INVESTMENT PLAN FOR THE ALTERNATIVE AND RENEWABLE FUEL AND VEHICLE TECHNOLOGY PROGRAM

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DRAFT STAFF PAPER

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Abstract

The Investment Plan for the Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007) Alternative and Renewable Fuel and Vehicle Technology Program serves as the guidance document for the allocation of program funding and is prepared annually based on input and advice of the AB 118 Advisory Committee. This first Investment Plan will cover the first two years of the program, and details how the Energy Commission and the advisory committee determined the priorities and opportunities for funding, consistent with the program's purpose:

> "to develop and deploy innovative technologies that transform California's fuel and vehicle types to help attain the state's climate change policies".

The Investment Plan describes the analytical method used to assure greenhouse gas (GHG) reductions for the Assembly Bill 32 target of 2020, and beyond to 2050; the non-GHG funding allocations for the program; the gap analysis showing where funding is most useful and productive; and provides a section of proposed funding recommendations, based on the these analyses and identified opportunities, for the first two years of the program. Appendices A-D include all the supporting analyses and important references for the development of this seven-year incentive program to help transform California's transportation sector to a low-carbon, cleaner, non-petroleum, and more efficient future.

INTRODUCTION

Assembly Bill (AB) 118 (Núñez, Chapter 750, Statutes of 2007) created the Alternative and Renewable Fuel and Vehicle Technology Program. This legislation authorizes the California Energy Commission (Energy Commission) to spend up to approximately $120 million per year for over seven years to "develop and deploy innovative technologies that transform California's fuel and vehicle types to help attain the state's climate change policies."

The statute, amended by Assembly Bill 109 (Núñez, Chapter 313, Statutes of 2008), directs the Energy Commission to create an advisory committee to help develop and adopt an *Investment Plan* to determine priorities and opportunities for the program, and describe how funding will complement existing public and private investments, including existing state and federal programs. The Energy Commission will use the *Investment Plan* as a guide for awarding funds. The statute calls for the *Investment Plan* to be updated annually. This initial *Investment Plan*, however, will guide funding decisions during the first two years of the program (fiscal years 2008/09 and 2009/10).

The statute provides a broad array of activities and projects that are eligible to receive funding under the program. The Energy Commission may select projects to:

- Develop and improve alternative and renewable low-carbon fuels.
- Optimize alternative and renewable fuels for existing and developing engine technologies.
- Produce alternative and renewable low-carbon fuels in California.
- Decrease the overall impact of an alternative and renewable fuel's life-cycle carbon footprint and increase sustainability.
- Install alternative and renewable fuel infrastructure, fueling stations, and equipment.
- Improve light-, medium-, and heavy-duty vehicle technologies to provide for better fuel efficiency and lower greenhouse gas (GHG) emissions, alternative fuel use and storage, or emission reductions.
- Accelerate the commercialization of vehicles and alternative and renewable fuels including buy-down programs through pre-commercial demonstrations and market-path deployments, advanced technology warranty or replacement insurance, development of market niches, and supply-chain development.
- Retrofit medium- and heavy-duty on-road and non-road vehicle fleets with technologies that create higher fuel efficiencies, including alternative and renewable fuel vehicles and technologies, idle management technology, and aerodynamic retrofits that decrease fuel consumption.
- Promote alternative and renewable fuel infrastructure development connected with existing fleets, public transit, and existing transportation corridors.
- Provide workforce training related to alternative and renewable fuel feedstock production and extraction, renewable fuel production, distribution, transport, and storage, high-performance and low-emission vehicle technology and high tower electronics, automotive computer systems, mass transit fleet conversion, servicing, and maintenance, and other sectors or occupations.
- Initiate education and program promotion within California and develop alternative and renewable fuel and vehicle technology centers.
- Conduct analyses, evaluations and assessments needed to assist in preparing the *Investment Plan* and implementing the program.

The statute allows the Energy Commission to use grants, loans, loan guarantees, revolving loans, and other appropriate measures and provide funding to a broad suite of entities, including

public agencies, private businesses, public-private partnerships, vehicle and technology consortia, workforce training partnerships and collaboratives, fleet owners, consumers, recreational boaters, and academic institutions.

The level of state funding that is envisioned for this program over the next seven years and the breadth of eligible activities will send a strong and consistent market development signal and will stimulate private investment in new fuels and vehicle technologies. This program creates the opportunity to make existing alternative and renewable fuels and vehicle technologies available in the marketplace to provide immediate GHG reduction benefits and to help create the impetus for the long-term transition and evolution of the transportation sector in California.

However, the vision for this program must extend far beyond California's borders, to other states and nations, and must extend far beyond the projected seven-year authorization for the program, to 2020 and 2050. The priority to attain the state's climate change goals must be approached in a careful and informed manner. The growing importance of improving and maintaining sustainability principles and practices in the production and use of energy is paramount in the design, preparation and implementation of the program. The many public benefits that can accrue from this landmark program necessitate setting the highest possible standard and vision from the outset.

Creating a Framework of Sustainability

The statute directs the Energy Commission to "establish sustainability goals to ensure that alternative and renewable fuel and vehicle deployment projects, on a full fuel-cycle assessment basis, will not adversely impact natural resources, especially state and federal lands."

The Energy Commission, in its *2007 Integrated Energy Policy Report*, adopted a goal of increasing the use of alternative and renewable fuels to 26 percent of on-road demand by 2022, which is more than 4 billion gallons of alternative and renewable fuel. Meeting this goal will require the addition of more than 1 million gallons of new supplies of alternative and renewable fuels per day into the California market for the next 14 years.

The Energy Commission recognizes that the volume of alternative and renewable fuels needed to help meet the state's GHG reduction goals from the transportation sector carries the risk of encouraging or promoting environmentally and socially destructive production practices in California, North America, and globally. These concerns compel California to expand its notions of sustainability beyond the express language in statute. As discussed in the many public workshops and meetings convened to design and implement the program, sustainability concerns permeate all aspects of fuels and transportation technologies and encompass environmental, social, and economic issues.

Investing in Clean Economic Development

California and the rest of the nation are in the grips of a recession. Investments in alternative and renewable fuels could become an important economic stimulus. The state is the third largest consumer of gasoline and diesel fuels in the world, second only to the United States as a whole and China. Transforming this complex petroleum-based fuels market to one based on a diversity of low-carbon alternative and renewable fuels represents a substantial investment opportunity and the potential to create new "green collar" employment. A reasoned and well-planned transition to a diversified, low-carbon transportation future will require substantial investment in fuel production and vehicle manufacturing facilities, fuel storage, distribution and retail infrastructure, and commercial development of advanced vehicle components "next generation" alternative and renewable fuels.

This transition will require private capital investment and public financial incentives to foster technology advancement and innovation. To stimulate a moderate growth rate of alternative

and renewable fuels, it is estimated that $2 billion in government incentives invested between 2008 and 2022 will stimulate more than $40 billion in private investment leading to a mature market rollout of alternative and renewable fuel options in 2050. Between 2008 and 2050 about $100 billion in total market (public and private) investment will be required. These estimates are based on capital cost assumptions, technology research and development needs, infrastructure requirements, manufacturing investments, and consumer education program cost estimates.

This transition can begin by offering consumers choice. California consumers have little or no choice in the fuels they use in their vehicles. In some respects, the expanded use of alternative and renewable fuels in the near term will be invisible to most consumers as it will likely be limited to blended fuels (such as ethanol and biodiesel) dispensed through existing petroleum retail stations. Alternative and renewable fuel and vehicle choices do exist to consumers, but are currently limited. Bringing to market a broader suite of alternative and renewable fuel sources and vehicles and allowing consumers more options will increase price competition and provide additional means to achieve early climate change and air quality benefits.

To provide consumers and businesses a choice in the fuels or vehicles they use, new markets must be created and existing markets significantly grown. Growing an alternative and renewable fuels industry coupled with a "state-of-the-science" vehicle technology development industry will attract and retain clean technology businesses, stimulate high-quality employment, and help reduce the state's vulnerability to price volatility.

"Centers of Excellence" have been successfully established in the state's college and university system and the non-profit sector to push advancements in alternative and renewable fuels, vehicle technologies, emissions reduction and workforce training and development. These centers are an essential element in the transition to a diverse, low-carbon market.

This transition also will require new sources of energy and fuel feedstocks. California's waste streams represent a large and growing and environmental challenge for the state, and the traditional solutions are overtaxed and ineffectual. The waste from agriculture, food processing, landfills, forests, and municipal or water treatment plants holds substantial resource potential for conversion to alternative and renewable fuels, and this program seeks to encourage this development in a responsible and sustainable manner. Also, purpose-grown, energy crops offer new commercial opportunities for the agricultural community in California. But, this endeavor must be carefully considered and pursued according to the best sustainability practices, principles, and goals for California natural resources. Lastly, the state has established aggressive goals for the development of renewable electricity. An alternative and renewable fuels and vehicle market can be developed with attention paid to the use renewable process energy, providing added stimulus for the expansion of businesses in California that manufacture clean, renewable energy systems.

DETERMINING PRIORITIES AND OPPORTUNITIES

The goal of AB 32 is to return the State of California's entire GHG emissions back to their 1990 emissions level by 2020. The Governor's Executive Order S-03-05 calls for an 80 percent GHG emissions reduction from 1990 levels by 2050. The Energy Commission has developed a goal-driven analytical method for establishing funding priorities and opportunities for the program to achieve the AB 32 statutory requirement by 2020 and examine the necessary "trajectory" of continual climate change emission improvements to achieve the 2050 target. The method is based, in part, on the *2050 Vision* included in the *State Alternative Fuels Plan* that was jointly adopted by the Energy Commission and the Air Resources Board in December 2007. The *2050 Vision* represents a plausible scenario for which specific categories of fuels and light-duty vehicles would be introduced and used over the next 42 years enabling the state to achieve the 2050 target. A similar analytical approach has been developed for medium- and heavy-duty

vehicles and used in a two-step process that produces a percentage allocation of available funds.

Step 1. Relative Greenhouse Gas Reductions

The first step establishes the relative contributions of each fuel and vehicle category to meeting the 2020 and 2050 GHG targets. The method uses as a base the Energy Commission's most recent fuel demand forecast incorporating the effects of the "Pavley" regulations, the Low-Carbon Fuel Standard (LCFS), and assumptions reduction in vehicle miles traveled (VMT).

Step 2. Gap Analysis

The second step determines where existing public and private funding is already in place to develop and deploy alternative and renewable fuels and vehicle technology, and where "gaps" of needed funding exist. As part of this gap analysis, the Energy Commission is seeking input from fuel, vehicle, and public interest stakeholders to help determine which identified funding gaps are anticipated and assumable by the industry or stakeholders and not necessary to be funded through the program. This second step also addresses funding for other important categories that are not directly driven or apportioned by their respective ability to reduce GHG emissions. These areas include funding workforce training, sustainability studies, standards and certification, public education and outreach, and analytical support. Each is discussed later in this *Investment Plan*.

Relative Greenhouse Gas Reductions

Light-Duty Vehicles

This analysis evaluates one potential scenario where the light-duty vehicle segment[1] can reduce GHG emissions in a partially successful attempt to meet "fair share" (not established by statute) reduction targets for 2020, and on to 2050. The "fair share" emission reduction is the calculated GHG emission reduction target for the transportation sector (or in this case for light-duty vehicles) based on the transportation sector's contribution to the state's overall GHG emission totals, stated as a percentage of the total of all GHG emissions.

The objective was to work backward from the *2050 Vision* to depict the alternative and renewable fuel and vehicle pathways that may be needed to meet the GHG emissions reduction statutory requirement of AB 32 and to be consistent with the trajectory needed to meet the 2050 target as well. Chapter 6 of the *State Alternative Fuels Plan* describes this vision.[2] The major attributes of this *2050 Vision* are that:

- Most vehicles in 2050 would achieve a fleet-average of 60 miles per gallon; electric-drive vehicles would achieve a fleet-average of 80 miles per gallon.
- The 2050 fuel mix would consist of electricity and hydrogen (40 percent), biofuels (30 percent) and petroleum fuels (30 percent).
- The carbon intensity of fuels used in these three populations of vehicles in 2050 would be reduced 90 percent relative to today's gasoline vehicles (for electric and hydrogen vehicles), 80 percent (for biofuels vehicles) and at least 10 percent (for other vehicles; those that meet the ARB's Low Carbon Fuel Standard).
- Vehicle miles traveled (VMT) in 2050 would be reduced from 10,300 under a business-as-usual (BAU) scenario to 8,200, a reduction of about 20 percent.

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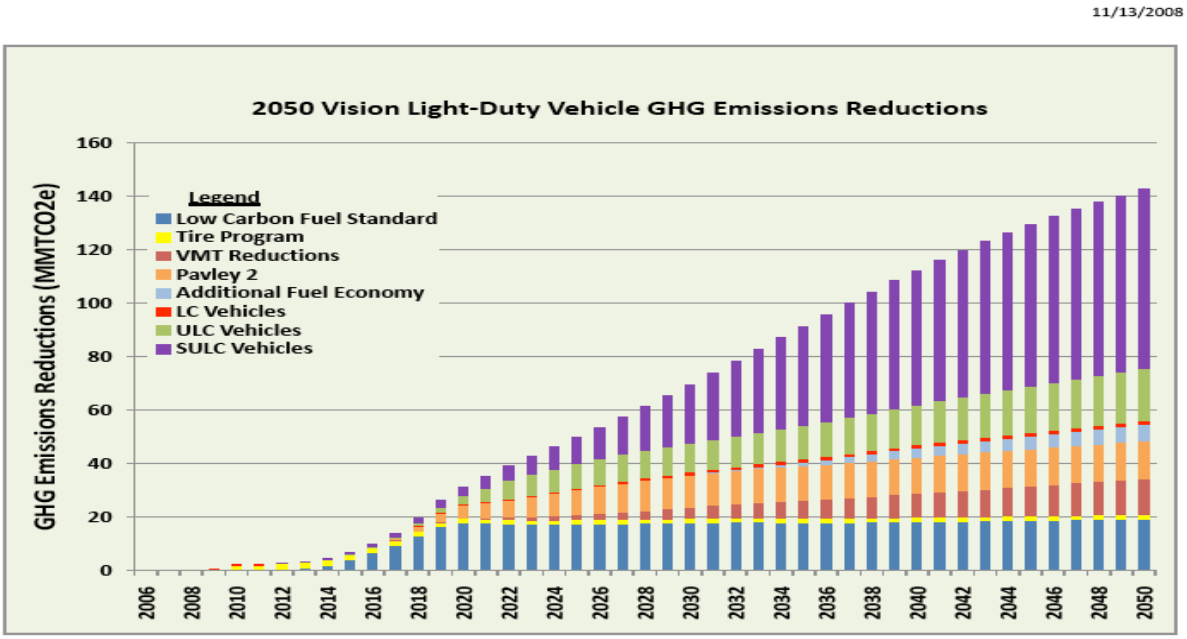
[1] The full Light-Duty Vehicle Analysis is in Appendix A.

[2] *State Alternative Fuels Plan*, Final Adopted Report CEC-600-2007-011-CMF, December 2007.

To establish funding priorities and opportunities for the program, specific fuel and vehicle categories were designated according to their ability to reduce GHG emissions. The categories are:

- The Low-Carbon (LC) category includes vehicles using propane, natural gas, and renewable diesel and show at least a 40 percent reduction in GHG emissions.
- The Ultra-Low-Carbon (ULC) category includes fuel-flexible vehicles using ethanol (E-85) and average at least a 60 percent reduction in GHG emissions.
- The Super-Ultra-Low-Carbon (SULC) category includes fuel cell, plug-in hybrid electric and battery electric vehicles and show at least an 82 percent reduction in GHG emission.
- The Additional Fuel Economy Improvements category includes efforts to improve vehicle fuel use efficiency beyond Pavley 1 and 2[3] and would apply to later years with a goal of 60 mpg on-road by 2050.

