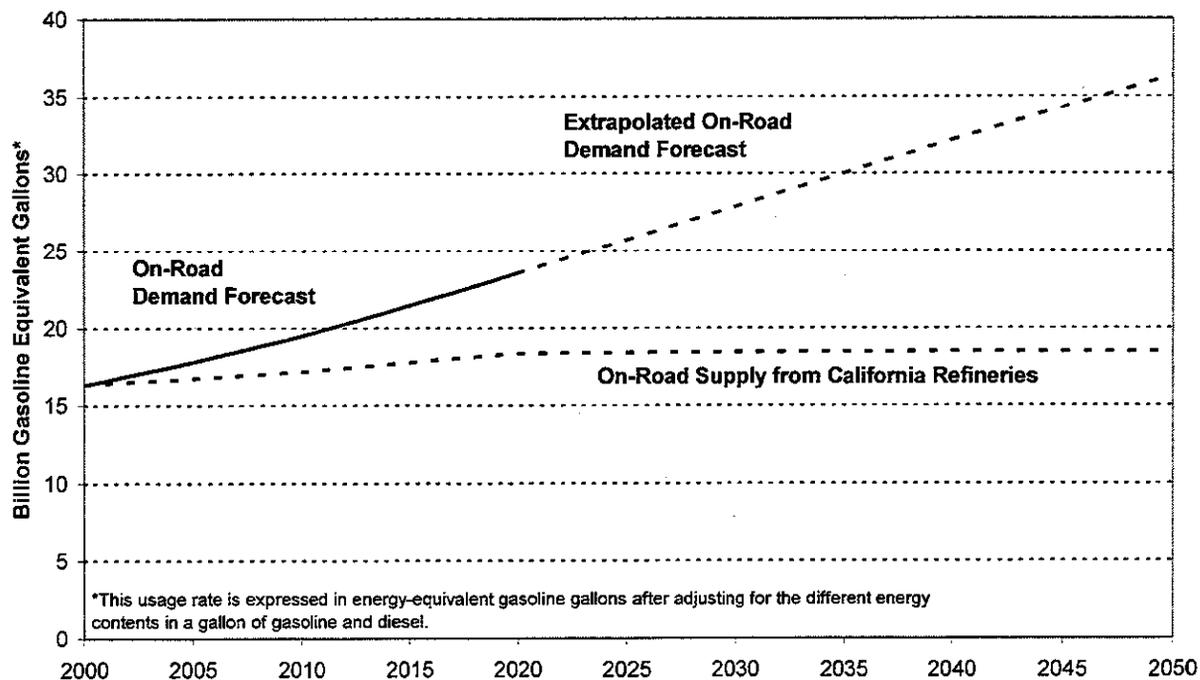
Why Does California Need to Reduce Its Dependence on Petroleum?

California faces a future of increasing petroleum dependence, supply disruptions, and price volatility. At the beginning of this decade, California had a population of 33.8 million people, driving 24 million registered vehicles, and consuming 16.4 billion gasoline equivalent gallons a year of gasoline and diesel fuel.

The California refining capacity has not been able to keep up with the growing demand for transportation fuels. As a consequence, the state has become a significant importer of petroleum products. This, in combination with marine and distribution infrastructure limitations, has made the California gasoline market increasingly unstable. As long as demand for transportation fuels continues to grow, California's gasoline supply will be subject to rapid and frequent price volatility.

By 2020, it is possible that 45.5 million Californians will have 31.5 million registered vehicles consuming 24.2 billion gasoline equivalent gallons of gasoline and diesel fuel (see Figure 1). If this consumption occurs, it would require Californians to accept major expansions in petroleum refinery and delivery infrastructure, further dependence on foreign energy supplies, decreased environmental quality, and reductions in public health.

Figure 1
On-Road Gasoline and Diesel Demand in California



A vibrant California economy depends on secure, reliable, and affordable sources of transportation fuels. The recent war in Iraq underscores the importance of reducing California's and the nation's growing dependence on unstable foreign oil sources. Although these concerns are long-term, the state must take action now to avoid the adverse consequences of California's growing petroleum dependence.

California faces three major problems from its increasing reliance on petroleum: economic, sources of supply, and environmental.

- **Economic.** Unless consumers are given viable options, California could continue to face significantly higher gasoline and diesel prices. Such options could dampen demand for petroleum and moderate price fluctuations.

Rising petroleum prices can have a significant impact on the U.S. and California economies. In addition to reducing the real income of consumers through higher fuel prices, oil price increases drive up the average cost of production of goods and services throughout the economy. The result is a negative impact on the state's economy (gross state product). In fact, the significant petroleum price hikes in 1973-74, 1979-80, and 1990 all led to U.S. recessions.

- **Sources of Supply.** Historically, California has obtained supplies of petroleum from in-state production, imports from Alaska, and imports from foreign sources. Because in-state production has been declining by about 2 percent per year, however, California will become increasingly reliant on sources outside of the state for petroleum and refined petroleum products.

Iraq and Saudi Arabia are or have been the two largest sources of California's foreign imports. If this import trend continues, the state's economy will be even more vulnerable to external disruptions and geopolitical instability. Recent disruptions in foreign petroleum and gasoline supplies have harmed the state's economy and led to peaks in gasoline prices. For example, the loss of oil production from Venezuela earlier this year temporarily caused oil prices to rise, leading to high gasoline prices. In addition, in early 2003, concerns about military conflicts in Iraq also resulted in a spike in world oil prices.

- **Environmental.** Increasing our reliance on petroleum would increase greenhouse gas emissions and be an obstacle to improved air quality. Scientific evidence points to the potential for severe climate change impacts on our ecosystems, economy, and health. For example, early melting of mountain snow packs could lead to water shortages in many parts of California. In addition, storm surges and flooding, combined with rising sea levels, could lead to major impacts on coastal communities, and warming of the earth's atmosphere could exacerbate urban smog.

In general, measures aimed at reducing transportation related petroleum use will reduce California's greenhouse gas emissions. In 1999, California sources emitted 428 million tons of greenhouse gases in carbon dioxide equivalent units. Mobile

source emissions of carbon dioxide, methane, and nitrous oxide were responsible for over half of the total statewide greenhouse gas emissions.

Less use of gasoline reduces smog-forming emissions that occur at each point in the distribution system. Zero-emission vehicles, such as fuel cell vehicles, result in no smog-forming or particulate emissions from the vehicle.

To avoid the adverse consequences of California's dependence on petroleum, the state must adopt measures to improve transportation energy efficiency and expand the use of non-petroleum fuels. Furthermore, supporting the use of non-petroleum fuels should allow for a smooth transition away from petroleum dependence in the transportation sector. There are steps that government can take in the near-term. The most effective strategies to reduce demand for petroleum, however, require long lead times to fully implement. Therefore, urgent focus on these issues is needed now.