Figure 1. 2050 Vision Light-Duty Vehicle GHG Emission Reduction



Source: California Energy Commission

Conclusions For Light-Duty Vehicles

By using the GHG emissions reductions from the graph above, staff developed percentages of reduction for each category relative to business as usual. These percentages, shown in Table 1 below, were developed by summing GHG reductions for each category over the 2009 to 2020 period and dividing the individual totals for each category by the total GHG reductions eligible for program funding. The Low-Carbon Fuel Standard, Tire Efficiency Program, and VMT

[3] In response to AB 1493 (Pavley, Chapter 200, Statutes of 2002), ARB adopted vehicular GHG regulations that also affect fuel economy for model year (MY) 2009 (applicability uncertain pending legal issues) through MY 2016. ARB has stated its commitment to adopt further "Pavley" GHG reductions in the AB 32 Scoping Plan, and has indicated it will implement "Pavley 2" requirements that would apply to MY 2017 through MY 2020 (and possibly to 2025). Under Pavley 2, on-road fuel economy would improve from about 21 miles per gallon (mpg) today to about 35.5 mpg in 2025.

reductions were excluded from the final results below because they are not eligible for funding under the program. The results of the analysis lead to the following percentages for each of the five categories evaluated:

Table 1. Light Duty GHG Emissions Reductions (2009 to 2020)

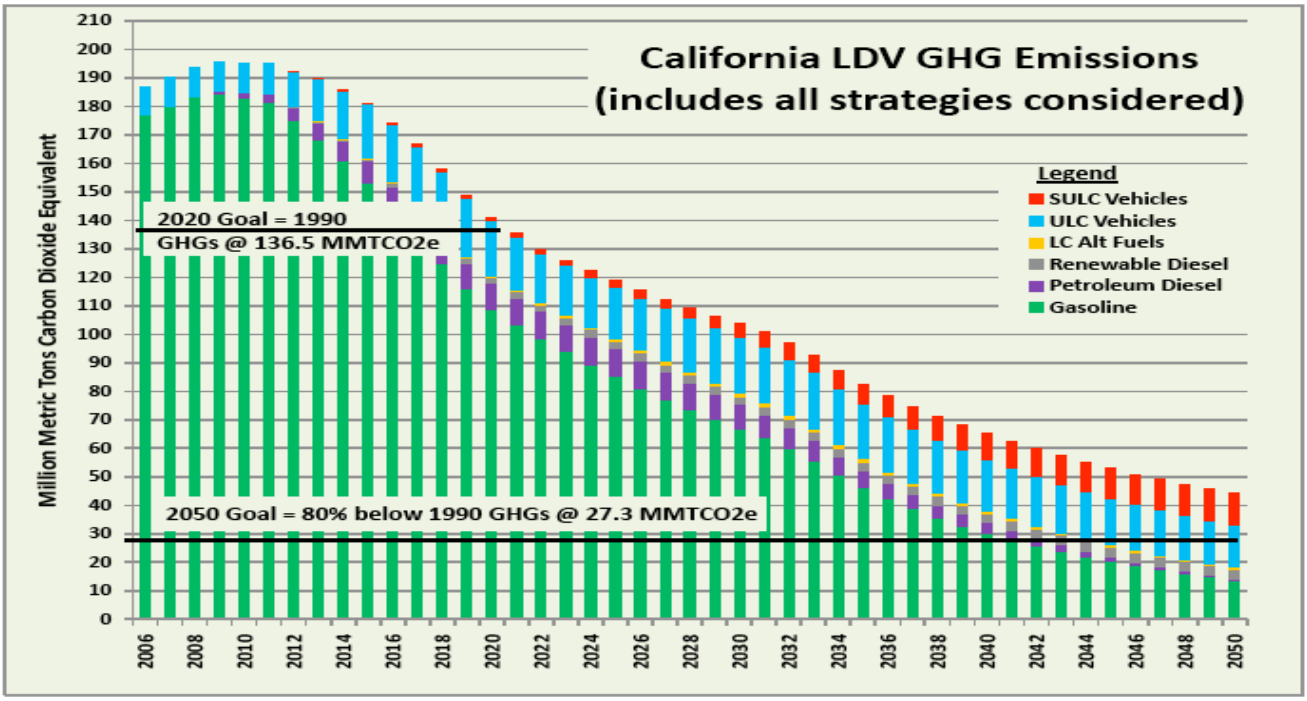
Category	GHG Emission Reduction ($MMTCO_2e$)[4]	Percent GHG Emission Reduction
Super Ultra Low Carbon Fuels	11	33%
Ultra Low Carbon Fuels	9	27%
Low Carbon Fuels	3	10%
Fuel Economy Improvements	10	30%
Total	33	100%

Source: California Energy Commission

Using these estimates, the following graph shows the effectiveness of this scenario in meeting the "fair share" 2020 and 2050 GHG reduction targets.

Figure 2. California LDV GHG Emissions

[4] Million metric tons carbon dioxide emissions.



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Source: California Energy Commission

Medium- and Heavy-Duty Vehicles

This analysis extends the evaluation of the *2050 Vision* for light-duty vehicles to medium- and heavy-duty vehicles. [5] The emerging fuels and vehicle technologies included in this analysis are renewable diesel, hydraulic hybrids, battery-electric hybrids, full-electric vehicles, fuel cell vehicles, propane, compressed natural gas, and liquefied natural gas vehicles. A third category, ultra-low-carbon vehicles, was used in the light-duty vehicle evaluation but is not applicable to medium- and heavy- duty vehicle fuels.

- The Low-Carbon category includes renewable diesel, liquefied petroleum gas, compressed natural gas, and liquefied natural gas.
- The Super-Ultra-Low Carbon category includes hydrogen and electric drive vehicles.
- The Additional Fuel Economy Improvements category includes the introduction of hydraulic hybrids and other technology advancements.

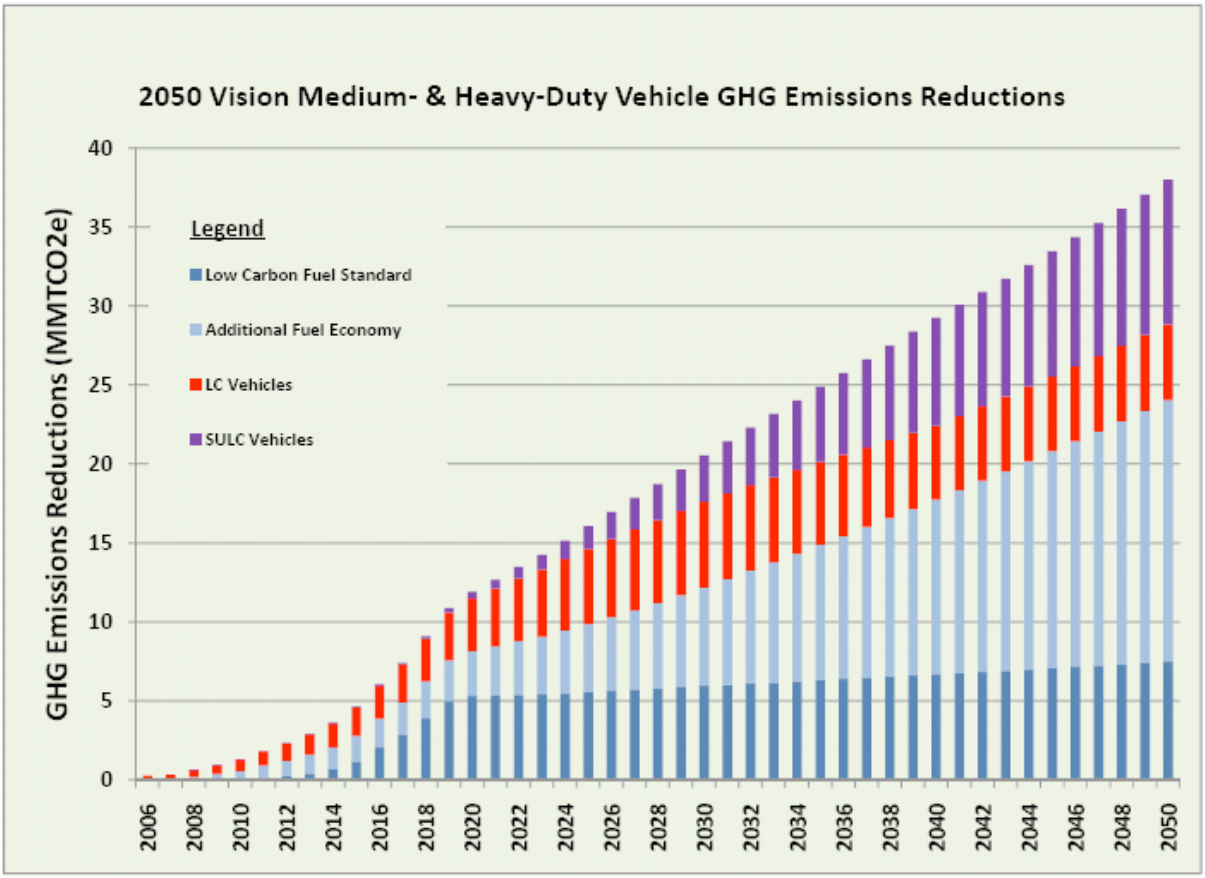
The total GHG reduction from medium- and heavy-duty vehicles is developed by summing GHG reductions for all categories over the 2009 to 2020 period, and then specific percentages of the total are derived for each category eligible for program funding.

The initial GHG emission reduction scenario was "unconstrained" in that projections had no limitations for cost, fuel supply, or biomass feedstock availability placed upon them, even though the updated fuel and technology market information is influenced by costs and considers barriers to market penetration. Still, these fuels and vehicle technologies were evaluated independently and do not reflect interactions in a competitive marketplace. The

[5] The full Medium- and Heavy-Duty Vehicle Analysis is in Appendix B.

Energy Commission used a simple accounting method to calculate the estimated emission reductions over a 42-year period for the medium- and heavy-duty vehicles and fuels based on market information develop in the preparation of the AB 1007 *State Alternative Fuels Plan*. The final GHG emission reduction scenario used in this evaluation assumed the moderate market development penetration estimates of the emerging fuels and vehicle technologies in the four categories.

Figure 3. Estimated GHG Reductions From Each Of The Four Categories



Source: California Energy Commission

Medium- and Heavy-Duty Vehicle Analysis Conclusions

The medium- and heavy-duty results displayed in the table below reflect the initial evaluation of GHG emission reductions from the three categories needed to meet the state's climate change requirements and goals for 2020 and 2050, respectively. As with the preceding LDV analysis, the ARB's Low-Carbon Fuel Standard was excluded from the final results because projects contributing to the attainment of the LCFS are not eligible for funding under the AB 118 program. The results of the analysis conclude the following percentages to meet the AB 32 GHG emission reduction requirement for each of the three categories.

Table 2. Medium- and Heavy-Duty GHG Emissions Reductions (2009 to 2020)

Category	GHG Emission Reduction ($MMTCO_2e$)	Percent GHG Emission Reduction
Low Carbon Vehicles	22	53%
Super Ultra Low Carbon Vehicles	1	2%
Fuel Economy Improvements	19	45%
Total Reductions	42	100%

Source: California Energy Commission

Combined Results -- Light-, Medium-, and Heavy-Duty Vehicles

Staff determined final, overall percentages by combining the light-duty vehicle GHG emissions reductions with those from the analysis of medium- and heavy-duty vehicles. The final GHG emission reduction percentages for meeting the AB 32 GHG emission reduction requirement by 2020, for the designated categories, are displayed below:

Table 3. Summary of GHG Emissions Reductions (2009 to 2020)

Category	GHG Emission Reduction ($MMTCO_2e$)	Percent GHG Emission Reduction
Super Ultra Low Carbon	12	**16%**
Ultra Low Carbon	9	**12%**
Low Carbon	25	**33%**
Fuel Economy Improvements	29	**39%**
Total	75	**100%**

Source: California Energy Commission

The percentages of GHG emission reductions resulting from this analysis will serve as a benchmark to help guide the Energy Commission in allocating available program funds to projects that will help the state attain its climate change requirement for 2020, and assure the proper trajectory for fuels and vehicle technology development to achieve the 2050 GHG reduction goals. The Energy Commission will exercise its judgment in allocating funds among these categories and between these categories and non-greenhouse gas categories.

Gap Analysis

The "gap analysis" [6] identifies areas where funding for advanced vehicle technologies and alternative and renewable fuels is either adequate or lacking, along the development pathway to commercialization and deployment to fleets and individual consumers. To make the most of program funding, the Energy Commission must assess what investments are already being made to develop new fuels and vehicles and prevent duplication of effort by identifying funding gaps.

The gap analysis shows that overall funding from all sources -- federal, state, and private -- for alternative fuels and drive trains totals about $35 billion per year. The most well-funded fuel category by far from all sources, individually and collectively, is biofuels, with most of the funding going to incentives and commercialization.

Expenditures for research and development from private sources (venture capitalists and others) total about $3.7 billion per year, with an additional $7.1 billion per year funded by the federal government. Biofuels also leads in this category and is seen as essential for the nation to achieve its Renewable Fuels Standard regulations. Public and private R&D for fuel cells and battery electric vehicles (including battery development) also seem to be adequately funded, and funding from the Program for these areas is unneeded and unlikely. However, little or no R&D funding is currently allocated to natural gas or propane, and while vehicle and fuel incentives do exist, they are largely unsubscribed due to the lack of available vehicle offerings.

The limited amount of federal funding for alternative and renewable fuels has been focused on three primary areas: next generation biofuels processes and pilot-plant construction; energy storage; and plug-in hybrid electric vehicles. Outside of the Federal Transit Administration's fuel cell bus program, federal investment in hydrogen has effectively stopped.

As a necessary part of understanding the "funding gaps" for the fuels and vehicle technologies eligible for funding, the Energy Commission has examined three recent and current incentive programs in addressing development and commercialization needs -- ARB's Alternative Fuel Incentive Program (AFIP), Energy Commission's Public Interest Energy Research (PIER) Transportation Program, and ARB's Air Quality Improvement Program (AQIP).[7]

Based on the current funding landscape and the status of the alternative and renewable fuels and advanced vehicle technologies, staff offers the following observations:

Low Carbon Fuels

Biodiesel and Renewable Diesel Fuel Blends: Biodiesel and renewable diesel fuels will be produced as 100 percent biofuels, which fall into the ultra-low-carbon category. Biodiesel and renewable diesel fuels will be blended with ultra-low-sulfur diesel fuels (typically at 5 percent to 20 percent levels) and use of these blends required no change in vehicles. These blended fuels fall into the low-carbon fuel category and they support early compliance to the low-carbon fuel standard. A strategic need for storage and blending facilities has been identified to improve the logistics of bringing biodiesel and renewable diesel fuels into a broader commercial market.

Natural Gas and Propane: Natural gas (methane) has been used as motor fuel in California for more than 20 years. Its use has experienced expansion in the transit sector, some package and beverage delivery applications, as well as limited trash truck and port applications. The natural gas fuel infrastructure is gradually expanding as a result of fleet rules in several California air basins, market-leader fleets, and the persistence of infrastructure developers. However, as opportunities expand to increase motor fuel natural gas use, vehicle availability is declining because fewer manufacturers are producing natural gas vehicles.

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[6] The Full Gap Analysis appears in Appendix C.

[7] Discussion of these three programs appears in Appendix D.

In the early 1980s, propane was the leading alternative fuel in California; more than 200,000 propane vehicles operating in the state. Despite its availability, less costly infrastructure, and price competitiveness, propane fuel has decline in its use and an attrition of the market to negligible levels in 2007 as vehicle availability declined. Nevertheless, propane continues to be an attractive motor fuel for medium-duty vehicle fleets in California.

Natural gas and propane receive the lowest investments today because very few vehicle products, by original engine manufacturers (OEM) or fuel system up-fitters[8] are being offered to the marketplace. Only Honda produces a compressed natural gas (CNG) light-duty vehicle, and no OEMs provide propane vehicles for the light-duty market. For medium-duty applications, only one OEM, Bluebird, produces an ARB-certified vehicle. Baytech provides a ARB-certified propane system that can be upfitted into certain vehicles. For heavy-duty applications, only two engine manufacturers -- Cummins Westport and Kenworth (using Westport technology) -- are providing natural gas engines.

A major market-entry issue, therefore, facing natural gas and propane fuels is product availability for the light-, medium- and heavy-duty vehicle markets. Both fuels have limited incentives for vehicle purchases, and a $0.50–per-gasoline-gallon equivalent fuel use tax credit. While these incentives encourage the use of these fuels, they are not used at the same level as biofuels due to the much lower number of vehicles existing and available for purchase. Program funding could be used to help bring more products to market by providing continued, sufficient levels of incentives for the purchase of OEM and upfitted vehicles for individuals and fleets.

Another major focus should be existing fuel and vehicle "assets" in which the state and private businesses have invested in the past. The existing alternative fuels infrastructure for natural gas and propane can be supported immediately to renovate, refurbish, and increase fuel capacity and throughput, and to "protect our past investments." Many institutions such as clean cities coalitions, community colleges, education centers, local area governments, transportation management authorities, cities, counties, air pollution control districts, and other special districts have been active in advancing early natural gas and propane infrastructure and vehicles. Investment in existing fueling infrastructure, new fueling sites, and in "human capital" assets meet an immediate need, and will pay dividends through the near-, mid- and long-term of the transition to low-carbon fuels and advanced vehicle technologies.

AFIP -- The natural gas and propane vehicle incentives offered by the ARB were oversubscribed, having received requests for twice the available funding amount. Fueling station incentives were also oversubscribed by three times the available funds.

PIER -- The Energy Commission support of low-pressure gaseous fuel storage tanks may provide future opportunities for demonstration and commercialization.

AQIP – Based on its November 2008 public workshops, ARB staff is not proposing to provide incentives for natural gas and propane vehicles with its FY 2009-10 AQIP funding and the AB 118 statutes does not authorize ARB to fund fueling infrastructure as part of AQIP.

Based on this information, the Energy Commission sees a need for program funding to support the following objectives:

- Provide financial incentives for the purchase of light-, medium-, and heavy-duty natural gas vehicles and light- and medium-duty propane vehicles. These incentives will be available for OEM and upfitted vehicles and will be coordinated with ARB in the implementation of the Heavy-Duty Vehicle Air Quality Loan Program and with ARB and air districts in the implementation of the Lower Emission School Bus Program. The funding also will be coordinated with the implementation of Proposition 1B funds and

[8] Upfitter refers to companies that install an alternative fuel system on an existing vehicle and differs from the OEM producing a vehicle with the alternative fuel system at its initial production.

air district programs to replace older diesel trucks at the Ports of Long Beach and Los Angeles and throughout the entire California goods movement sector, particularly where existing goods movement affects environmental justice communities.

- Support the development of advanced medium- and heavy-duty natural gas and propane engines, and fueling and fuel storage technologies.
- Install new and retrofit natural gas and propane fueling infrastructure and dispensing systems for the state fleet, other public and private fleets, and retail outlets. These incentives should be provided for projects in proximity to existing natural gas and propane vehicle populations.

Ultra Low Carbon Fuels

Biofuels: Biofuels are derived from biological materials, as opposed to fossil fuel feedstock. Several types of biofuels are being produced from a wide range of biomass materials and through a variety of conversion processes or pathways. The primary biofuels that are commercially produced today are ethanol, made from sugars and starches, and biodiesel produced from animal fats or vegetable oils.

Corn ethanol is widely used in California in today's 5.7 percent blended gasoline. In June 2007, ARB revised its reformulated gasoline regulations to make it more feasible and likely that up to 10 percent ethanol will be blended with gasoline. If all gasoline were to be blended with 10 percent ethanol (E-10), California will see an increased use of ethanol from 900 million gallons today to approximately 1.5 billion gallons by 2012.

Increasing California ethanol use beyond the 10 percent blend levels will require widespread use of flexible fuel vehicles (FFV) running on 85 percent ethanol blended gasoline (E-85) along with the necessary E-85 distribution infrastructure (stations). Further, the development of advanced gasoline biofuels blending components could allow system wide blends beyond 10 percent.

Virtually all of the ethanol currently used in California is imported from out of state. Near-term ethanol supplies will continue to be produced from imported Midwest corn, while in-state production will feature both waste stream sources and purpose-grown energy crops, such as switch grasses and sugar cane in the Imperial Valley. Relying on biomass residues from agricultural, forestry, and urban sources should be optimized, given the large volume of California's untapped biomass resources.

Renewable diesel and biodiesel fuels are produced from a broad range of feedstock options, including animal waste, soy beans, vegetable oils, wood wastes, animal fats, and protein. Renewable diesel and biodiesel contain no petroleum but are typically blended with conventional diesel fuel. Recently, the American Society of Testing and Materials (ASTM) revised their standard for diesel fuel to include B5 (a blend of 5 percent biodiesel and 95 percent conventional diesel). The ASTM also recently adopted a new B20 fuel standard. This essentially allows the use of B20 in diesel engines with no major modifications. The U.S. Navy and Marine Corps use B20 in their non-tactical diesel vehicles and account for approximately one-third to one-half of all biodiesel purchases in California. California currently consumes about 42 million gallons of biodiesel fuel, most of which is imported. This is expected to increase significantly under the LCFS.

Biomethane, another potential biofuels, is being produced from animal manure at dairies in California's Central Valley as a methane fuel (natural gas) for electricity generation. Capturing methane from dairy farms is an important GHG reduction strategy, especially since methane has 23 times more global warming potential than CO_2. Biomethane can also be used as a feedstock for ethanol and hydrogen production.

Methane gas emitted from landfills represents another significant biofuel resource. While methane gas from some landfills is being used to generate electricity, most landfills are still flaring the gas. This gas could be used to fuel the hundreds of trucks coming and going fro a given site each day. The technology exists to convert landfill gas to a transportation fuel.

Program funds could provide incentives to turn a significant number of landfills into fuel production facilities.

Considerable investment is already being made by the private sector in fuel production and the federal government in tax incentives, especially for Generation I biofuels (for example, starch-based ethanol). R&D investments by the federal government and the private sector for Generation II biofuels (cellulosic ethanol and other low-GHG biofuels) in support of the Renewable Fuel Standard appear to be adequate, and it is not clear that additional state funding will accelerate commercialization.

A key policy objective is to produce low GHG biofuels to achieve the state's bioenergy goals. In 2006, the Energy Commission adopted the *Bioenergy Action Plan* to:

- Maximize the contributions of bioenergy toward achieving the state's petroleum, climate change, renewable energy, and environmental goals.
- Establish California as a market leader in technology innovation, sustainable biomass development, and market development for bio-based products.
- Coordinate research, development, demonstration, and commercialization efforts across federal and state agencies.
- Align existing regulatory requirements to encourage production and use of California's biomass resources.

Governor's Executive Order S-06-06 set in-state biofuel production targets of a minimum of 20 percent of biofuels used in California by 2010, 40 percent by 2020, and 75 percent by 2050; and charged the Energy Commission, along with other commissions and departments, to identify and secure funding for research, development, and demonstration projects to advance the use of biofuels for transportation. However, very little funding is available for California-based, low-GHG biofuels production. Funding is also lacking for the cost-shared support of biofuel distribution and retail and fleet infrastructure that will be needed to expand the high-blend biofuel market, particularly E-85, for the approximately 400,000 fuel flexible vehicles now operating in the state.

AFIP – ARB funded four biomethane demonstrations and six biodiesel start-up facilities. All fuel production projects were greatly oversubscribed, and it is evident that more statewide E-85 infrastructure funding is needed beyond the 27 funded in the greater Sacramento region.

PIER -- Coordinated biofuels research and demonstration-to-commercialization will be necessary to foster the production of ultra-low-carbon biofuels, and to assure the lowest possible GHG, energy, and environmental profile of the production facilities and the fuels produced.

AQIP – The AB118 statute does not authorize ARB to fund alternative and renewable fuel production facilities or infrastructure as part of AQIP .

Based on this information, the Energy Commission sees a need for program funding to support the following objectives:

- Facilitate the transition of existing ethanol production facilities in California from imported corn to lower-carbon California biomass feed stocks (including waste residues and purpose-grown crops).
- Develop new in-state facilities that produce lower-carbon biofuels from biomass and waste feedstocks.
- Stimulate the development of biomethane/biogas production for use as a transportation fuel.
- Expand the installation of E-85 stations based on the geographic distribution of fuel flexible vehicles capable of operating on E-85.

- Develop fuel blending terminals for renewable diesel and biodiesel fuels in Northern and Southern California.

Super-Ultra-Low-Carbon Fuels

Hydrogen and Fuel Cells: Federal and state governments have made substantial investments in R&D for this technology with the hope that the vehicles will be accepted in the marketplace. These zero-tailpipe emissions vehicles will provide significant GHG and petroleum reductions when substantial numbers of vehicles are deployed. Through 2007, OEMs have operated more than 250 vehicles that have driven more than 2 million miles. These vehicles fuel at 25 hydrogen stations built and operated by industry and government. Some first generation fuel cell vehicles have shown 1,700 hours of durability, indicating significant progress toward meeting the 2009 Department of Energy goal of 2,000 hours. Bench-scale durability has already exceeded DOE's 2015 goals. Current vehicles are close to meeting DOE's 2015 range target of 300 miles.

DOE has provided $1.2 billion sine 2004 under the Hydrogen Fuel Initiative. Funds have been allocated for R&D of fuel cells and hydrogen, including fuel cell stacks, hydrogen storage and production, safety codes and standards, manufacturing systems analysis and technology validation. DOE has provided funding for a number of the vehicles and fueling stations in California.

Automakers are at the verge of introducing a limited number of vehicles, but fuel infrastructure will be needed to support them. At these limited vehicle volumes the infrastructure investments will not be economical, and therefore public funding is necessary. In addition, Senate Bill (SB) 1505 (Lowenthal, Chapter 877, Statutes of 2006) requires, among other things, that, on a statewide basis, no less than 33.3 percent of the hydrogen produced for, or dispensed by, fueling stations that receive state funds be made from eligible renewable energy resources.

Thus far, the Hydrogen Highway[9] has provided the most recent funding for hydrogen infrastructure. Program funding could be used to establish fueling stations in limited areas where vehicles are likely to be demonstrated and sold, and where needs of multiple users can be met with one location.

AFIP – ARB provided funding for two projects to demonstrate hydrogen fuel cell buses.

AQIP – Based on its November 2008 public workshops, ARB staff is proposing funding consumer incentives for the purchase of zero-emission light-duty vehicles (including fuel cell vehicles) and is considering funding demonstration of fuel cell buses and fuel cell forklifts with its FY 2009-10 AQIP funding. However, the AB118 statute does not authorize ARB to fund fueling infrastructure as part of AQIP.

Based on this information, the Energy Commission sees a need for program funding to support the following objectives:

- Support implementation of high-volume fleet and retail hydrogen fueling stations strategically located to serve early market vehicles.
- Promote mixed-use hydrogen fuel infrastructure to support transit fuel cell buses, possible hydrogen/compressed natural gas blending for transit buses, light-duty vehicle fleets, and other applications (such as forklifts).

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[9] The California Hydrogen Highway Network, administrated by the California Air Resources Board, is an initiative to establish hydrogen infrastructure to support commercialization of sustainable, zero, and near-zero emission hydrogen vehicles. Since 2005, the California Hydrogen Highway has been appropriated $24.033 million to fund the state's share of various activities related to hydrogen vehicles and infrastructure.

- Support projects that demonstrate low-cost production of hydrogen from renewable feed stocks, develop reduced-pressure, low-cost tank designs for fueling station storage, and evaluate the use of fuel cells in niche applications such as truck stop electrification systems.

Plug-In Hybrids and Battery Electric Vehicles: Electricity is used in various segments that are collectively called "electric drive applications." These include battery electric vehicles (that is, on-road and off-road vehicles, such as electric forklifts and airport ground support equipment), plug-in hybrid electric vehicles (PHEV), electric truck refrigeration units, truck stop electrification, and ship cold ironing. The latter two applications refer to the use of electricity from the grid to eliminate truck idling at truck stops and ships in port using their main or auxiliary internal combustion diesel engines.

Although most of the on-road electric drive technologies require high capital cost investments in the near-term (through 2012), anticipated technology improvements, scale economies, and state incentives will reduce the associated incremental costs and improve the economic performance of these vehicles. Light-duty PHEVs are anticipated to achieve attractive economic performance earlier than pure battery electric vehicles (EVs) and heavy-duty PHEVs. Moreover, the success of other alternative fuels could be enhanced by integration with PHEV technology. A number of off-road electrification applications are already cost-competitive.

Considerable investments are being made in R&D for battery technologies for these vehicles, but substantial work is necessary to "prove" these vehicles to consumers. Some of the important commercialization efforts center on the following questions: Will "smart meters"[10] be necessary to encourage night charging? What will their impact be on the electric grid? Will the vehicle designs incorporate large enough batteries to gain the GHG benefits of California's clean grid? Currently, funding levels are inadequate for the planned large-scale demonstrations of varying vehicle types and designs that will be needed to "prepare the market" and better understand their impacts and value proposition in a carbon-constrained world.

Further, the electric drive sector includes a nascent retrofit and conversion market. The former includes the retrofit of a conventional hybrid to a PHEV. The latter involves the complete replacement of a gasoline or diesel engine with an all electric drive system. While there are quality control, warranty, performance, and reliability issues associated with retrofits and conversions, they do offer a means of tapping into the significant population of existing vehicles to achieve substantially greater GHG reductions.

AFIP -- The initial vehicle incentives offered by ARB for PHEVs and BEVs were very oversubscribed, nearly 10 times the amount offered, resulting in funding redirection to natural gas vehicle incentives and research and demonstration activities.

PIER -- The PHEV Research Center at UC Davis-ITS will continue to serve as an important "Center of Excellence" and a useful conduit for learning, demonstration, possible vehicle incentives, and focused infrastructure planning and establishment.

AQIP – Based on its November 2008 public workshops, ARB staff is proposing funding consumer incentives for incentives for the purchase of new PHEV light-duty vehicles with its FY 2009-10 AQIP funding. However, the AB118 statute does not authorize ARB to fund charging infrastructure as part of AQIP.

Based on this information, the Energy Commission sees a need for program funding to support the following objectives:

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[10] "Smart meters" refers to the advanced meters now in limited demonstration by Pacific Gas & Electric (PG&E) that allow customers utility interaction to manage time of high energy use and real time automated meter reading.

- Support the pre-commercial, demonstration and deployment of electric-drive technologies for light-, medium-, and heavy-duty applications. This funding would be coordinated with that proposed through ARB's AQIP to help ensure that adequate funding is available for incentives to purchase new PHEVs and BEVs.
- Support upfit, retrofit, and conversion applications for PHEV and BEV light-, medium-, and heavy-duty vehicles.
- Support public access electric charging infrastructure and early adopter incentives for home and private fleet charging.
- Support non-road demonstrations and deployment incentives including truck-stop electrification, truck refrigeration and auxiliary power units, port cold ironing, forklifts and harbor craft, etc.

Improved Vehicle Efficiency

Improving vehicle efficiency is funded mostly by the automakers and engine manufacturers as part of their normal product improvement, although both receive public funding as well. Proposed Corporate Average Fuel Economy standards (CAFE) – the "miles-per-gallon" fuel economy average that automakers must attain across all their produced vehicles – will require the automakers to invest heavily in advanced and conventional technologies to improve fuel economy. Further, to meet the 2020 and 2050 GHG targets, light-duty vehicles will ultimately need to exceed even the CAFE standards. This will require greater collaboration between the OEMs and federal and state R&D programs.

Considerable potential exists to improve the efficiency of medium- and heavy-duty vehicles through the application of hybrid electric and hydraulic hybrid technologies. Presently, a large number of US-based manufacturing companies are developing hybrid electric and hydraulic hybrid technologies that cut GHG emissions and diesel use by 20 to 50 percent. The primary obstacle facing this industry is high purchase costs resulting from low sales and production volumes. There are less than 600 commercial hybrid trucks on the road today.

AQIP -- Based on its November 2008 public workshops, ARB staff is proposing incentives for new medium- and heavy-duty diesel hybrid vehicles with its FY 2009-10 AQIP funding, but does not propose funding for alternative and renewable fuel hybrids or retrofits of existing vehicles with hybrid technology.

Based on this information, the Energy Commission sees a need for program funding to support the following objectives:

- Develop and demonstrate new light-duty engine design and vehicle component efficiency improvements.
- Develop and demonstrate medium- and heavy-duty hybrid technology with diesel engines and alternative and renewable fuel engines. This funding would focus on pre-production research and development for the next generation hybrid systems. These funds also would be coordinated with ARB's AQIP to help ensure that adequate funding is available for incentives to purchase new hybrid trucks.

Non-Greenhouse Gas Categories

Additional categories for funding are specifically mentioned in the statute and, while not directly associated with GHG or other climate change emission reductions, are important to the success of the program. These categories are workforce training, sustainability studies, standards and certification, public education, and outreach, and program analytical support.

Workforce Training

The transition to a diversified, low-carbon transportation fuels market can only be sustained in the long-term by a well-trained work force that can design, construct, install, operate, service and maintain new fueling infrastructure and vehicles. California's Economic Strategy Panel estimates that private investment into more advanced, cleaner transportation technologies grew from 2005 to 2007 by 1218 percent alone, with venture capital investment increasing from $23 million to $308 million in just two years. A systematic approach is needed that includes input from government, industry, and education to achieve a sustainable program capable of adapting to future industry needs.