Legislative Direction

In response to the public's concerns about price volatility, supply shortages, and the frequency of refinery outages, the California Legislature passed Assembly Bill 2076 in 2000 (AB 2076, Shelley, Chapter 936, Statutes of 2000). This bill directs the California Energy Commission (Energy Commission) and the California Air Resources Board (CARB) to develop and adopt recommendations for the Governor and the Legislature on a California strategy to reduce petroleum dependence.

The statute requires the strategy to include goals for reducing the rate of growth in the demand for petroleum fuels. Options to be considered include increasing transportation energy efficiency and using non-petroleum fuels and advanced transportation technologies including alternative fueled vehicles and hybrid electric vehicles.

In response to this direction, the Energy Commission and the CARB developed a process to evaluate and analyze various demand reduction options. The goal of this effort is to provide policy makers with an objective analysis of the possible measures to reduce California's dependence on petroleum. An important part of the process involved an extensive and comprehensive public review of the analysis. The Energy Commission and the CARB worked together to hold public workshops and meetings with representatives of the oil industry, natural gas industry, the ethanol industry, diesel engine industry, and environmental groups.

This report addresses both near-term and mid- to long-term strategies to reduce the demand for petroleum fuels in California. AB 2076 also requires the Energy Commission to examine the feasibility of a strategic fuels reserve as another near-term option to moderate price volatility in California. The analysis of a strategic fuels reserve and other supply-related options are examined in a separate Energy Commission proceeding. These various studies are located on the Energy Commission's website at [www.energy.ca.gov/fuels/pipeline/documents/index.html].

Proposing the Solution

In this section, the staff addresses the following questions on reducing the state's dependence on petroleum:

- What options were evaluated?
- What demand reduction goal is recommended and how was it determined?
- What options can be used to meet the goal?

What Options Were Evaluated?

The two agencies evaluated various demand reduction options and categorized them as fuel efficiency, fuel substitution, pricing, and other options. The agencies estimated the reduction in petroleum demand and the direct net benefits for each option. Direct net benefit is defined as the combined costs and benefits associated with each petroleum reduction option. Detailed information on each can be found in Appendices A, C and D. The costs and benefits analyzed for each option include the following:

- Incremental costs associated with the purchase and use of new and/or additional technologies.
- Loss of government revenue due to reduced sale of fuel.
- Reductions in the external costs associated with petroleum dependence, including energy security and economic costs.
- Savings associated with reduced operational cost, for example, the savings associated with reduced fuel usage.
- Savings associated with avoided damages from pollution, including health cost savings and avoided damages from climate change impacts.

The estimated direct net benefits evaluated accrue within the state. The only exceptions are the avoided damages from climate change, which are global benefits, and reduced external costs associated with petroleum dependency, which are national benefits.

Two of the categories, fuel efficiency and fuel substitution, are discussed below. They are highlighted because they contain multiple options that have the potential for modest but real, near-term petroleum reductions, or longer-term but significant reductions. They also have positive cost-benefit results or provide long-term sustainable petroleum reductions. The remaining options (pricing and other options) are not included in the recommendations for a variety of reasons. Some of the pricing options did not meet a positive cost-benefit threshold while the remaining pricing options were judged to be politically impractical.

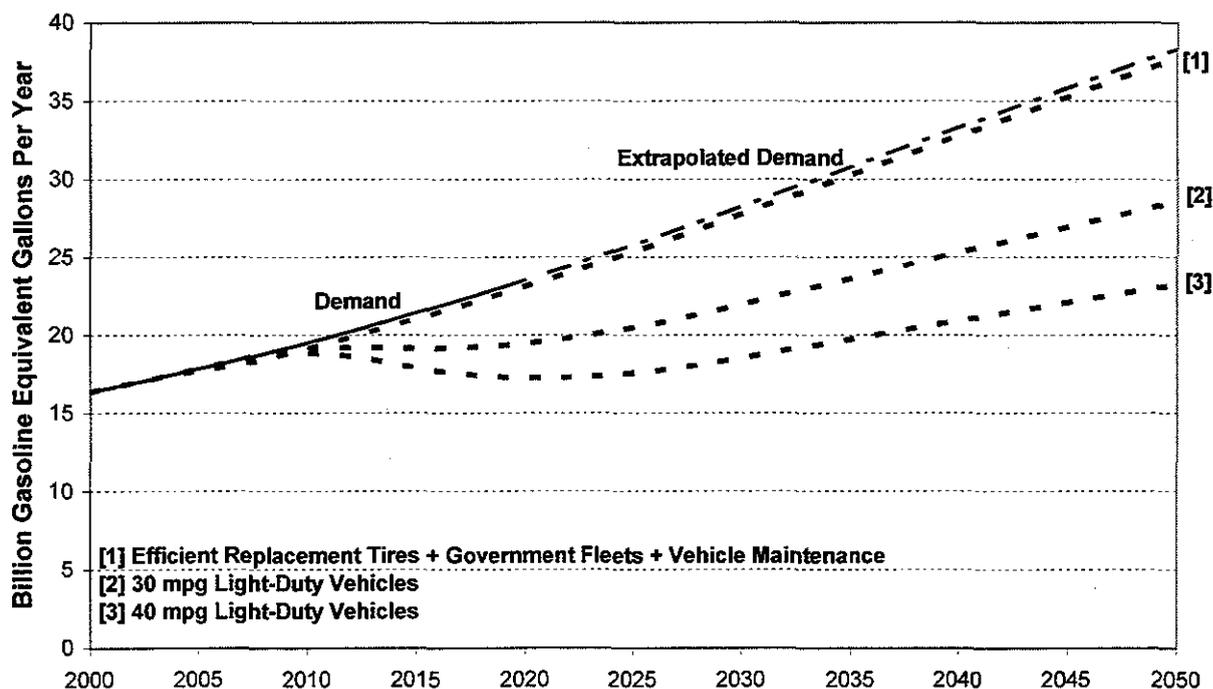
1. Fuel Efficiency Options

The most dramatic reduction in petroleum demand is achieved by improving vehicle fuel efficiency. The agencies evaluated a number of options to improve the fuel efficiency of on-road vehicles, including the following:

- Improved fuel economy of cars and light-duty trucks.
- Improved fuel economy of medium and heavy duty trucks.
- More fuel efficient replacement tires.
- Improved vehicle maintenance.
- Increased purchase by government of fuel efficient vehicles.

Figure 2 illustrates that improving the fuel efficiency of new vehicles would have the greatest effect in reducing petroleum demand. If the fuel economy of new cars and light trucks were improved to 40 mpg beginning in model year 2008 and increasing to 100 percent of all new vehicle sales by the year 2014, growth in demand for on-road transportation fuels would begin to decline by the year 2010 and continue to decline until 2020. However, shortly after 2020, demand for on-road transportation fuels would again begin to increase.