California, as of October 2008, has the third highest rate of unemployment behind Michigan and Rode Island according to the U.S. Department of Labor. Workforce development offers California a unique opportunity to develop training programs designed to lead to long-term employment in a new emerging low-carbon fuels market. These programs must provide education and training for people who want to (re)enter the workforce, or advance in their current career paths. It must also be cognizant of and responsive to the needs of an industry in change striving to form commitments and partnerships from our environmental community, labor unions, private sector industries, workforce development programs, primary and secondary education systems and government. California must stimulate green economic growth, increase job opportunities in this emerging market, and build a green low-carbon economy to fight global warming.

In the coming years, the Obama administration will be implementing an economic recovery plan. The Center for American Progress (CAP) has developed a Green Recovery[11] plan, which aims to leverage $100 billion in funding to create nearly 2 million green jobs over the next two years in the following sectors: building retrofitting, smart grid, wind power, solar power, advanced biofuels, and mass transit/freight rail. Ultimately, the plan is expected to lead to the creation of as many as 5 million green jobs. The potential for a large workforce in California in green jobs is realized in this assessment, with an anticipated $12.7 billion of the $100 billion estimated to be allocated to California alone.

In response to national efforts, new legislation, AB 3018 (Nunez, Chapter 312, Statutes of 2008), established the California's Green Workforce Council, a collaborative effort amongst state agencies to address the growing need for green jobs in California. The Green Workforce Council is comprised of representative from agencies such as the California Air Resources Board, Employment Development Department, and Employment Training Panel, California Workforce Investment Board, California Public Utilities Commission, the California Department of Education, the Department of Corrections, and several others. By working with one another, state agencies will be able to address multiple issues associated with workforce development, which includes providing funding for training facilities and faculty training, as well as program expansion to meet industry needs.

The Green Workforce council will play an important role in deciding where funding is needed and how AB118 can be leveraged to create jobs that are needed in the transportation sector. The California Workforce Investment Board has been appropriated $2 million specifically for the development of green collar jobs, focusing primarily on "high wage high growth" jobs, and creating easier accessibility to jobs for special populations, such as prisoners re-entering the workforce and underserved communities. The Department of Labor has also funded an initiative that will focus on creating jobs in the renewable energy sector.

Workforce development also will provide an opportunity to reach out to low income and underserved communities. These communities will benefit greatly from the increased efforts and funding going into workforce development in California, as many jobs in this sector can provide

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[11] Pollin, R.; Garrett-Peltier, H.; Heintz,J.; Schraber, H., *Green Recovery: A Program to Create Good Jobs and Start Building a Low-Carbon Economy,* September 2008.

pathways to successful and stable long-term careers. There are several career pathways that require two year degrees, while some certification programs can be completed in months, which can prove to be beneficial to people reentering the workforce, or wanting to advance in their current careers. The Advanced Transportation, Technology and Energy (ATTE) already offer programs throughout the state of California that emphasize work in vehicle technologies and alternative energy, such as hybrid vehicle maintenance, Intelligent Transportation Systems, and wind and solar power generation.

Based on this information, the Energy Commission sees a need for program funding to support the following objectives:

- Support proposals that expand existing successful programs, target unemployed or displaced workers, or complement efforts[12] of agencies such as the California Public Utilities Commission, the Employment Development Department, or local Workforce Investment Boards. Particular favor will be placed on projects directly benefitting communities in need, for example, a workforce training program targeting areas with high unemployment rates or poor air quality may receive greater priority.
- Coordinate with employers, employer groups, and equipment and vehicle manufacturers to identify the labor market demands and quantify job openings, internships, and apprenticeships.

Sustainability Studies

Improving the sustainability of the transportation system has emerged as the foremost issue, and therefore is the foremost need for ongoing analysis and evaluation as society transitions to new fuel sources and vehicle technologies. Since fuels and vehicle systems must offer improvement over the conventional fuel and vehicle baselines, ongoing analysis of these improvements is essential.

The Energy Commission is developing a comprehensive framework that integrates sustainability into all aspects of the program. Crafting this integrated framework will develop a process to identify and promote transportation-related GHG reduction projects that can serve as national and international examples for sustainable production and superior environmental performance. An important objective for the program is to support the development of an in-state bioenergy industry and to ensure its environmental sustainability from the start. The primary focus of the Energy Commission's initial sustainability framework has been the in-state production of bioenergy crops and biomass resources. The Energy Commission is working cooperatively with California producers, growers, sister agencies, and expert institutions such as the University of California to create new standards and processes for in-state bio-energy production.

Sustainability will also be crucial in the consideration of out-of-state biofuel production such as Midwest corn, palm oil from Southeast Asia, and sugar cane from Brazil. The Energy Commission is working to create incentives that can improve grower, harvest, and production practices, minimize use of natural resources, minimize environmental damage, and maximize production of low-carbon fuels. The incentives provided through the program are intended to create model practices that may be of interest to other parts of North America and the world.

For national-level issues, the Energy Commission is tracking the sustainability work from the federal working group of agencies: U.S. Environmental Protection Agency, U.S .Department of

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[12] Governor Schwarzenegger announced new workforce training funding for the Employment Training Panel ($28.7 million) and Workforce Investment Act ($12 million), which is available through the Labor and Workforce Development Agency.

Agriculture, and the U.S. Department of Energy. The Energy Commission is also evaluating the sustainability goals and definitions in federal legislation such as the 2007 Energy Independence and Security Act, most notably the Renewable Fuel Standard.

For internationally produced biofuel feedstocks, staff is assessing the major international initiatives and sustainable certification programs that are in development. The Energy Commission is working with the California Air Resources Board and other stakeholders to determine how to evaluate international certification programs to determine if they might meet California's goals and standards for sustainable production.

Looking beyond the sustainability of biomass-related fuels, sustainability can be applied to nearly every aspect of alternative fuel production and low-carbon vehicle technology. Again, sustainability compels California to look beyond the current regulatory standards and status quo manufacturing processes to identify production methods and consumption patterns that reduce the total environmental footprint of the transportation sector. Sustainability should also be considered and applied to other alternative fuels and vehicle technologies, such as use of electricity, batteries (as storage), and natural gas as vehicle fuels, improved environmental performance of vehicle manufacturing, construction and deconstruction processes.

Based on this information, the Energy Commission sees a need for program funding to support the following objectives:

- Development of best management practices for purpose-grown energy crops, crops, or forest biomass; development of quantified environmental indicators that could be used in establishing numeric sustainability standards, evaluation, or auditing of international sustainability certification programs; technical support for applicants who need assistance compiling sustainability data as part of their grant applications; and ongoing technical research to effectively integrate environmental data from program-funded projects into the California Greenhouse Gases, Regulated Emissions, and Energy use in Transportation (GREET) [13] model.

Standards and Certification

It is essential that California uphold and improve upon its existing environmental standards as new alternative and renewable fuels and advanced vehicle technologies are demonstrated and deployed. These new fuels and advanced vehicle technologies will require standards and certifications to be researched and adopted for the fuels and vehicles themselves, equipment, engines, fuel storage, and fleet and retail dispensing systems. Once these standards and certifications are established, methods and protocols will be determined for responsible state and local agencies to use as they assure compliance and enforcement, while assuring straightforward, reasonable and timely certification and approval processes. Examples of such needed support include the efforts of the California Department of Food and Agriculture, Division of Measurement Standards (DMS) for the "type approved" retail hydrogen dispenser, and the efforts of the State Water Resources Control Board (SWRCB) to certify and approve liquid alternative fuel storage in Underground Storage Tanks (USTs).

The mission of DMS is to assure consumer confidence in conventional and alternative fuels for retail and commercial fuel dispensing. Presently there is no approved commercial or retail hydrogen dispenser for fueling vehicles, meaning that hydrogen cannot be sold in California on a retail per unit basis. It is essential similar to what was done for natural gas fueling systems dispensers nearly fifteen years ago. Typically, DMS is the lead agency (with ARB) for the development of fuel quality standards and commercial fuel measurement standards. Support

[13] The GREET model was developed by Argonne National Laboratory and sponsored by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy.

for DMS may include the cost-shared purchase of laboratory equipment to test pressure, volume, quality and temperature of fuel dispensing into vehicles.

The mission of the SWRCB is to promote consumer confidence in conventional and alternative fuels by certifying the fuel stored is not contaminated or out of compliance with the established ASTM fuel specification. In this regard, the SWRCB certifies that the alternative fuel is as labeled; B5, B20, E-85; and certifies that the fuels, or fuels with additives, meet established standards for aquatic toxicity. In addition, the SWRCB mission is to reduce the risk of an unauthorized release of fuel to the environment by ensuring that the fuels stored are the same fuels tested by UL for material compatibility (the fuels stored meet ASTM specification), and the UST does not exhibit indications of material incompatibility (corrosion and products of elastomer degradation). Support of the SWRCB, and their affiliated local agencies, would include areas of testing and analysis that are not presently funded by UST fees paid for conventional (petroleum) fuel storage and dispensing systems.

Based on this information, the Energy Commission sees a need for program funding to support the following objectives:

- Support state agency programs in the development of the standards and the technical evaluation for the reasonable and timely certification of the fuels and vehicles. Cost-sharing these efforts and capabilities will help to 'ready the market' and help the state achieve its environmental, energy and economic goals more efficiently.

Public Education and Outreach

As with other program areas, the Energy Commission will leverage efforts and program funds by working with other public and private organizations, with similar outreach objectives to promote cleaner alternative fuels and advanced vehicle technologies. The Energy Commission describes some of the notable education and outreach efforts below to frame the array of opportunities that exist with public and private programs.

The California Air Resources Board has developed the "Drive Clean" campaign which is a resource for car buyers searching for green technology vehicles. An interactive on-line website [www.driveclean.ca.gov] allows consumers to research and find alternative vehicles, related incentives and appropriate fueling stations in their neighborhoods. Starting in 2009, car buyers can check for the "Environmental Performance Label" displayed on new vehicles allowing for comparison of smog and global warming scores.

The goal of the Bureau of Automotive Repairs is to maintain existing vehicles for maximum fuel efficiency. Their website [www.drivehealthy.com] helps consumers find smog testing stations and repair facilities. Consumers can also download applications for cash incentives in exchange for retiring aging polluters. Additionally, compelling reasons for changing behaviors are outlined in the detailed descriptions of tailpipe emissions such as carbon monoxide, hydrocarbons, and nitrogen oxides.

Private industry can also play a huge role in getting the public's attention. The Progressive Automotive X PRIZE, in collaboration with the U.S. Department of Energy, has developed a national education program with the goal of engaging students and the public in learning about advanced vehicle technologies, energy efficiency, climate change, alternative fuels, and the science and math behind efficient vehicle development. The Energy Commission is interested in supporting projects that develop and implement curriculums for the K-12 levels. These curriculums can create an awareness that will inspire and guide students toward advanced education and career choices necessary to sustain the emerging technologies. Combined with their education efforts, the Progressive Automotive X PRIZE will offer a multi-million dollar

prize for teams which can best engineer a clean, production-ready vehicle. A project of the X PRIZE Foundation, the competition expects to reach millions of people nationwide and globally.

The *Teaching Green Alt Fuel Roadshow* is one program example that offers consumers an opportunity to learn about the AB 118 program and alternative fuel vehicle offerings available in their region. The *Teaching Green Alt Fuel Roadshow* is a consumer education and outreach program in the South Bay that will highlight the attributes, costs, performance, availability, and fueling station locations for the various alternative fuels and vehicles. Recognizing that new vehicle technologies will be deployed in Southern California, this program offers focused, regional outreach to those among the first to have the opportunity to purchase these new technologies.

These Energy Commission plans to develop a communication plan during the first year of the program. The plan will provide a comprehensive look at the messages and media the Energy Commission will use to reach target audiences in the most effective manner. During the second year of the program, the Energy Commission will seek proposals to implement the communication plan and develop a comprehensive education, outreach, and marketing campaign for the program.

Based on this information, the Energy Commission sees a need for program funding to support the following objectives:

- Support proposals that expand and leverage other state outreach and education efforts with shared objectives, provide comprehensive consumer outreach in areas that are targeted for vehicle deployment, develop and implement K-12 curriculum, and maximize program exposure through national and statewide outreach campaigns.
- Support proposals to implement the communication plan and outreach campaign developed during the first year of the program.

Program Analytical Support

The program is comprehensive undertaking that requires the Energy Commission to periodically update and re-assess key operational aspects.

The Energy Commission has begun updating the California-modified GREET model first used jointly with ARB in the preparation of the *State Alternative Fuels Plan*. The model is now being used ARB in developing the Low-Carbon Fuel Standard (LCFS). The CA-GREET model will play a critical role in the program in that the Energy Commission is required to base its funding decisions of the full fuel cycle implications of alternative and renewable and vehicle options. This area of analysis is a rapidly evolving science, and the CA-GREET model must keep pace with developments in this area consistently. The Energy Commission and ARB staffs are carefully coordinating the continuation modification and use of the CA-GREET model as the key tool to be used as the foundation for both the LCFS and the respective AB 118 programs to be administered by each agency.

The Energy Commission also needs to periodically prepare a revise market assessment. Prior market assessments were prepared in 2001, 2003, and 2006. A market assessment is essential to establish a baseline of alternative and renewable fuel development and use in California, to identify the existing vehicles, users, and fueling locations and throughput, and to understand the advances in fuel and vehicle technologies. The market assessment is important also in defining the market potential for alternative and renewable fuels, establishing strategic alliances, and developing funding opportunities. This work is critical to develop current data regarding the continually evolving status of alternative and renewable fuels and vehicle technologies to ensure that our market analyses and forecasts are based on the most current and credible data

available. The analyses provide an important basis in developing the priorities and opportunities for the Investment Plan.

Since the program uses incentives to drive the markets for fuels and new technology, the Energy Commission must evaluate efficacy of various incentive mechanisms. Specifically, is a financial incentive necessary and is the funding level sufficient? It is also important to determine the most "capital-efficient" method to encourage a particular application. For example, grants may not be suitable for capital improvements for a business but much more suitable for rebating the differential cost of a fleet or individual consumer purchasing of an alternative fuel vehicle or more efficient model. Evaluating the incentives based on their likely application is essential to make the incentive more valuable to the user and potentially more cost-effective for the state.

Lastly, statute requires the Energy Commission to include in the 2011 Integrated Energy Policy Report, and in the subsequent reports adopted thereafter, an evaluation of research, development, and deployment efforts funded through the Program that will include all of the following:

- A list of projects funded
- The expected benefits of the projects in terms of air quality, petroleum use reduction, greenhouse gas emissions reduction, technology advancement, and progress towards achieving these benefits.
- The overall contribution of the funded projects toward promoting a transition to a diverse portfolio of clean, alternative transportation fuels and reduced petroleum dependency in California.
- Key obstacles and challenges to meeting these goals identified through funded projects.
- Recommendations for future actions.

Based on this information, the Energy Commission sees a need for program funding to support the following objectives:

- Support periodic updates to the full fuel cycle assessment methodology and market assessment for alternative and renewable and advanced vehicle technologies, conduct an analysis of incentive mechanisms, develop a methodology and metrics necessary to evaluate the effectiveness of the program.

Proposed Funding Recommendations

The following funding recommendations are based on the relative percentage reduction potential of the fuel and vehicle categories, the gap analysis of the fuel, vehicle and non-GHG categories, and input from the Advisory Committee and other stakeholders. Taking this information into account, the Energy Commission has used its discretion in setting the proposed funding levels for the current year (FY 2008-09) and next year (FY 2009-10).

The proposed funding recommendations are based on percentage allocation for each fuel and vehicle category on the analysis of relative GHG reductions projected from the present to the AB 32 requirement for 2020, with the intent of meeting the 2050 goals. A funding strategy that emphasizes 2020 goals spurs commercial development of market-ready clean fuels and technology, which fulfills 2020 state mandates and maximizes reductions of GHG emissions in the earliest timeframes possible. This would generate additional private investment to accelerate advances in new fuels and technologies and provide time for technology to mature to achieve even greater amounts of GHG emission reductions and achieve the 2050 goals. As a result, this approach would stimulate step-by-step commercial successes that enhance and quicken the transition to greater uses of super-ultra-low and ultra-low fuels and technologies from the low-carbon fuels and technologies sought in 2020 policy objectives. For example, one funding strategy might be to spur a transition from low-sulfur diesel use to 20 percent biodiesel

to renewable sources of diesel blends to hydraulic hybrid electric-diesel vehicles to full electric vehicles over a multi-year period. Each step is initially more costly than the previous step but achieves greater GHG emission reductions. Successes may also lead to parallel development or merging of technologies. The step-by-step sequence would need to reflect the time needed for the fuels and technologies to mature, the ability of manufacturers to produce the products for consumers at an affordable market price, and investors to see a reasonable return on investment.

The recommendations for Program funding will be guided not only by the analysis of relative GHG reductions projected from the present to the AB 32 requirement for 2020, but will be guided by a temporal portfolio approach for investments over the near-term, mid-term and long-term time intervals. Many funding recommendations will focus on the funding needs for immediate vehicle purchase and deployment rebates, and existing fueling station asset refurbishment and establishment of needed new fuel distribution and dispensing infrastructure. These early funding recommendations address the "pent-up" potential for alternative fuels and advanced vehicle technologies that have not been well supported recently, but also offer significant GHG reductions now, in advance and surplus to regulations taking effect. In each funding category it is also important to support mid-term development and commercialization efforts for fuels and vehicle technologies that will be able to provide more GHG reduction in the future, but nevertheless provide some demonstrated reductions and other public benefits, now. In this time-balanced portfolio of investment strategy, support must and will be given to those fuels and vehicle technologies that although not commercially viable now or for some time to come, still hold the promise to provide significant GHG reductions and other public benefits over the long term, if strategically and wisely invested in now. To recommend the wisest and most strategic funding portfolio over time, it will be essential that this Program be consistently engaged and informed for the key trends, developments, and fuel and technology breakthroughs that will occur over the next decade and beyond.

Some of the funding recommendations can be accomplished cooperatively with federal, state and other public agencies and partners by using memorandums of understanding (MOU), interagency agreements, and other collaborative mechanisms that can meet each entity's objectives and shared goals. These partnerships, many of which will be cost-shared and jointly directed, provide a cost-efficient means to achieve the program's desired goals and opportunities.

The Energy Commission will use its best judgment in setting specific allocations and its flexibility to redirect funding within a fiscal year as emerging conditions (environmental, energy, or economic) require.

Proposed Funding Recommendations

Fuel/Technology		Proposal	FY 2008-09	FY 2009-10	Two-Year Total
Super-Ultra-Low-Carbon	Electric Drive Hydrogen (From Renewable Resources)	• Support the pre-commercial, demonstration and deployment of electric-drive technologies for light-, medium-, and heavy-duty applications. • Support upfit and retrofit applications for PHEV and BEV light-, medium-, and heavy-duty vehicles. • Support public access electric charging infrastructure and early adopter incentives for home and private fleet charging. • Support non-road demonstrations and deployment incentives including truck-stop electrification, truck refrigeration and auxiliary power units, port cold ironing, forklifts and harbor craft, etc. • Support implementation of high-volume fleet and retail hydrogen fueling stations strategically located to serve early market vehicles. • Promote mixed-use hydrogen fuel infrastructure to support transit fuel cell buses, possible hydrogen/compressed natural gas blending for transit buses, light-duty vehicle fleets, and other applications (such as forklifts). • Support projects that demonstrate low-cost production of hydrogen from renewable feed stocks, develop reduced-pressure, low-cost tank designs for fueling station storage, and evaluate the use of fuel cells in niche applications such as truck stop electrification systems.			
		Super-Ultra-Low-Carbon Total	$18,000,000	$23,000,000	41,000,000

Proposed Funding Recommendations

Fuel/Technology		Proposal	FY 2008-09	FY 2009-10	Two-Year Total
Ultra-Low-Carbon	Biofuels	• Facilitate the transition of existing ethanol production facilities in California from imported corn to lower-carbon California biomass feed stocks (including waste residues and purpose-grown crops). • Develop new in-state facilities that produce lower-carbon biofuels from biomass and waste feedstocks. • Stimulate the development of biomethane/biogas production for use as a transportation fuel. • Expand the installation of E-85 stations based on the geographic distribution of fuel flexible vehicles capable of operating on E-85.			
		Ultra-Low-Carbon Total	10,000,000	12,000,000	22,000,000

Proposed Funding Recommendations

Fuel/Technology		Proposal	FY 2008-09	FY 2009-10	Two-Year Total
Low-Carbon	Natural Gas, Propane, and Bio/ Renewable Diesel	• Provide financial incentives for the purchase of light-, medium-, and heavy-duty natural gas vehicles and light- and medium-duty propane vehicles. These incentives will be coordinated with ARB in the implementation of their Heavy-Duty Vehicle Air Quality Loan Program and the Lower Emission School Bus Program. • Support the development of advanced medium- and heavy-duty natural gas and propane engines, and fueling and fuel storage technologies. • Install new and retrofit natural gas and propane fueling infrastructure and dispensing systems for the state fleet, other public and private fleets, and retail outlets. These incentives should be provided for projects in proximity to existing natural gas and propane vehicle concentrations. • Develop fuel blending terminals for renewable diesel and biodiesel fuels in Northern and Southern California.			
		Low-Carbon Total	26,000,000	36,000,000	62,000,000

Proposed Funding Recommendations

Fuel/Technology		Proposal	FY 2008-09	FY 2009-10	Two-Year Total
Vehicle and Engine Efficiency		• Develop and demonstrate new light-duty engine design and vehicle component efficiency improvements. • Develop and demonstrate medium- and heavy-duty hybrid and hydraulic hybrid technology with diesel engines and alternative and renewable fuel engines.			
		Vehicle Efficiency Total	7,000,000	15,000,000	22,000,000

Proposed Funding Recommendations

Fuel/Technology		Proposal	FY 2008-09	FY 2009-10	Two-Year Total
Non-GHG Categories	Workforce Training	• Support proposals that expand existing successful programs, target unemployed or displaced workers, or complement efforts of agencies such as the California Public Utilities Commission, the Employment Development Department, or local Workforce Investment Boards. • Coordinate with employers, employer groups, and equipment and vehicle manufacturers to identify the labor market demands and quantify job openings, internships, and apprenticeships.			
	Sustain-ability	• Development of best management practices for purpose-grown energy crops, crops, or forest biomass; development of quantified environmental indicators that could be used in establishing numeric sustainability standards, evaluation, or auditing of international sustainability certification programs; technical support for applicants who need assistance compiling sustainability data as part of their grant applications; and ongoing technical research to effectively integrate environmental data from program-funded projects into the California Greenhouse Gases, Regulated Emissions, and Energy use in Transportation (GREET) model.			
	Standards / Certification	• Support state agency programs in the development of the standards and the technical evaluation for the reasonable and timely certification of the fuels and vehicles. Cost-sharing these efforts and capabilities will help to 'ready the market' and help the state achieve its environmental, energy and economic goals more efficiently.			
	Public Education and Outreach	• Support proposals that expand and leverage other state outreach and education efforts with shared objectives, provide comprehensive consumer outreach in areas that are targeted for vehicle deployment, develop and implement K-12 curriculum, and maximize program exposure through			

	Program Analytical Support	national and statewide outreach campaigns. • Support proposals to implement the communication plan and outreach campaign developed during the first year of the program. • Support periodic updates to the full fuel cycle assessment methodology and market assessment for alternative and renewable and advanced vehicle technologies, conduct an analysis of incentive mechanisms, develop a methodology and metrics necessary to evaluate the effectiveness of the program.			
		Non-GHG Program Total	9,000,000	10,000,000	19,000,000

Fuel/Technology		Proposal	FY 2008-09	FY 2009-10	Two-Year Total
Manufactur-ing and Production Incentives		• Implement an incentive financing program through the State Treasurer's Office to develop in-state facilities that produce low-carbon alternative and renewable fuels and that manufacture advanced vehicles and components. Potential incentives include loans, loan guarantees, manufacturing sales tax exemptions, enterprise zones, and local property tax incentives.			
		Incentive Total	$5,000,000	5,000,000,	10,000,000
		TOTAL FUNDING	**75,000,000**	**101,000,000**	**176,000,000**

APPENDIX A: Analytical Method for Determining Funding Priorities and Opportunities

Analysis for Light-Duty Vehicles

The first step in the effort was to use the Energy Commission's adopted forecast[14] for gasoline and diesel demand for the 2005 to 2030 period. Staff developed this forecast using the California Light-Duty Vehicle Conventional and Alternative Fuel Response Simulator (CALCARS), a California consumer choice model. The second step was to project business as usual (BAU) development out to 2050. Staff used the estimate of 10,300 vehicle miles traveled (VMT) under the business as usual case (BAU), extending a straight line backward to the VMT from CALCARS. A straight line was representative of the data, extending to well before 2030. The third step was to construct a scenario that implemented the 2050 Vision to the fullest extent possible. The fourth step was to modify that scenario to incorporate "Story Lines," a description of each alternative fuel's development and growth potential and barriers taken from the *State Alternative Fuels Plan* and updated into the scenario. For the most part, this last step constituted "populating" the three vehicle classes identified with market penetrations of alternative-fueled vehicles from those story lines that were deemed most likely to meet the attributes identified for the 2050 vision.

For this analysis, the population of vehicles that achieve a pooled average of 80 miles/gallon and a 90 percent carbon intensity reduction were labeled "super-ultra-low carbon" (SULC) vehicles. The population of vehicles that achieve a pooled average of 60 miles/gallon and an 80 percent carbon intensity reduction were designated "ultra-low-carbon" (ULC) vehicles. The remaining petroleum fueled vehicles and non-renewable alternative fueled vehicles could rightfully be considered "low-carbon" (LC) vehicles, since they also achieve a pooled average of 60 miles /gallon and at least a 10 percent carbon intensity reduction. Finally, the reduction of vehicle miles traveled per capita is called VMT and not strictly allocated to "land use changes", since these could be achieved (at least to the degree required in earlier years) by drivers shifting from light-duty passenger cars to transit, increased telecommuting, and similar measures. However, achieving the endpoint of a 20 percent reduction in VMT would certainly require land use changes such as "smart growth" and other density increasing measures.

Business-As-Usual (BAU)

The first step was to develop a spreadsheet to incorporate results from CALCARS for the 2005 to 2030 period. This incorporation essentially "froze" consumer choices in terms of vehicle class and usage at the values set for the estimated "high fuel price" range. Since this estimate has been exceeded by actual fuel prices, the CALCARS model is being updated to better represent current market conditions for the *2009 Integrated Energy Policy Report (IEPR),* but this update is not yet available.

The next step was to project light-duty vehicle fuel consumption to 2050 under BAU. The *2007 IEPR* forecast was limited to the 2005 to 2030 period, but the forecast was extended to 2050 using the *State Alternative Fuels Plan's 2050 Vision* estimate of 10,300 annual VMT under BAU

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[14] *Transportation Energy Forecasts for the 2007 Integrated Energy Policy Report* – Staff Final Report, CEC-600-2007-009-SF. September 2007.

(Table 8, *State Alternative Fuels Plan*). To reflect the most timely and accurate estimate, population data[15] were taken from the Department of Finance, with a 2050 value of 59.6 million in 2050 (rather than the 55 million from Table 8 of the *2050 Vision*). VMT for the 2005 to 2030 period was approximately linear from 2016 to 2030 and, when projected to 2050, matched the value of 10,300 from Table 8. Future VMT is estimated simply by multiplying VMT by population.[16]

Fuel economy for the 2030 to 2050 period under BAU was held constant at 2030 fuel consumption rates for all 15 vehicle classes used in CALCARS and three fuel/drive configurations (gasoline internal combustion engines, gasoline hybrid vehicles, and diesel internal combustion engines) for a total of 45 combinations in all. VMT per the 45 "vehicle classes" was projected based upon the ratio of VMT in 2030 and the projected VMT in each year from 2031 to 2050. Staff projected the number of new vehicles sold in 2050 for BAU as a straight line from the CALCARS trend line for 2017 to 2030.

The BAU shows a population and VMT growth-driven trend of increased fuel consumption from 2005 to about 2011, where it begins to decrease as Assembly Bill (AB) 1493 (Pavley, Chapter 200, Statutes of 2002) requirements take effect. It continues to decline to about 2024, when population and VMT growth lead to renewed increases in overall fuel consumption extending out to 2050. It was not necessary to update BAU for the recently adopted federal CAFE requirements of 35 miles/gallon because ARB staff analysis indicated that the AB 1493 /Pavley requirements, which were already in the BAU forecast, exceed the miles/gallon requirement of the new federal CAFE requirements

Emissions Reduction Strategies

Staff evaluated strategies to reach the greenhouse gas (GHG) emission reduction targets in a step-wise fashion. This process proceeded from those strategies most likely to occur (or to occur earlier), proceeding to those strategies that would require more work to develop or more time to implement. Staff used this approach in a partially successful attempt to develop at least one GHG reduction strategy that meets both the 2020 and 2050 GHG emissions reduction targets. The results approached the 2020 target but exceeded the 2050 target.

Due to the time constraint, this analysis did not evaluate the technological readiness, the necessary development costs or probability for this scenario for meeting these GHG reduction goals. It also did not evaluate the funding amounts that would be needed to provide the necessary market-changing incentives.

Estimating Future GHG Emissions

The analysis used portions of the 2050 vision, updating data where appropriate and as explained below. It proceeded in the following order (the order matters in terms of relative GHG emissions reductions for at least some of these strategies):

- **Low-Carbon Fuel Standard (LCFS): T**he analysis assumes that the Low-Carbon Fuel standard (being implemented by ARB) begins in 2010. The standard reduces the carbon intensity of the pool of gasoline and diesel used by all vehicles on the road by 1 percent

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[15] Data from Department of Finance: http://www.dof.ca.gov/html/DEMOGRAP/ReportsPapers/Projections/P1/P1.php.

[16] A draft chart shown to the TAC on September 2, 2008, inadvertently used VMT/capita rather than total VMT.

every year until 2020. Since the Energy Commission analysis, ARB released its LCFS proposal, which has a back-loaded phase-in schedule for the carbon content reduction in the fuel, with most of the reductions coming in 2015 and beyond. Fuel contains 90 percent of the pre-LCFS carbon content by 2020 and remains at this level from 2020 through 2050. This LCFS applies to both gasoline and diesel on-road light-duty vehicles (as well as other vehicles beyond the scope of this discussion). Staff does not have any information on the manner in which bio-derived fuels and other non-petroleum fuels will be used to meet LCFS requirements. The use of fuels in this analysis is in addition to the degree to which they are used to meet LCFS requirements.

- **Tire Efficiency Program:** The Energy Commission's Tire Efficiency program is assumed to begin in 2010, reducing annual light-duty vehicle fuel consumption by 1 percent from 2010 to 2050. The AB 1493/Pavley requirements already include use of low-rolling-resistance tires. Therefore, the benefits of the Energy Commission's Tire Efficiency Program, which this analysis may include, are limited to efforts to get consumers to maintain tire pressure and any state standards that may require lower rolling resistance tires than what vehicle manufacturers provide as original tires on their vehicles.
- **ARB's Pavley 2 Program**: The Air Resources Board is committed to extending its AB 1493/Pavley requirements, called "Pavley 2." While not yet adopted, and therefore eligible for AB 118 Program funds at the time of this writing, ARB staff expects its board to adopt additional GHG reduction requirements that would likely be implemented with fuel economy improvements beyond the scope of their existing "Pavley 1" program requirements. The original Pavley requirements apply to model year 2009 (which may be delayed due to legal issues) to 2016. Pavley 2 is expected to lead to increasing fuel economy requirements annually until 2024. Staff assumed the 2024 levels through 2050. Additional fuel economy improvements are considered in a separate component of this analysis, and these are described below. Pavley requirements are often converted into their fuel economy effects. These effects are expressed in terms of laboratory testing conditions (often expressed by CAFE or Federal Test Procedure, FTP, requirements). These must be converted into equivalent "on-road" fuel economy values which are used in this anaylsis. Staff divided CAFE-equivalent fuel economy values by 0.85 to estimate the on-road fuel economy equivalent.
- **Low-Carbon (LC) Alternative Fuel Vehicles:** The analysis included natural gas-and propane-fueled vehicles as potential substitutes for gasoline and diesel vehicles. These were considered in a separate category because their GHG emissions reduction potential was much less than for the ultra-low carbon or super-ultra-low-carbon vehicles (which have at least a 72 percent GHG emissions reduction relative to gasoline). Staff considered CNG an option for all vehicle classes except sub-compact vehicles because of their small size (no room for CNG cylinders) and sports cars (too much weight and not enough power boost to overcome the increased weight). The analysis considered propane to be an option only for gasoline internal combustion standard pickup vehicles, and more recently, school buses. Market penetration rates for these vehicles are described in corresponding story lines for these vehicle types.
- **Ultra-Low Carbon (ULC) Vehicles:** As stated above, the *2050 Vision* included "ultra-low carbon-vehicles" (or ULC vehicles), which achieve up to an 80 percent GHG emissions reduction relative to petroleum-fueled vehicles and have a fleet-average of 60 miles per gallon in 2050. ULC vehicles were described in the *2050 Vision* as being flexible-fueled vehicles. Therefore, this group of vehicles includes gasoline internal combustion engines (ICEs) and gasoline hybrids only, fueled with bio-derived fuels. It does not include diesel ICEs. The *2050 Vision* included a ULC vehicle market penetration rate of 0.3 million vehicles in 2005, 5 million vehicles in 2022, 11 million vehicles in 2030, and 28 million vehicles in 2050. Correspondingly, biofuels used in these ULC vehicles were "envisioned" to be 4 percent of the on-road light-duty vehicle fuel

mix in 2005, 16 percent in 2022, 38 percent in 2030, and 30 percent in 2050 (from Table 9).