Figure 2
Demand Reduction of Selected Fuel Efficiency Options



According to national experts, it is technically possible to more than double the efficiency of new cars and light-duty trucks using existing and emerging automotive technologies. These technologies include improvements in engines and transmissions, aerodynamic styling, and increased use of hybrid electric and diesel propulsion systems. Many of the technologies evaluated in this report are being used in one or more vehicle models in limited production today.

Figure 3 illustrates the direct net benefits for all efficiency options evaluated. The length of the bar for each option reflects the range of technology costs and fuel costs assumed (e.g., \$1.47 to \$1.81 per gallon of gasoline). Positive numbers indicate direct net benefits, while negative numbers indicate a direct net cost. The fuel efficiency values listed in the figure refer to on-road fuel economy. In this report, the Energy Commission and CARB staff relied on work by the National Research Council (NRC) and American Council for an Energy-Efficient Economy (ACEEE). Two additional options, labeled ARB, involved modifying the costs used in the ACEEE studies to reflect a more aggressive, long-term cost reduction of hybrid electric drive train technology.

Nearly all of the fuel efficiency options have a positive direct net benefit. The increased purchase price of a new car is more than offset by the lifetime fuel savings. This analysis is sensitive to the estimated future cost of fuel and technologies. For more detail, see *Appendix C: Petroleum Reduction Options (Task 3)*.

2. Fuel Substitution Options

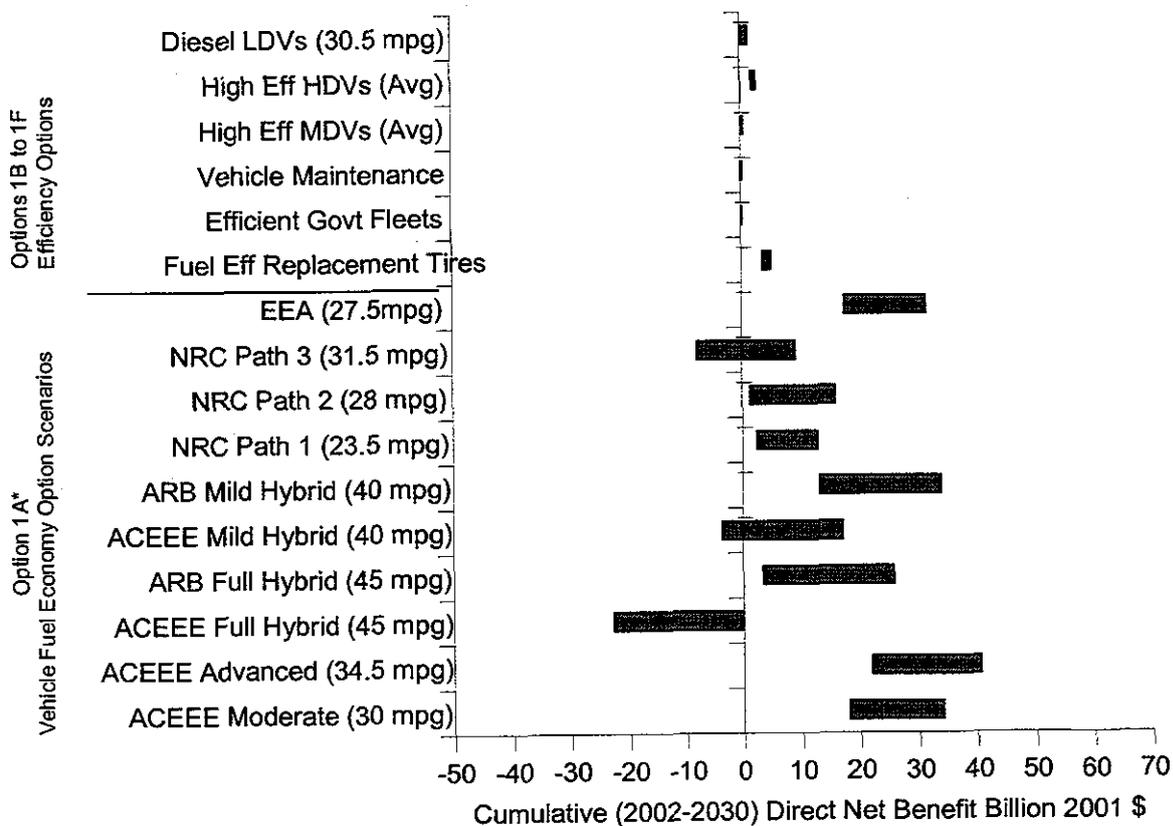
Significant reduction in petroleum demand can also be achieved by substituting non-petroleum fuels for gasoline and diesel. The staff evaluated the following non-petroleum fuel options:

- Natural gas used in gasoline and diesel-like engines
- Ethanol blends
- Liquefied petroleum gas (LPG)
- Non-petroleum derived diesel fuel (Fischer-Tropsch and biodiesel)
- Electric vehicles
- Fuel cell vehicles

For many of the non-petroleum fuels, it is difficult to estimate the degree to which they could substitute for gasoline and diesel. For example, many of the non-petroleum fuels currently lack the necessary infrastructure to support widespread use. In the case of battery electric and fuel cell technology, significant technological improvements and cost reductions are necessary before the vehicles would be widely accepted.

In general, the agencies did not attempt to estimate likely fuel-by-fuel penetration scenarios, but rather assumed a fixed penetration rate of 10 percent of new vehicle

Figure 3
Direct Net Benefit of
Fuel Efficiency Options and Scenarios



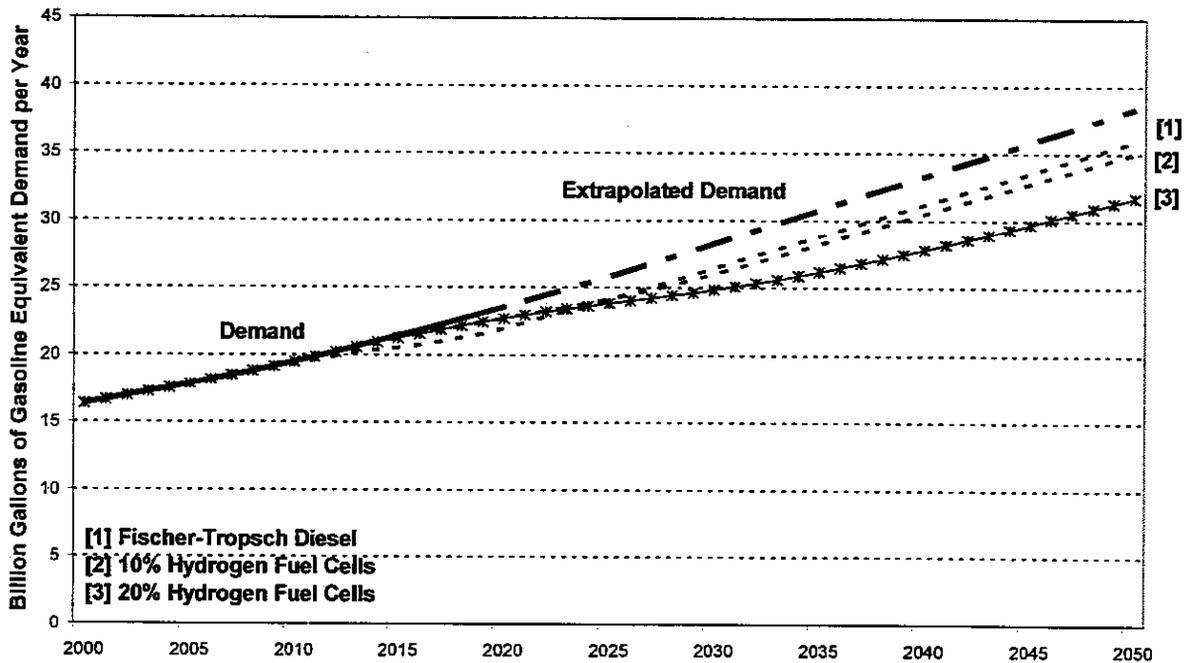
* Fuel Economy Option Scenarios are based upon 100% market penetration by 2014; others vary.