Staff developed annual estimates for the number of ULC vehicles on the road that correspond to the *2050 Vision* fuel mix estimates extending out to 2050 (see Table 9 of *2050 Vision*). The percent of vehicle sales in each of the 45 vehicle classes in 2030 was held constant from 2030 to 2050. Text under "VMT Reductions under 2050 Plan" explains the total number of new vehicles sold yearly from 2031 to 2050 under the *2050 Vision*. The fuel economy of the fleet of ULC light-duty vehicles was a harmonically averaged[17] 60 miles/gallon in 2050, taken from page 67 of the *2050 Vision* of the *State Alternative Fuels Plan*. This overall fleet average fuel economy, the number of new vehicles in 2050 in each vehicle class, and the BAU miles/gallon in 2050 (held constant for all 45 vehicle classes at 2030 values) were all used to calculate the harmonic average fuel economy for 2050. Once staff derived the 2050 fuel economy values for the 45 vehicle classes, these interpolated values for 2031 through 2049 using the 2030 values from CALCARS and 2050 values derived from the 60 miles/gallon harmonic averaging. Staff was not able to estimate the number of vehicles by class that would transition from gasoline ICEs to hybrids and diesels over this period, nor their impact on fuel economy improvement. This complication results from freezing consumer preference with the transfer of values from CALCARS to the analysis spreadsheet.

It is likely that achieving a fleet-average on-road economy of 60 miles/gallon would involve considerable use of hybrid-electric vehicle technology. However, because staff froze the market shares of internal combustible engine (ICE) vehicles and hybrid-electric vehicles at their 2030 percentages, this transfer of technology was not assessed. As a practical matter, since both groups of vehicles converge on 60 miles/gallon by 2050, the only other difference that matters is vehicle miles traveled per year. Since for a given vehicle class (sub-compact, compact, and so forth) the annual mileage of a conventional gasoline ICE is very similar to its hybrid-electric counterpart, results would not change had the analysis somehow included the class-by-class transfer from ICE to hybrid.

The *2050 Vision* in the *State Alternative Fuels Plan* includes an assumption that ULC vehicles have an 80 percent reduction in GHG emissions relative to gasoline. An example of a ULC vehicle is a flex-fueled E-85 (85 percent ethanol/15 percent gasoline) vehicle fueled with an advanced form of ethanol that does not compete with food production and does not incur indirect GHG emissions from land conversions. The *2050 Vision* describes the method of achieving this 80 percent carbon intensity reduction for this class of vehicles as including biofuels, electricity and hydrogen produced from renewable or very-low-carbon emitting technologies (page 68).

Therefore, staff assumed that ULC vehicles were all flexible-fueled vehicles using E-85 (85 percent ethanol and 15 percent gasoline), with the ethanol produced from purpose-grown popular trees. The carbon intensity of popular tree ethanol was obtained from Figure A-6 of the Energy Commission's *Full Fuel Cycle Assessment*.[18] These data indicate that the carbon intensity

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[17] Harmonic Averaging: This approach is used to compute the overall average fuel economy for a fleet of vehicles. For example, harmonic averaging is used to compute the Corporate Average Fuel Economy (CAFE) value for a specific automobile manufacturer. Harmonic averaging is done using the following four steps: (1) divide specific fuel economy (in miles/gallon) into the number of vehicles sold with that particular fuel economy, (2) repeat for each fuel economy value reported, (3) sum these values, (4) divide the total number of vehicles sold by the sum derived in Step 3.

[18] *Fuel-Fuel Cycle Assessment: Well to Wheels Energy Inputs, Emissions and Water Impacts: State Plan to Increase the Use of Non-Petroleum Transportation Fuels – Assembly Bill 1007 (AB 1007, Pavley) Alternative Transportation Fuels Plan Proceeding* – REVI CEC-600-2007-004-REV, revised August 1, 2007.

of the ULC vehicles would constitute a 72 percent decrease rather than the 80 percent decrease stated in the *2050 Vision*. Thus, the carbon intensity of ULC vehicles in the staff analysis, as applied to intermediate years, was somewhat higher than the *2050 Vision*. The *Full Fuel Cycle Assessment* included values for 2012, 2022, and 2030. Staff assumed the 80 percent carbon intensity reduction was reached by 2050 and developed values for intervening years using linear interpolation.

Staff compared the number of gallons of ethanol demand for these flex-fueled vehicles to the non-electric portion of travel by plug-in hybrid vehicles (see below). Staff estimates that the total demand for ethanol for all these vehicles would be about 12 percent of nationwide supply, consistent with the percentage of the nationwide population, which is currently about 12 percent and rising. Since California oftentimes leads the nation in breaking new ground, this portion of the nationwide ethanol supply should be manageable.

Super-Ultra-Low Carbon (SULC) Vehicles: Above, staff describes the total number of new vehicles entering the California light-duty vehicle market in 2050 under both BAU and *2050 Vision* scenarios. SULC vehicles include fuel cell vehicles, battery electric, and plug-in electric vehicles. Collectively, staff refers to these as "electric-drive vehicles." All 45 vehicle classes were considered to be eligible for treatment as SULC vehicles.

Market penetration begins in 2012 for each of the three types of SULVs, reaching about 55 percent of new vehicle sales by 2050. The market penetration rate steadily increases throughout the time period for fuel cell and battery electric vehicles. However, plug-in electric vehicles peak at 35 percent of new vehicle sales in 2035. After that, they lose market share[19] to battery electric vehicles as these vehicles become more capable of providing the service life and function of plug-in electric vehicles. By 2050, fuel cell vehicles comprise 22 percent of new vehicles sales and battery electric vehicles comprise 26 percent, while the plug-in vehicle sales have fallen to 7 percent of new vehicle sales. See corresponding story lines for more details on market penetration rates.

Staff developed fuel economy values for electric drive vehicles (in units of equivalent gallons of gasoline per mile of travel), adjusted to be consistent with the *2050 Vision* of a fleet average of 80 miles per gallon for these vehicles.

Separate GHG emissions rates were developed for fuel cell, battery electric and plug-in hybrid electric vehicles. Staff used data from the *Full Fuel Cycle Assessment* (footnote 5) to estimate full fuel cycle emissions relative to gasoline and the same approach of interpolation between years where data were available. Staff also held 2030 values constant for the 2031 to 2050 period. Carbon intensity for hydrogen used as a fuel for fuel cell vehicles was estimated based upon use of steam-reformed methane for the 2012 to 2022 period. For 2030 to 2050, staff assumed 70 percent of the hydrogen could be supplied by biomass-derived hydrogen and the remainder by steam-reformed methane. Values were interpolated between 2022 and 2030.

Staff developed an emissions factor for GHG emissions related to recharging batteries for battery electric and plug-in electric vehicles using Case 4A from the report, *Scenario Analysis of California's Electricity System*, third addendum, prepared for the Energy Commission's *2007 Integrated Energy Policy Report*.[20] Since values were available only for 2009 through 2020, staff

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[19] Staff used data from Table 1 (gasoline) and Table 2 (diesel) of ARB's October 2008 staff draft report for their analysis. ARB updated values slightly in their December 2008 staff draft rule, but only for 2018 and 2019. All other values are identical in both sources. These slight changes are not expected to have a noticeable impact on the staff results.

[20] *Scenario Analysis of California's Electricity System: Preliminary Results for the 2007 Integrated Energy Policy Report – Addendum*. CEC-200-2007-010-AD3.

assumed that the emissions factor continued to decline somewhat below the 2020 value of 595 pounds carbon dioxide per megawatt hours (MWh), leveling off at 500 pounds carbon dioxide per MWh in 2030 and later years. Since this emissions factor was applicable only for carbon dioxide, there was a need to adjust this value to account for other GHG emissions associated with electricity production and transmission, notably methane, nitrous oxide, and sulfur-hexaflouride. Using Air Resources Board GHG emissions inventory date, staff developed percentage trends for each of these additional gases. The percentage of methane and nitrous oxide were fairly constant over the 1990 to 2004 period, while the percentage of sulfur hexaflouride declined over time. Since the sulfur hexafluoride decline is due to a concerted effort by electric utilities to reduce these emissions, and since the other two relevant gas emissions were relatively constant over the study period, the percentages computed for 2004 was assumed to represent a reasonable ratio to be used for future emissions, at 1.25 percent.

Since greenhouse gas emissions for other fuels included upstream emissions (usually called a "well-to-wheels" analysis), staff also needed to estimate upstream GHG emissions associated with electricity production for use in transportation. This estimate was derived in a similar manner to that described above for the non-carbon dioxide portion of GHG emissions for electricity. Staff used nationwide GHG emissions data from the U.S. GHG emissions inventory[21] for this analysis. National values were available only for 1997 through 2006. Staff used values for 1997 to 2004 to compute the percentage of the nation's natural gas and coal used to make electricity. Staff used California electricity production compared to national values to pro-rate results to California. In the case of coal, out-of-state coal plants that were known to supply coal-derived electricity to California were included. Since the computed "adder" for these upstream emissions declined from 2000 to 2004, staff used the 2004 value for future estimates. These upstream emissions add another 4.57 percent.

A less carbon-intense case (Case 5A) could also be used which includes more aggressive energy efficiency improvements, although it leads to only slightly lower emissions factor values. Finally, staff assumed that the non-electric portion of the plug-in vehicle trip was fueled with E-85, using the same frequency of fueling with E-85 as described above for flex-fuel vehicles.

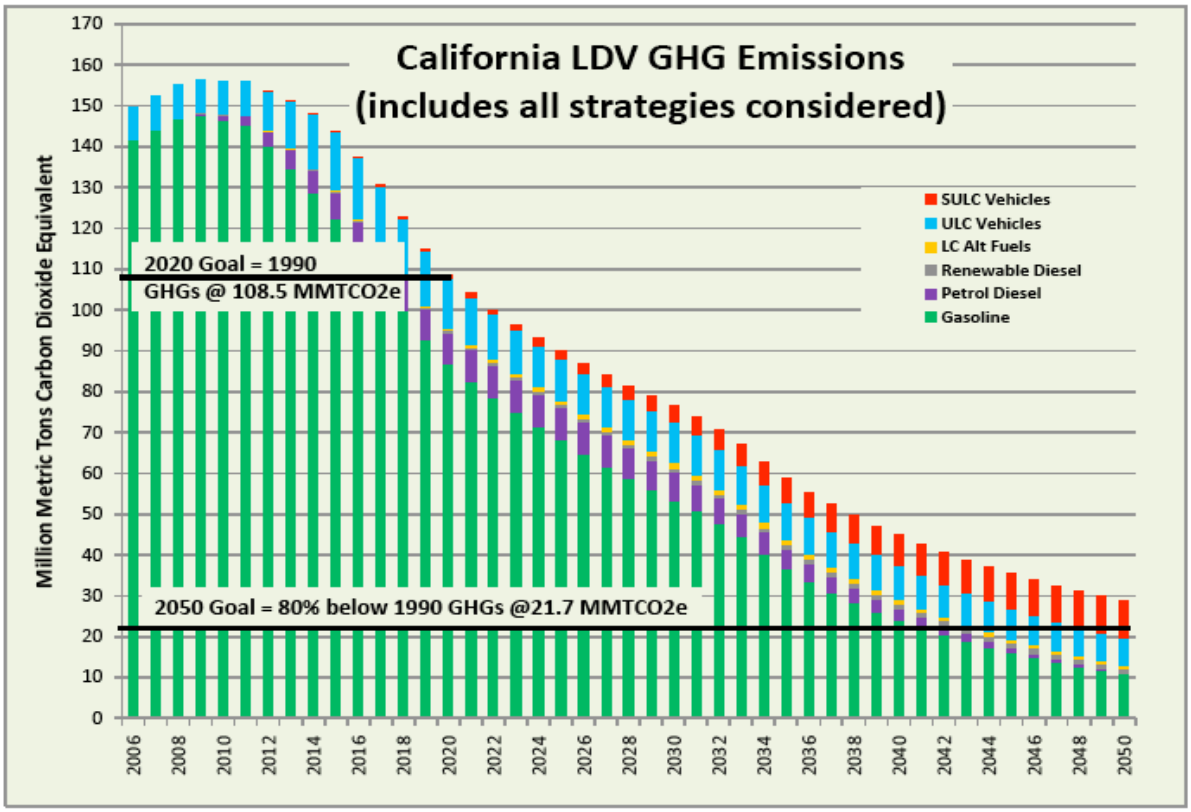
Vehicle Miles of Travel (VMT) Reductions From 2050 Vision

The *2050 Vision* (Chapter 6 of the State Alternative Fuels Plan) called for reduced vehicle-miles of travel (VMT) per capita from a BAU-projected amount of 10,300 in 2050 to 8,200, about a 20 percent reduction by 2050. Staff assumed these changes to begin in 2016, increasing linearly until reaching the required reduction in 2050. A ratio of "*2050 Vision* VMT" to "BAU VMT" was developed for each year from 2016 to 2050.

The analysis modified the number of new vehicles purchased yearly between 2031 and 2050 under BAU to a smaller number set to match the 20 percent reduction in VMT. As a direct result, the annual number of miles of travel *per vehicle* remains the same under BAU and the *2050 Vision*. This improves the economics of using vehicles, compared to an alternative approach of absorbing the VMT reduction by using a larger number of vehicles but operating them fewer miles per year. This correspondingly reduces fuel demand.

Figure A-1: California LDV GHG Emissions

[21] *Inventory of U.S. GHG Emissions and Sinks: 1990 to 2006*, April 15, 2006; Table 3-34 (methane) and 3-36 (non-combustion carbon dioxide) from natural gas supply system and methane emissions from Tables 3-26 (coal mines) and 3-30 (abandoned coal mines).

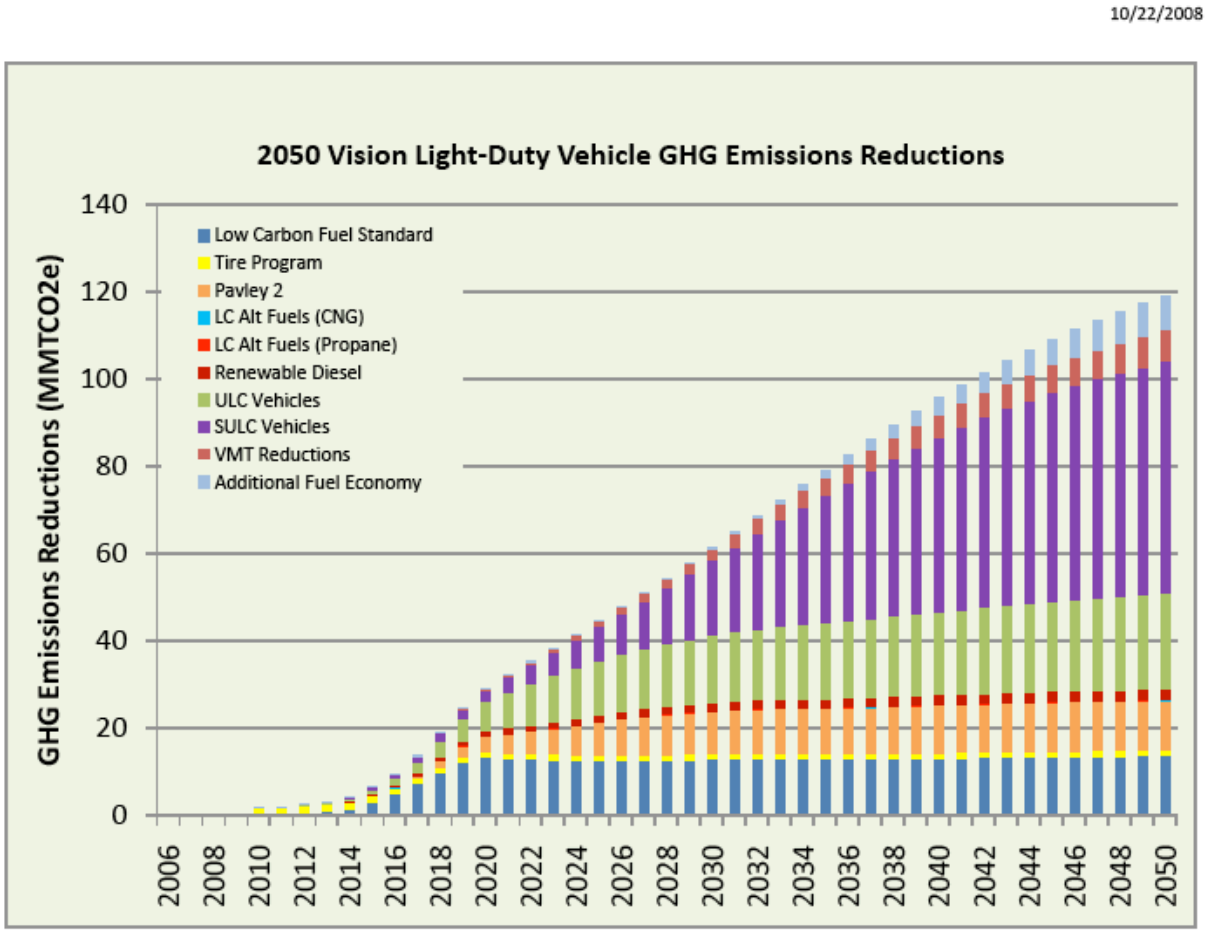


Source: California Energy Commission

Computed Carbon Intensities

By using the results of staff's analysis of the computed effective carbon intensities relative to gasoline, diesel, propane, and natural gas, vehicles all show at least a 40 percent reduction in GHG emissions. ULC vehicles achieve a 70 percent or better reduction in GHG emissions and SULC vehicles achieve over 90 percent reduction. These reductions, while impressive, do not meet the 2050 target.