Note: These results are based on the best data available at the time of this analysis. Technologies are advancing quickly and future results may vary substantially.

sales for each type of non-petroleum fuel vehicle. This approach allowed different non-petroleum fuel vehicles to be compared to each other on a consistent cost and benefit basis. Because fuel blends do not pose the same infrastructure issues, however, they were assumed to reach 100 percent penetration. For example, the agencies analyzed 100 percent penetration rates for both a diesel fuel blend of 33 percent Fischer-Tropsch fuel and 67 percent conventional diesel, and gasoline blends containing up to 10 percent ethanol in conventional vehicles.

Figure 4 shows the demand reduction for sample fuel substitution options. Using Fischer-Tropsch diesel made from natural gas in heavy-duty vehicles as a

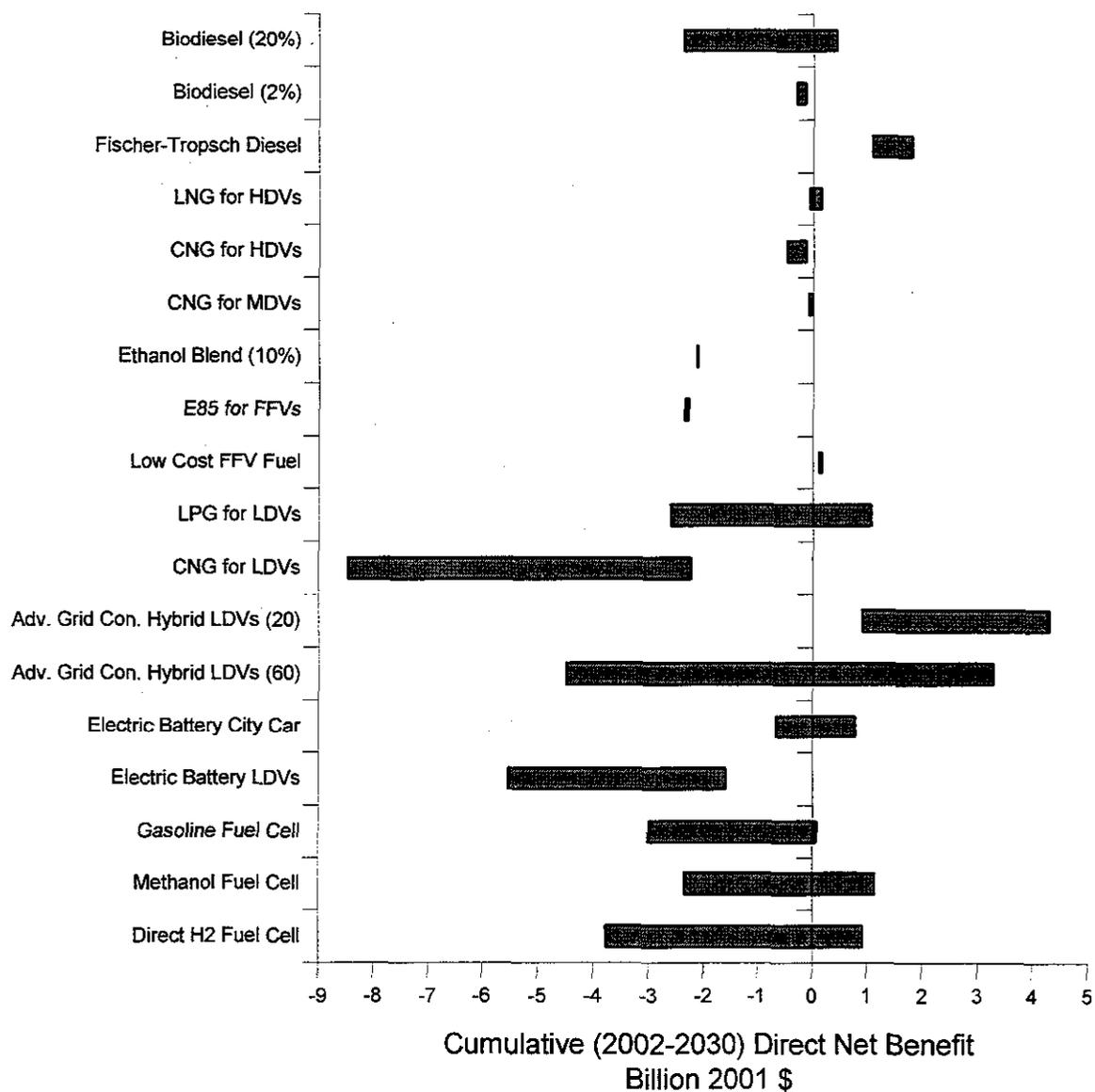
Figure 4
Demand Reduction of Selected Fuel Substitution Options



33 percent blend would reduce the state's total petroleum demand about 6 percent in the 2020 timeframe. Furthermore, replacing 10 percent of new light-duty gasoline vehicle sales with hydrogen fuel cell vehicles would reduce overall petroleum demand about 4 percent in the 2020 timeframe, increasing to 8 percent in the 2030 timeframe. To illustrate the potential for greater petroleum displacement, increasing hydrogen fuel cell penetration to replace 20 percent of new light-duty gasoline vehicle sales would reduce overall petroleum demand by about 17 percent in the 2030 timeframe.

The two agencies evaluated each of the fuel substitution options for its direct net benefit. The results are shown in Figure 5. Most of the non-petroleum fuel vehicle

Figure 5
Direct Net Benefit of Fuel Substitution Options



Note: These results are based on the best data available at the time of this analysis. Technologies are advancing quickly and future results may vary substantially.