Figure A-2. 2050 Vision Light-Duty Vehicle GHG Emissions Reductions



Source: California Energy Commission

Once these initial weighting factors were obtained, they were adjusted to allow for new ideas outside the scope of the *2050 Vision* ("Way cool things we haven't thought of yet") and considerations derived from the "gap analysis" where we considered other alternative fuel programs that may be in progress or planned at the federal, state, local, or private levels.

Light-Duty Vehicle Analysis Conclusions

According to the 2050 Vision scenario to achieve the state's climate change goals for 2020 and for 2050, the specific categories of Fuel Economy Improvements, Low-Carbon, Ultra-Low-Carbon, and Super-Ultra-Low-Carbon shaded areas displayed on the concluding graph were computed as percentages of the whole. This result can be described as the unconstrained trajectory for GHG emission reductions needed to make significant progress toward the state's climate change goals for 2020 and for 2050. The ARB's Low-Carbon Fuel Standard and the Energy Commission's Tire Efficiency Program were both excluded from the final results because they are not eligible for funding under the AB 118 program.

The results of the analysis are summed below over several periods to show the effect of the period in terms of affecting the final results. The analysis uses values summed over the 2009 to

2020 period for final determination of funding percentages. Other periods are shown for information only.

Table A-1. Light-Duty GHG Emissions Reductions (2009 to 2020)

Category	GHG Emission Reduction ($MMTCO_2e$)[22]	Percent GHG Emission Reduction
Super-Ultra-Low-Carbon Fuels	11	33%
Ultra-Low-Carbon Fuels	9	27%
Fuel Economy Improvements	10	30%
Low-Carbon Fuels	3	10%
Total	33	100%

Source: California Energy Commission

Using these estimates, the following graph shows the effectiveness of this scenario in meeting the "fair share" 2020 and 2050 GHG reduction targets.

[22] Million metric tons carbon dioxide emissions.

APPENDIX B: Analytical Method for Establishing Funding Priorities and Opportunities

Analysis for Medium- and Heavy-Duty Vehicles

This analysis extends the evaluation of the *2050 Vision* for light-duty vehicles (LDVs) to medium- and heavy-duty vehicles in a manner similar to that for the LDVs. This analysis uses a different list of fuel and vehicle emission reduction strategies but also determines a percentage for specific fuel categories in the *2050 Vision*. The calculated percentage will help establish funding priorities and opportunities for the evaluated fuel or technology. The fuels and technologies included in this analysis are biomass-derived diesel, hydraulic hybrids, battery electric hybrids, full electric vehicles, fuel cell vehicles, propane, compressed natural gas, and liquefied natural gas. The projected market penetrations, fuel economies, fuel consumption, and diesel displacement for evaluated fuels and technologies were obtained from the *AB 1007 State Alternative Fuels Plan* and updated. The initial projections have no constraints placed upon them and were evaluated without consideration of market competition or biomass constraints. However, the updated fuel and technology market information should be influenced by costs and potentially do consider barriers to market penetration, which may include some of the constraints mentioned above. Still, the fuels and technologies themselves were evaluated independently and do not reflect a truly competitive marketplace or instances of direct synergistic effects. Additionally, staff is currently evaluating California biomass constraints and is working with other California Energy Commission divisions to ensure a consistent set of assumptions related to the availability and use of biomass in California.

Generally, the Energy Commission used a simple accounting method to calculate the estimated emissions for the medium- and heavy-duty greenhouse gas (GHG) emissions for the AB 118 *Investment Plan*. All calculations and assumptions are documented in a simple spreadsheet model. As can be observed in the spreadsheets, the fuel consumption is used to directly calculate the associated full fuel cycle GHG emissions using emission factors derived from the CA-GREET[23] model results.

Carbon Content Calculation

This section describes the method and references used to calculate the carbon content for all fuels and technologies.

Gasoline and diesel GHG emission carbon contents were held constant over the forecast period at values of 8,130 grams (gms) carbon dioxide equivalent (CO_2e) per gallon and 10,300 gms CO_2e per gallon, respectively. All other fuels used values from the CA-GREET correlated to the gasoline and diesel constant values. The selection of the CA-GREET specific carbon contents were obtained from specific past evaluated scenarios. The list of scenarios used from the well to tank (WTT) and tank to wheel staff reports[24] to estimate the corresponding fuel and technology carbon content are listed in Table B-1.

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[23] The CA-GREET model is being updated again as part of the AB 118 work. Additionally, the CA-GREET model was developed in cooperation with the California Air Resources Board during the *AB 1007 California State Alternative Fuels Plan* work in 2007.

[24] (*REVISED) Full Fuel Cycle Assessment: Well to Wheels Energy Inputs, Emissions and Water Impacts: State Plan to Increase the Use of Non-Petroleum Transportation Fuels* - AB 1007 (Pavley) *Alternative Transportation Fuels Plan Proceeding*, REVISED Final Consultant Report #CEC-600-2007-004-REV. Original posted June 22, 2007; revised posted August 1, 2007. (PDF file, 165 pages, 1.5 megabytes)

Table B-1. Carbon Content of Selected Tank-to-Wheel Scenarios (kg CO_2e per gallon)

Fuel	2012	2017	2022	2030	Assumed 2050
Gasoline	11.127	11.113	11.096	11.096	11.096
California Ultra Low Sulfur Diesel	12.382	12.373	12.363	12.364	12.364
Biodiesel, Canola	4.070	4.031	3.997	3.993	3.993
Renewable Diesel, Palm	4.229	4.238	4.225	4.237	4.237
BTL	0.708	0.706	0.705	0.704	0.704
Hydrogen	9.389	9.071	8.703	8.703	8.703
Propane	10.986	11.203	11.314	11.428	11.428
Electricity	12.729	10.763	9.492	8.475	8.475
CNG	9.662	9.684	9.639	9.629	9.629
LNG	11.093	11.147	11.054	11.042	11.042

Source: California Energy Commission

The carbon content of electricity used in battery electric vehicles (BEVs) was derived from Case 4A from the scenario analysis[25] work performed by the Energy Commission in 2007 as part of the *Integrated Energy Policy Report (IEPR)*. The understanding is that as part of the state's effort to achieve numerous emission goals, Assembly Bill (AB) 32, and climate change goals, the CO_2 emissions from electricity generation will change. The values from Case 4A of the scenario analysis were the closest to the state Renewables Portfolio Standards (RPS) and were originally calculated in units of pounds of CO_2 per megawatt hour. The electricity emission factors were converted and used alongside the carbon content values shown in Table B-1.

Initial Transportation Fuel Demand Forecast

The high price case transportation fuel demand forecast that includes GHG regulations adopted as part of the *2007 IEPR* was used as the basis of this evaluation. The use of this high price forecast used for the preparation of the *State Alternative Fuels Plan* and the corresponding Assembly Bill (AB) 118 light-duty vehicle sector evaluation. The basis of the medium- and heavy-duty vehicle transportation fuel demand is derived from a few models used to forecast fuel demand for the medium- and heavy-duty sectors, primarily freight and transit. Additional analysis work was performed to forecast the demand for transportation fuels in other

[25] Scenario Analyses of California's Electricity System: Preliminary Results For the *2007 Integrated Energy Policy Report*. June 2007. CEC-200-2007-010-SD.

transportation sectors, which are discussed in detail in the final Fossil Fuels Office Transportation Fuel Demand Forecast[26].

The medium- and heavy-duty portions of the transportation fuel demand forecast is composed of public transportation fuel demand, freight movement fuel demand, and off-road fuel demand. These demand sectors are summed to provide the details of the overall transportation fuel demand forecast for the medium- and heavy-duty sector from 2005 to 2030. To extend the forecasted transportation fuel demand to 2050, staff used the trends from the final five years of the forecasts for each sector. Each sector was extended using the observed trends and then was summed to estimate the total fuel demand for the medium- and heavy-duty sector.

The final transportation fuel demand used for the medium- and heavy-duty sectors evaluated is provided in Table B-2.

Table B-2. Extended Gasoline and Diesel Forecast

Year	Total Gasoline Demand	Total Diesel Demand
	(million gallons)	(million gallons)
2005	252.02	3,204.4
2006	254.35	3,360.6
2007	247.93	3,423.1
2008	241.81	3,446.8
2009	233.52	3,528.2
2010	225.52	3,594.7
2011	217.38	3,650.9
2012	210.55	3,698.1
2013	203.49	3,742.6
2014	197.47	3,781.6
2015	191.69	3,817.0
2016	186.75	3,857.3
2017	182.18	3,901.1
2018	178.33	3,947.7
2019	175.13	3,989.4
2020	172.62	4,030.4
2021	170.76	4,066.8
2022	169.03	4,103.5
2023	167.75	4,109.2
2024	166.45	4,167.0
2025	165.68	4,223.1
2026	165.01	4,277.6
2027	164.56	4,332.1
2028	164.24	4,388.0
2029	163.92	4,443.0
2030	163.97	4,498.1
2031	163.52	4,551.6

[26] *Transportation Energy Forecasts for the 2007 Integrated Energy Policy Report* – Staff Final Report, CEC-600-2007-009-SF.

Year	Total Gasoline Demand	Total Diesel Demand
	(million gallons)	(million gallons)
2032	163.25	4,605.3
2033	162.98	4,659.2
2034	162.71	4,713.4
2035	162.44	4,767.8
2036	162.16	4,822.5
2037	161.89	4,877.4
2038	161.62	4,932.6
2039	161.35	4,988.0
2040	161.08	5,043.6
2041	160.80	5,099.7
2042	160.53	5,155.8
2043	160.26	5,212.2
2044	159.99	5,268.8
2045	159.72	5,325.7
2046	159.44	5,382.8
2047	159.17	5,440.2
2048	158.90	5,497.8
2049	158.63	5,555.7
2050	158.36	5,616.0

Source: California Energy Commission

Emission Reduction Strategies

There are four distinct emission reduction strategies that affect the medium- and heavy-duty sectors and are included in this evaluation:

- Vehicle miles traveled (VMT) reduction strategies
- Low-Carbon Fuel Standard
- Fuel economy gains
- Introduction of emerging fuels and technologies

Each of the four strategies and the assumptions and impacts are discussed in detail in the following sections.

Vehicle Miles Traveled Reduction Strategies

A large part of the *2050 Vision* involves strategies focused on reducing VMT by Californians. Among the detailed strategies is the shifting from personal vehicles toward public transportation. Therefore, as a result of successful VMT reduction strategies, increasing ridership of public transportation is anticipated. This increased public transportation ridership will result in an increase in the fuel consumed by transit agencies and increase the GHG emissions of this sector.

Staff estimated the increased ridership of public transportation as a result of the VMT reduction strategies outlined in the *2050 Vision* document and included in the light-duty vehicle evaluation. The calculation of displaced VMT is discussed as part of the light-duty vehicle emission reduction evaluations.

The displaced VMT is primarily the difference between two per capita VMT estimates, the California Light-Duty Vehicle Conventional and Alternative Fuel Response Simulator

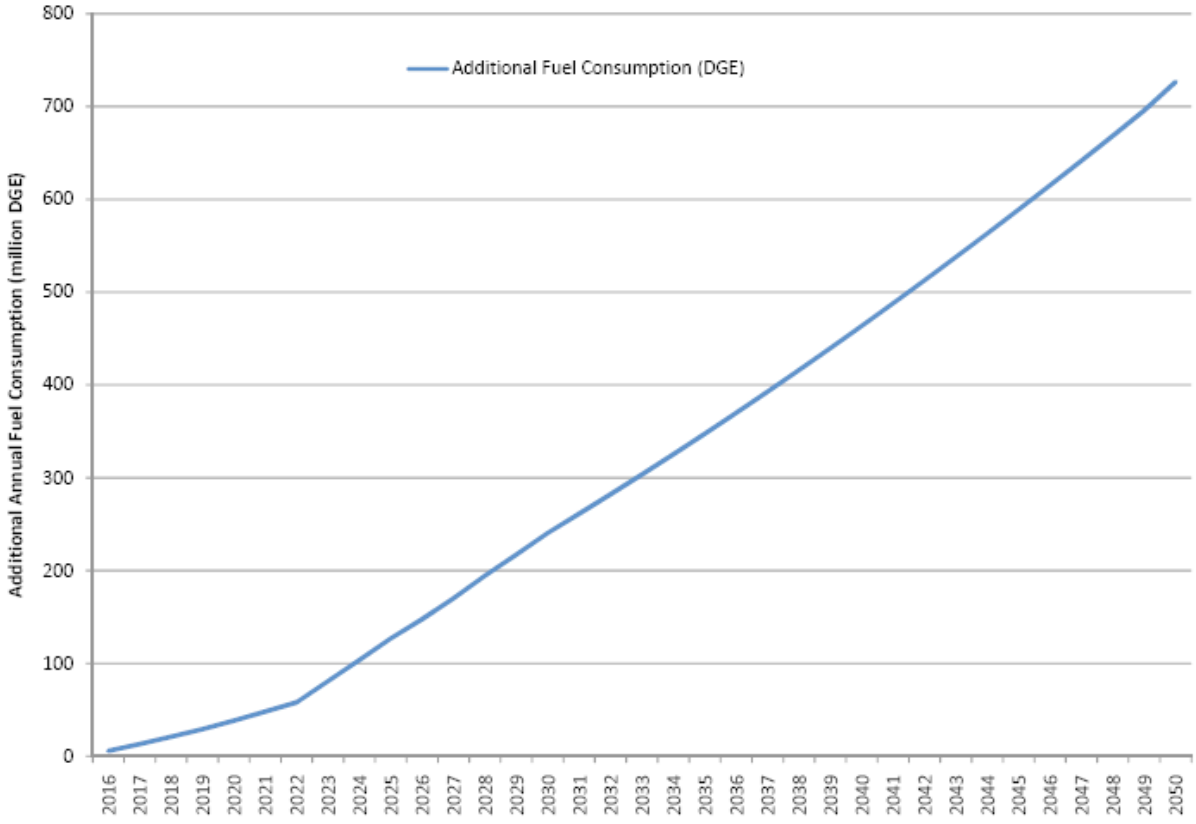
(CALCARS) model and the AB 1007 *2050 Vision's*. The difference between per capita VMT is multiplied by the population to arrive at total displaced VMT due to the reductions strategies outlined in the *2050 Vision* document.

The increase in public transportation use assumes that two-thirds (66 percent) of the displaced VMT will be replaced with public transportation trips. The load factors, or the number of passengers per vehicle, of an average personal vehicle and an average transit bus were then used to estimate the number of addition transit bus miles traveled. The assumed fuel economy of 6 miles per diesel gallon equivalent (mpdge) was used to then calculate the fuel consumption created by the additional VMT.