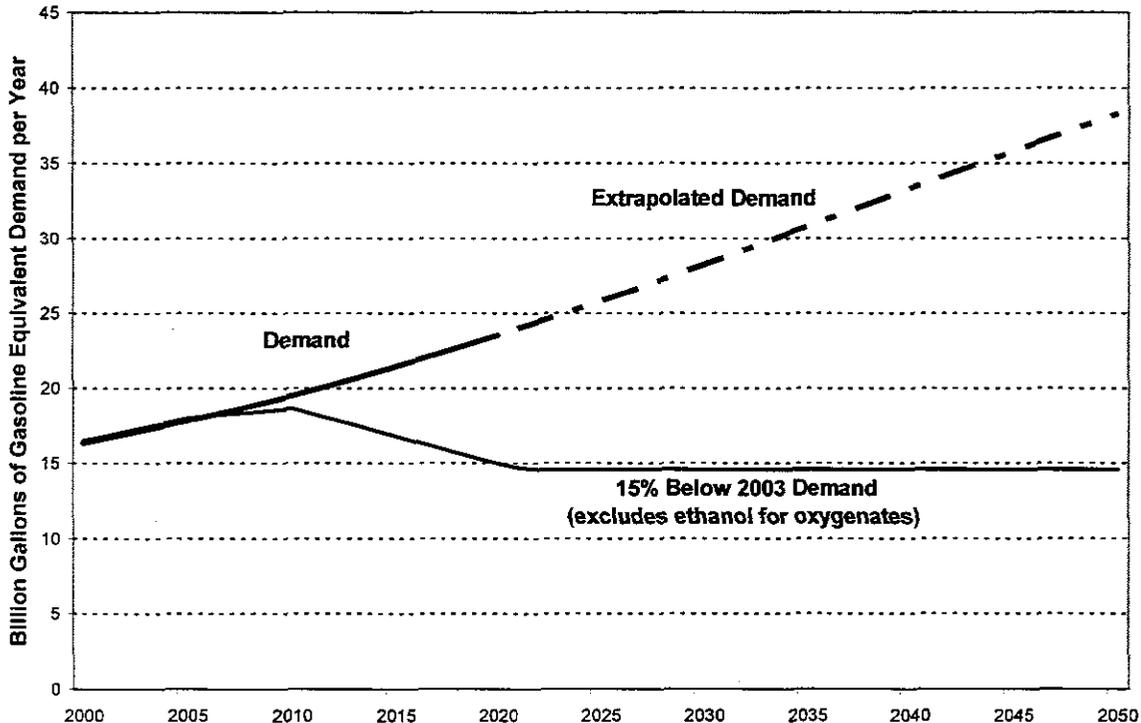
options have a direct net cost, in contrast to the net benefit of many of the fuel efficiency options. For some combinations of technology and fuel costs, positive net benefits occur.

The negative direct net benefit of many of the non-petroleum fuels and vehicles is largely a result of higher incremental capital or fuel costs compared to the projected price for gasoline and diesel (\$1.47 to \$1.82 per gallon). If the price of gasoline and diesel should rise and be sustained to the \$2.00 to \$2.50 per gallon range, the analysis shows that most of the non-petroleum options would have positive net societal benefits, assuming the price of the non-petroleum fuel did not rise concurrently.

What Petroleum Reduction Goal is Recommended and How Was it Determined?

The agencies evaluated California's increasing demand for petroleum fuels, and the options that are currently feasible and economical to reduce the rate of growth in demand for petroleum fuels. As directed by statute, and based on the analysis in this report, the two agencies recommend that California adopt a policy to reduce gasoline and diesel fuel demand to 15 percent below 2003 demand levels by 2020 and maintain that level for the foreseeable future. Figure 6 illustrates this goal.

Figure 6
Recommended Petroleum Reduction Goal



To develop the goal, the agencies selected various options that appeared to be reasonably achievable and cost-effective. The next step was to place the options into

three categories of short-term, mid-term, or long-term. Near-term was for options that could be fully implemented by 2010; mid-term was for the 2010 to 2020 timeframe; and long-term was for 2020 to 2030. The agencies then selected representative options from each of these implementation categories.

The next step was to look at the amount of petroleum that could be displaced by implementing a particular option. In choosing which options would be used to determine the goal, the agencies selected those options that balanced fuel type (i.e., diesel versus gasoline), magnitude of displacement, cost-benefit, and timing of implementation.

For example, in the mid-term category there are numerous options that could have been chosen. These options include Fischer-Tropsch diesel, ethanol, LNG, CNG and grid-connected hybrids among others. Because some of these options compete in the same market applications (e.g., Fischer-Tropsch diesel and LNG would compete in heavy-duty vehicle applications and their individual petroleum displacements would not necessarily be additive), it would not be reasonable to add all possible options together in the process of trying to set a reduction goal. Thus, the agencies chose independent options to represent the myriad possibilities. Fischer-Tropsch diesel was chosen because it is both cost-effective and provides significant petroleum reduction.

The volumes of petroleum reduction were then combined for these selected options for the year 2020. This total petroleum reduction volume was used to establish the recommended goal of 15 percent below 2003 demand.

This goal is aimed at keeping California's transportation sector, and the broader economy which depends on it, vibrant, competitive, and environmentally sustainable. It is an aggressive petroleum reduction strategy that is technically and economically feasible using existing and emerging technologies. This goal reflects ambitious but achievable levels of demand reduction through the combined effects of enhanced fleet fuel efficiency and use of non-petroleum fuels.

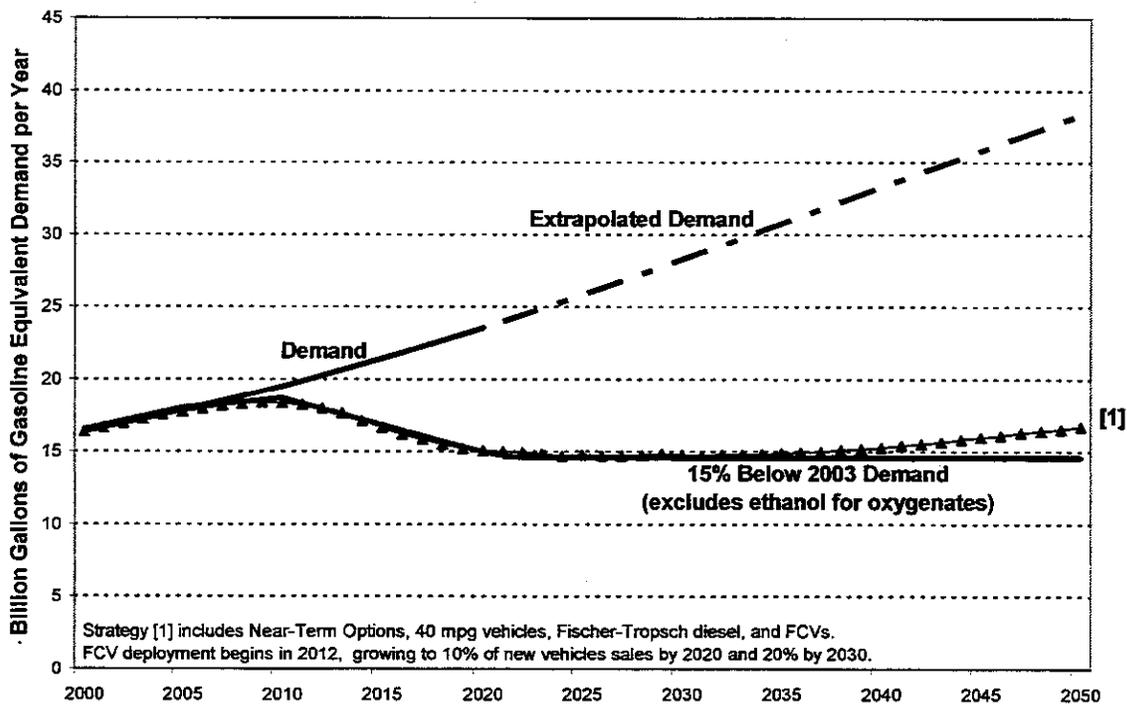
What Options Can Be Used to Meet the Goal?

As illustrated in Figure 7, the agencies combined the following options to meet the petroleum reduction goal. These options were selected based on their relative ability to reduce petroleum usage and provide net societal benefits. When evaluating the non-petroleum options, particularly in the long term, sustainability was also a factor. The identified options are listed below and then discussed more completely in the following section.

- **Near-Term Options (Could be Fully Implemented by 2010)**
 - Use more fuel efficient replacement tires with proper inflation.
 - Improve fuel economy in government fleets.
 - Improve private vehicle maintenance.

- Mid-Term Options (Could be Fully Implemented in the 2010 to 2020 Timeframe)
 - Double the fuel efficiency of current model light duty vehicles to 40 miles per gallon.
 - Use natural gas-derived Fischer-Tropsch fuel as a 33 percent blending agent in diesel.

Figure 7
Strategy for Meeting the Petroleum Reduction Goal



- Long-Term Options (Could be Fully Implemented in the 2020 to 2030 Timeframe)
 - Introduce fuel cell light-duty vehicles in 2012, increasing to 10 percent of new vehicle sales by 2020, and 20 percent by 2030.

This strategy meets the petroleum reduction goal through 2035. Beyond 2035, California's growth in population and vehicle use will overcome the reduced demand for petroleum fuels provided by this strategy. Additional use of non-petroleum fuels and/or a further increase in vehicle efficiency would be needed to continue to meet the recommended goal.

The options selected to meet the recommended goal are discussed below although the staff did not evaluate all possible options and combinations. A more detailed

description of the fuel efficiency, fuel substitution, pricing and other options is contained in *Appendix C: Petroleum Reduction Options (Task 3)*.

Near-Term Options (Could be Fully Implemented by 2010)

Various fuel efficiency options can be used in the near-term to begin to decrease petroleum demand between now and 2010. These options include efficient replacement tires, efficient government fleets, and improved vehicle maintenance. Together, these options provide an immediate 3 to 5 percent reduction in the rate of growth of petroleum usage at a societal net benefit. Further, implementing these options sets an important positive leadership example.

Mid-Term Options (Could be Fully Implemented in the 2010 to 2020 Timeframe)

To avoid the adverse effects of California's dependence on petroleum it is necessary to do more than just the near-term options listed above. The mid-term options listed here were selected because they provide significant reductions in petroleum usage at a net societal benefit. Doubling light duty vehicle fuel efficiency provides the largest reduction of petroleum usage in the mid-term, almost a 30 percent reduction by 2020. This improvement can be achieved using existing and emerging technologies, at a societal net benefit. Fischer-Tropsch fuel can reduce petroleum usage by 6 to 7 percent and is one of the few non-petroleum derived fuels that provides a net societal benefit given current gasoline and diesel prices.

- **Doubling of Vehicle Fuel Efficiency.** The average, on-road fuel economy of cars and light-duty trucks in California increased from 12.6 miles per gallon in 1970 to 20.7 mpg in 1985 as a result of federal CAFE standards. These standards have not substantively changed since 1985, and on road fuel economy has remained relatively constant since that time, decreasing in recent years as consumer purchase greater percentages of sports utility vehicles.

Because CAFE standards have been largely unchanged since 1985, most technological improvements to engines and vehicles have been used to increase performance and overcome gains in weight, rather than to improve fuel economy. These weight gains have occurred as consumers purchased a growing number of larger vehicles, especially trucks and SUVs.

National experts, such as the National Research Council of the National Academy of Sciences and the American Council for an Energy Efficient Economy, have identified multiple pathways to achieve an on-road fleet average fuel economy of 30 to 45 mpg. The analysis shows that, in most instances, increasing fuel economy creates consumer fuel savings that exceed the increased cost of the more fuel-efficient vehicle. In addition, society benefits from improvements to the environment and energy security.

Requiring vehicle manufacturers to improve fuel economy, however, is the sole domain of the federal government. The challenge for California policy makers is to work effectively with the federal government to improve new vehicle fuel economy.

- **Fischer-Tropsch Diesel.** Fischer-Tropsch diesel is a fuel made using a process that converts natural gas to a liquid fuel. It can be used in existing diesel engines either in "neat" form (i.e., as produced) or as a blend. When used as a neat fuel, Fischer-Tropsch diesel costs about 10 cents per gallon more to produce and retail prices are about 15 to 25 cents per gallon more than California diesel. However, Fischer-Tropsch diesel can also be blended with federal diesel which costs less than California diesel. The effect is to produce more California diesel at a price less than or equal to the usual supply of California diesel fuel. A blend of 33 percent Fischer-Tropsch diesel and 67 percent federal diesel is expected to meet California diesel fuel requirements. This blended fuel can be used in existing fueling infrastructure and vehicle engines.

The vehicle fuel efficiency option provides the greatest net benefit, based on current information. The Fischer-Tropsch diesel option provides the best net benefit for displacing diesel. Over the timeframe encompassed by these recommendations, other feasible options could play a role in reducing petroleum dependency. For example, other mid-term options that are attractive, but do not provide the same percentage reduction in petroleum use or as great a net societal benefit, are ethanol blends for flexible-fuel vehicles, liquefied natural gas (LNG) and compressed natural gas (CNG) for use in heavy-duty vehicles, and grid-connected hybrid vehicles.

- **Ethanol.** Ethanol is already blended into California gasoline and has the potential to be blended at higher rates and used in conventional vehicles or when used in higher percentages can be used in flexible- or dedicated-fuel vehicles. There could also be significant economic and environmental benefits if the ethanol needed were produced in-state or from renewable sources. A separate Energy Commission report entitled *Costs and Benefits of a Biomass-to-Ethanol Production Industry in California* contains additional information on this subject.
- **LNG and CNG.** LNG and CNG are also being used in some California vehicles. The expanded use of LNG and CNG in heavy-duty vehicles are options that appear attractive and could provide reductions in petroleum usage at a net societal benefit. Natural gas fuel infrastructure developed for near- and mid-term niche markets can be the genesis of hydrogen fueling infrastructure needed in the long term. LNG and CNG are included here as mid-term options because of the time needed to significantly expand fuel infrastructure.
- **Grid-connected hybrid vehicles.** Grid-connected hybrid vehicles, by virtue of their high efficiency, could help improve vehicle fuel economy. Due to their use of electricity for propulsion, they also could contribute to the use of non-petroleum fuels. Unlike the other options selected, the major barrier to expanded use of grid

connect vehicles at this point is the lack of significant manufacturer interest in further development of this technology.

All of these options are expected to have a role to play as California moves away from its near-total dependence on petroleum fuel. They provide further assurance that the goal established in this report is technically feasible and achievable using strategies that result in a net societal benefit.

Long-Term Options (Could be Fully Implemented in the 2020 to 2030 Timeframe)

In the post-2020 timeframe, continuing growth in population and vehicle use begins to overtake the benefits of improved vehicle fuel efficiency and use of fuel blends such as Fischer-Tropsch diesel, and petroleum fuel consumption begins to rise again. The increased use of a sustainable, non-petroleum fuel such as hydrogen will be needed to assure the long-term effectiveness of a petroleum reduction strategy. The hydrogen fuel cell vehicle option was selected because it can provide a net societal benefit under somewhat optimistic assumptions and increased price for gasoline and diesel, both of which are plausible in the long-term. Additionally, there is significant on-going government and auto manufacturer support for hydrogen fuel cell technology.

- **Hydrogen Fuel Cell Vehicles.** The advantages of direct hydrogen fuel cell vehicles include high efficiency, reduced climate change impacts, and zero emissions from the tailpipe. A primary disadvantage is the lack of an extensive hydrogen-fueling network. Other barriers must also be overcome, such as the high initial costs of the early prototype vehicles and need for improved on-board fuel storage.

California is a founding member of the California Fuel Cell Partnership, located in West Sacramento. This partnership of 29 members has been working for four years to begin the process of deploying fuel cell vehicles and establishing the necessary fueling infrastructure. The objective of the partnership is to pave the way for commercialization of hydrogen fueled vehicles.

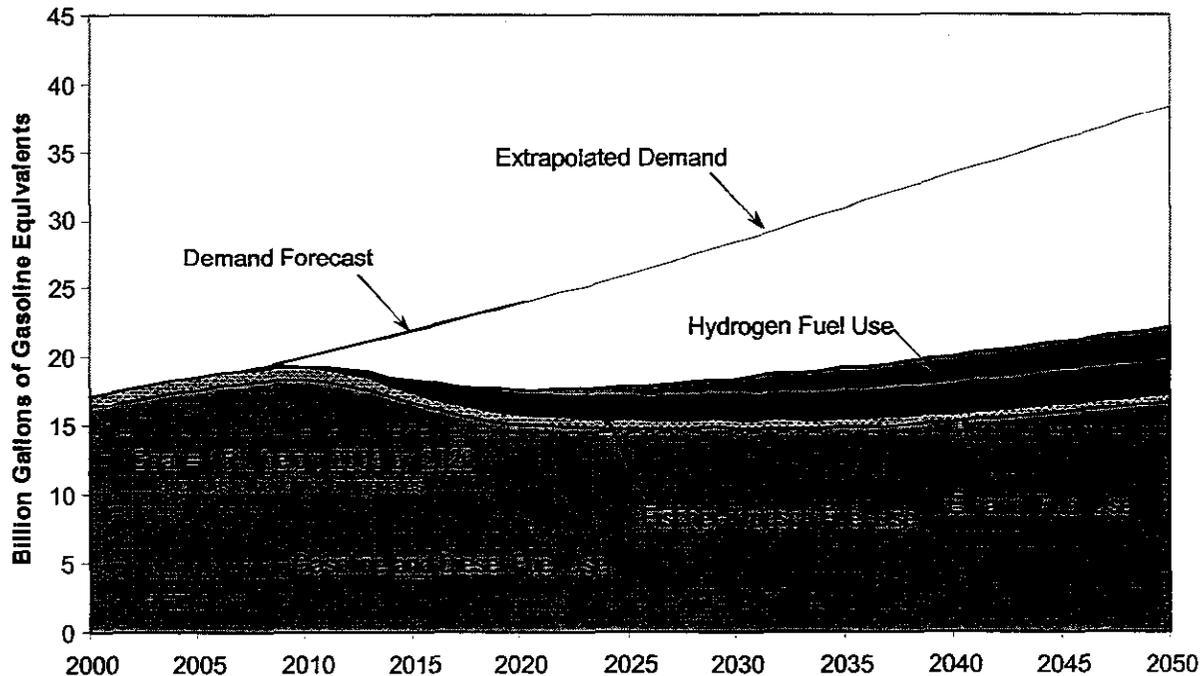
Following in the steps of California, President Bush has established several initiatives to advance fuel cell technology and fueling infrastructure. The National Fuel Cell Initiative would expend 1.2 billion dollars over 5 years on research and demonstration of hydrogen production, storage and distribution. The National Freedom Car Initiative aims to develop the technologies to enable the production of affordable fuel cell light-duty vehicles. The California Fuel Cell Partnership is working closely with the federal agencies to coordinate efforts and advance their compatible goals.

These efforts are also designed to identify the need for policies to help remove barriers and accelerate the introduction of hydrogen fuel and vehicles.

If the recommended strategy is implemented, California's future on-road fuel supply mix will become much more diverse, consisting of petroleum for use in very fuel efficient

gasoline and diesel vehicles; Fischer-Tropsch diesel derived from remote sources of natural gas; and domestic natural gas used to make hydrogen for fuel cell vehicles. The resulting fuel supply mix is shown in Figure 8. This more diverse fuel mix would lessen the potential for petroleum supply disruptions to produce severe price spikes. Prudent efforts will be needed, however, to ensure that the strategy can be implemented without adverse effects upon fuel prices.

Figure 8
On-Road Demand Forecast and Fuel Use
After Implementing Recommended Goals*



* Note that the white area below the Demand line represents the amount of petroleum reduced due to increased vehicle efficiency, specifically: 40 mpg vehicles, near-term options, and the increase in efficiency of hydrogen vehicles relative to gasoline vehicles.

What are the Recommendations?

Recommendation # 1. The Governor and Legislature should adopt the recommended statewide goal of reducing demand for on-road gasoline and diesel to 15 percent below the 2003 demand level by 2020 and maintaining that level for the foreseeable future.

The two agencies recommend a goal of 15 percent below the 2003 demand level because that level can be achieved by using a set of cost-effective options. If the Governor and Legislature adopt this goal, it will provide a framework to guide California down the path to significantly reduced petroleum consumption. Achieving the goal will reduce California's dependence on imported oil and petroleum production, moderate

price volatility, improve environmental quality, and demonstrate positive leadership in the effort to reduce greenhouse gas emissions.

Recommendation #2. The Governor and Legislature should work with the California delegation and other states to establish national fuel economy standards that double the fuel efficiency of new cars, light trucks and SUVs.

The most effective way to improve vehicle fuel economy is to revise the federal CAFE standards. In cooperation with other states, California should press the Congress to adopt new standards, which double the fuel economy of new vehicles. The goal in Recommendation #1 (15 percent below 2003 demand) assumes that the federal government doubles the current CAFE standard. Should the federal government fail to implement a CAFE standard that doubles the fuel efficiency of new cars, it would be necessary to reassess the goal in Recommendation #1.

Recommendation #3. The Governor and Legislature should establish a goal to increase the use of non-petroleum fuels to 20 percent of on-road fuel consumption by 2020 and 30 percent by 2030.

California should act to increase the use of non-petroleum fuels as a strategy to reduce petroleum demand and to hedge against the costs and risks of a growing dependence on petroleum fuels. The Governor and Legislature should adopt a goal establishing a minimum fraction of on-road transportation fuel that is derived from non-petroleum sources. Consistent with the petroleum reduction goal of Recommendation #1, the agencies recommend an additional goal of 20 percent use of non-petroleum fuels by the year 2020 and 30 percent by 2030. This recommendation is expressed as a percentage of fuel that is used, not as a percentage reduction in forecasted demand.

The goal of 20 percent non-petroleum fuel use in 2020, increasing to 30 percent in 2030, would include the non-petroleum portion of fuel blends such as Fischer-Tropsch diesel and conventional gasoline. By the end of 2003, California's gasoline will contain approximately 5.7 percent ethanol and that ethanol should be recognized as meeting a portion of the recommended non-petroleum fuel goal. In 2020, the 20 percent recommended goal equates to approximately 15 percent non-petroleum fuel in fuel blends (ethanol as a portion of conventional gasoline and Fischer-Tropsch fuel as a portion of diesel) plus another 5 percent non-petroleum fuel such as hydrogen used in hydrogen fuel cell vehicles. The 30 percent goal in 2030 equates to approximately 13 percent non-petroleum fuel in fuel blends (again ethanol as a portion of conventional gasoline and Fischer-Tropsch as a portion of diesel) plus another 17 percent non-petroleum fuel such as hydrogen used in hydrogen fuel cell vehicles.

This goal would be met if the petroleum reduction strategy outlined in this report is implemented. The value of this goal is to assure that regardless of how petroleum reduction is achieved, a minimum percentage of the fuel used in California will come

from non-petroleum sources. This provides for fuel diversity and helps pave the way towards a sustainable transportation fuel supply.

Modifications Made as a Result of Public Comment

The two agencies modified this document in the following ways as a result of public comment at the June 6, 2003 Joint Agency Hearing:

1. Some stakeholders argued that the goal in Recommendation #1 (15 percent below 2003 demand) would require the imposition of taxes or other pricing measures in the event that the federal CAFE standard is not revised. This report in no way recommends taxes and/or other pricing measures, and to clarify this matter the report has been modified in two ways. First, the discussion under Recommendation #2 has been modified to state that should the federal government fail to implement as stringent a CAFE standard as would be necessary to meet the goal in Recommendation #1, then the goal would need to be reassessed. Second, language was added to the "What Options Were Evaluated?" section to clarify that this report in no way endorses taxes or fees of any kind.
2. Based on public comment from a variety of stakeholders, most of the figures include minor revisions such as changing labels and adding footnotes in order to clarify the information being presented and changing the vertical scale to make all of the figures consistent. Figures 3 and 5 were modified to include all the fuel efficiency and fuel substitution options, respectively, that were evaluated. These two figures were also adjusted to include the results of various minor corrections to the underlying data. A new figure (Figure 8) was added that displays a break-out of the possible fuel usage, by fuel type, after implementing the recommended goals.
3. One stakeholder argued that Fischer-Tropsch diesel would cause an increase in the price of diesel in California. To clarify that Fischer-Tropsch would not result in higher costs relative to California ultra-low-sulfur diesel, staff rewrote the paragraph on Fischer-Tropsch.
4. Stakeholders from the ethanol industry, the natural gas industry, and advocates for grid-connected hybrid vehicles provided comments and information about their respective products. This information was included in the discussion of "Mid-Term Options" under the "What Options Can Be Used to Meet the Goal?" section. This section now includes a paragraph each on ethanol, natural gas, and grid-connected hybrid vehicles. Modifications were also made to Figure 5 to update the grid-connected hybrid assessment by using advanced vehicle efficiency technologies consistent with Option 1A.
5. There was confusion related to the percentage number for Recommendation #3. The percentage was adjusted from 18 percent in 2020 to 20 percent in 2020 for two reasons. First, the previous version did not include the current ethanol content of

gasoline. Second, the previous percentage was based on a reduction from the "business as usual" forecasted demand. The revised percentage more appropriately represents the non-petroleum fuel options as a percentage of total fuel consumption for the year indicated assuming that the overall petroleum reduction goal is achieved. Figure 8 was added to illustrate the percentages of on-road demand that would be met with non-petroleum fuels.

6. Many stakeholders supported the addition of a non-petroleum fuel usage goal out to 2030. The agencies were directed by the author of AB 2076 to consider a timeframe at least out to 2030, therefore it is appropriate to extend the non-petroleum fuel goal out to 2030. The goal of 30 percent non-petroleum fuel usage by 2030 is based on a feasible and cost-effective estimate of the non-petroleum fuel usage necessary to maintain the goal in Recommendation #1 (15 percent below 2003 demand).

Conclusion

This report describes a prudent strategy that addresses the three major transportation energy issues facing California. It provides an opportunity for California to demonstrate state leadership in reducing greenhouse gases from the transportation sector. The recommended strategy hedges against the risks of future oil and fuel supply disruptions. In addition, the strategy will dampen fuel demand and moderate price impacts on the California economy through cost-effective efficiency improvement and use of non-petroleum fuels.

The recommended goal described in this report is presented as a target and not a mandate. It is a performance based goal that can be used to guide decision makers in forming transportation-related policies for the state.

A possible "best case" strategy was presented in order to show that the goal can be achieved using a combination of existing and emerging technologies in a cost-effective manner. By improving vehicle fuel efficiency and expanding use of non-petroleum fuels, the state can dramatically reduce the demand for petroleum without additional taxes or fees. Thus, taxes and fees pricing options are not recommended.

The analysis upon which this report is founded was based upon the best information available to the Energy Commission and ARB at the time the report was prepared. Many of the technologies evaluated are evolving rapidly. As the technologies mature, their relative cost-effectiveness will change, including their ability to produce desirable air pollution and global climate change benefits. Thus, it is advisable to update the analysis if future fuel prices and technology attributes are significantly different from those used in this analysis, especially non-petroleum fuel prices.