The fuel consumption was divided among the four fuel types for transit buses, CNG, Diesel, LNG, and LPG. The fuel distribution of the base year was used for estimating the additional forecasted fuel consumption. The additional fuel consumption was then included in the emission estimates.

The results of the additional VMT were significant, resulting in an increase in fuel consumption of 726,657,286 diesel gallon equivalents in 2050. Figure B-1 shows the increasing fuel consumption over the forecast period.

Figure B-1. Additional Transit Fuel Consumption



Source: California Energy Commission

Low-Carbon Fuel Standard

California's Low-Carbon Fuel Standard (LCFS) requires the reduction of transportation fuel carbon content by 10 percent by 2020. The method for the evaluation of the LCFS will be consistent with the compliance schedule for diesel fuel from recently produced draft LCFS document.

The analysis assumes that the LCFS (being implemented by ARB) begins in 2010. The standard reduces the carbon intensity of the pool of gasoline and diesel used by all vehicles on the road by the scheduled percentage every year until 2020. Fuel contains 90 percent of the pre-LCFS carbon content by 2020 and remains at this level from 2020 through 2050. This LCFS applies to both gasoline and diesel on-road and off-road medium- and heavy-duty vehicles (as well as the other vehicles that is beyond the scope of this discussion).

The resulting GHG reductions from the LCFS assumptions amount to 6.19 millions of metric tons of carbon dioxide equivalent ($MMTCO_2e$) in 2050. All additional scenario specific emission reductions are assumed to be above the reductions attributable to LCFS.

Fuel Economy Gain

The fuel economy of medium- and heavy-duty vehicles will improve over current levels through 2050. The transportation fuel demand forecasts have basic assumptions involving the fuel

economies of medium- and heavy-duty vehicles but do not include recent technologies. Consequently, the evaluation of technologies increasing the fuel economy of medium- and heavy-duty vehicles was performed separately.

Information for fuel economy technologies was obtained from U.S. Environmental Protection Agency (EPA) SmartWay[27] program and a literature search of medium- and heavy-duty vehicle technologies. The default evaluated values for the estimation of fuel economy were modified to better reflect California.

Specifically, the 32.2 percent idle vehicle heating time was calculated using the National Oceanic and Atmospheric Administration's (NOAA's) heating degree-day[28] records reflecting California's year-round moderate temperatures, when compared to the national average.[29] Table B-3 shows the data associated with the introduction of fuel-efficient technologies.

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[27] Calculations used reflect methodology described at U.S. EPA website on SmartWay technology benefits and costs. http://www.epa.gov/smartway/transport/calculators/index.htm.

[28] Heating degree-days are a quantitative index used to reflect the amount of heating required over a one year period.

[29] U.S. Department of Commerce, NOAA, National Environment Sat, Data, and Information Service. Historical Climatology Series 5-1, Monthly, State, Regional, and National, Heating Degree Days Weighted by Populations. September 2008.

Table B-3. U.S. EPA SmartWay Fuel Economy Technology Projections

Travel Fuel Economy Gains			
Aluminum Wheel Sets for Single Wide Tires	4 %		
Trailer Aerodynamics	4 %		
Automatic Tire Inflation	0.6 %		
Travel Fuel Economy Gain Subtotal	8.6 %		
Idle Fuel Economy Gains			
Estimated Values			
Annual Idle Hours	2400	857.1	1744
Annual Percentage Idle for Heat	32.2 %	32.2 %	32.2 %
Annual Consumption of Diesel	18000	18000	18000
Bunk Heater	3.4 %	1.2 %	2.4 %
Auxiliary Power Unit	8.0 %	2.9 %	5.8 %
Idle Fuel Economy Gain Subtotal	11.4 %	4.1 %	8.2 %
Total Efficiency Gain	20.0 %	12.7 %	16.8 %

Source: California Energy Commission

From the evaluated estimates four fuel efficiency gain estimates were obtained. The description of the four cases:

- 20.0 Percent Case: Aluminum wheel set, aerodynamics, tire inflation, 2,400 annual idle hours, 32.2 percent idle heating time, 18,000 gallons annual diesel consumption with bunk heater and auxiliary power unit.
- 12.7 Percent Case: Aluminum wheel set, aerodynamics, tire inflation, 857.1 annual idle hours, 32.2 percent idle heating time, 18,000 gallons annual diesel consumption with bunk heater and auxiliary power unit.
- 8.6 Percent Case: Aluminum wheel set, aerodynamics, and tire inflation technologies only.
- 16.8 Percent Case: Aluminum wheel set, aerodynamics, tire inflation, 1,744 annual idle hours, 32.2 percent idle heating time, 18,000 gallons annual diesel consumption with bunk heater and auxiliary power unit.

The fourth case was used in the evaluation of potential future fuel-efficient technologies.

For comparison staff looked at other reports evaluating projected fuel economy gains, one document being the ARB AB 32 Scoping Document[30]. Three items were identified in the document relating to efficiency:

[30] [http://www.arb.ca.gov/cc/scopingplan/document/draftscopingplan.pdf] p. 30.

- Heavy-duty vehicle GHG emission reduction measure aerodynamic efficiency (discrete early action) (1.4 $MMTCO_2E$ by 2020)
- Medium- and heavy-duty vehicle hybridization (0.5 $MMTCO_2E$ by 2020)
- Heavy-duty engine efficiency (0.6 $MMTCO_2E$ by 2020)

The evaluated combined efficiency for the medium- and heavy-duty sector amounted to a reduction of 3.291 $MMTCO_2E$ by 2020 and includes benefits from hybridization that were calculated separately. Efficiency gains for the system wide optimization of goods movement was not evaluated as part of this work because it involved technologies and strategies not evaluated in this report, such as empty cargo container logistic improvement and increased use of barges to transfer containers to smaller distribution ports.

Introduction of Emerging Fuels

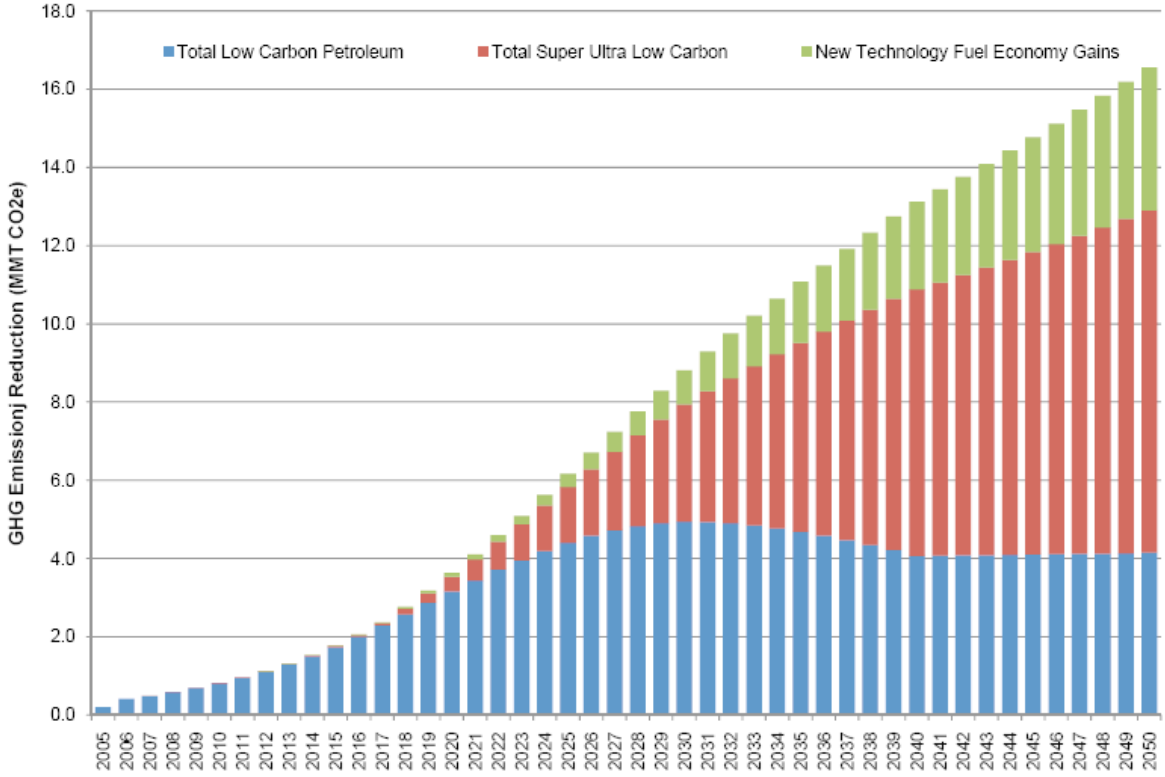
The final reduction strategy included in the evaluation involved the increased market penetration of various emerging fuels and technologies. The vehicles included in this evaluation are divided into two categories, those considered low-carbon-fueled vehicles and super-ultra-low-carbon fueled vehicles. A third category was used in the light-duty vehicle evaluation but is not applicable to the evaluated medium- and heavy-duty vehicle fuels, ultra–low-carbon vehicles.

Low-carbon fuels included in this evaluation included renewable diesel, liquefied petroleum gas, compressed natural gas, and liquid natural gas.

Super-ultra-low-carbon included hydrogen and electric drive vehicles.

Figure B-2 presents the estimated GHG reductions from the Low-Carbon Fuel Standard, low-carbon, super-ultra-low-carbon, and new technology fuel economy gains primarily due to the introduction of hydraulic hybrids.

Figure B-2. GHG Reductions From Emerging Fuels



Source: California Energy Commission

Medium- and Heavy-Duty Vehicle Analysis Conclusions

For the medium- and heavy-duty transportation sector, the developed priorities for funding will again follow the method outlined in the light-duty sector to achieve the state's climate change goals for 2020 and 2050. The specific categories used to calculate the priorities for funding are displayed in the Figure B-2 and include fuel economy improvements, low-carbon, and super-ultra-low-carbon shaded areas. the results reflect the initial evaluation of GHG emission reductions needed to move toward meeting the state's climate change goal for 2020 and 2050. As with the preceding light-duty analysis, the ARB's Low-Carbon Fuel Standard was excluded from the final results because projects contributing to the attainment of the LCFS are not eligible for funding under the AB 118 program. The results of the analysis conclude the following percentages for each of the three categories evaluated:

Table B-4. Medium- And Heavy-Duty GHG Emissions Reductions

Category	GHG Emission Reduction ($MMTCO_2e$)	Percent GHG Emission Reduction
Low-Carbon Vehicles	196	35%
Super-Ultra-Low-Carbon Vehicles	123	22%
Fuel Economy Improvements	240	43%
Total Reductions	560	100%

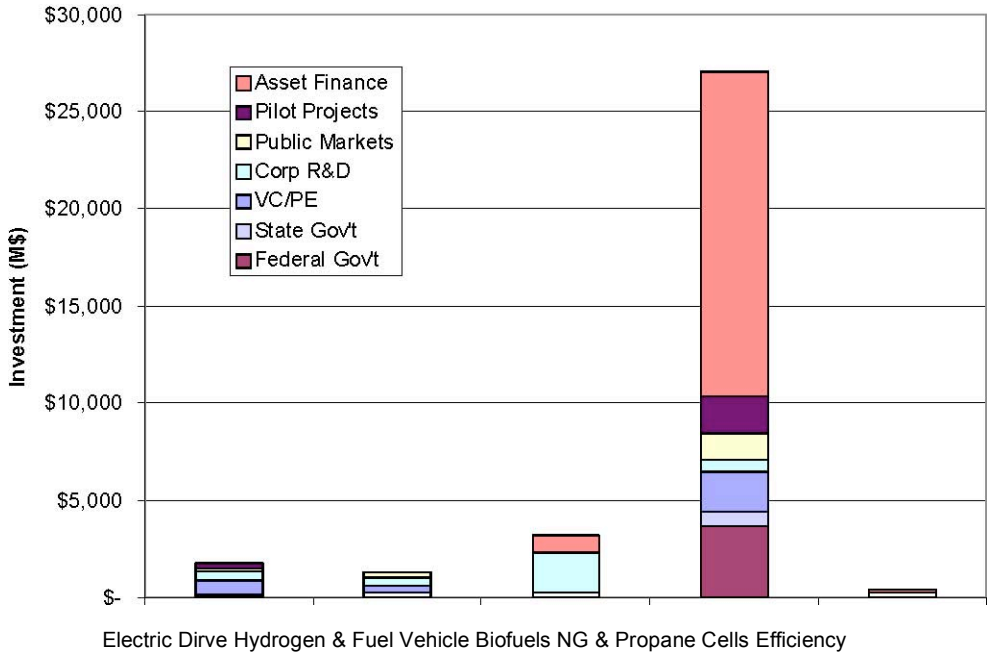
Source: California Energy Commission

APPENDIX C: Gap Analysis For The AB 118 Program

To make the most of AB 118 funding, the Energy Commission must assess what investments are already being made to develop new fuels and vehicles. The Energy Commission needs to prevent duplication of effort by identifying funding gaps.

Current annual investments in advanced vehicle technologies are shown in Figure C-1. Investments include federal and state government funding as well as private investments. Staff estimates that over $35 billion is spent annually on electric drive, hydrogen fuel cells, improved vehicle efficiency, biofuels, and natural gas and propane technologies. The majority of the investment is focused on biofuels, which is primarily driven by the Renewable Fuels Standard (RFS) (EISA 2007). The RFS requires up to 15 billion gallons of corn derived ethanol and 21 billion gallons of cellulosic ethanol by 2022. The RFS, along with high prices for petroleum derived fuels (that is gasoline, diesel), has driven considerable investment in the production of ethanol from corn and in research and development (R&D) and demonstration of ethanol and other biofuels from cellulosic feedstocks.

Figure C-1. Total Estimate Annual Investment In Advanced Vehicle Technologies



Source: TIAX

Electric drive technologies, which include battery electric vehicles, plug-in hybrid vehicles (PHEVs), and hydrogen fuel cell vehicles, offer considerable reductions in emissions and substantial displacement of petroleum. Some combination of these technologies will be required in the future to meet the aggressive reduction goals for GHG emissions. Current public and private investments are focusing on R&D and early stage investments (that is, venture capital, private equity, and pilot projects) as shown on Figures 1 and 3. The estimated investment in electric drive technologies is $2 billion per year, while hydrogen and fuel cell investment is about $1.2 billion per year. Currently, federal funding is higher for hydrogen and fuel cells than for

electric drive technologies. Hydrogen fuel cell vehicles are being demonstrated in small numbers with automakers ready to increase the number of vehicles, but this will require additional investment in hydrogen fueling infrastructure to support these limited production vehicles.

PHEVs or range-extended electric vehicles are just being developed by the major automakers.[31] No large-scale, coordinated demonstration of these technologies has yet occurred. Current investments focus on the batteries for these vehicles as well as for "pure" battery electric vehicles. Several automakers are developing PHEVs and are committed to demonstrating and selling these vehicles in the near future. Automakers are developing different vehicle designs, and it is yet to be determined how these differing designs will be accepted in the marketplace.

Based on an analysis of the current funding landscape and staff's understanding of the status of the advanced vehicle technologies, staff offers the following observations:

Biofuels: Considerable money is already being invested by the private sector for fuel production, and by the federal government's fuel tax credits of Generation I biofuels, and the combined federal government/private sector support for the R&D of Generation II (cellulosic) biofuels. It t is not clear that additional funding will accelerate commercialization, especially Generation I biofuels (that is, starch-based ethanol). Nevertheless, a key California objective is to produce biofuels in-state. So it is recommended that some portion of the AB 118 funding be invested in California-based biofuels production. Funding could also be used to support the distribution and use of high-blend biofuel.

Natural Gas and Propane: Natural gas and propane receive the lowest investments. This is a result of very limited end-use product being offered to the marketplace. There is one automaker producing a CNG light-duty vehicle (Honda) and one heavy-duty engine manufacture providing natural gas or propane engines (Cummins Westport). No automakers are providing propane or LPG for the light-duty sector. Both fuels have incentives for vehicle purchases and a $0.50-per-gasoline-gallon-equivalent fuel credit. These incentives encourage the use of these fuels but are not used at the same level as biofuels.

A major funding issue facing these technologies is product development for the light-duty and heavy-duty vehicle markets. AB 118 funding could be used to help bring more products to the marketplace, including continued incentives to help support infrastructure and the purchase of vehicles for individuals and fleets. Funds could also be used to develop and demonstrate advanced gas-to-liquids technologies if the resulting GHG emissions are low enough.

Improved Vehicle Efficiency: Improving vehicle efficiency is funded mostly by the automakers and engine manufacturers themselves as part of their normal product improvement, although both receive public funding as well. Proposed CAFE standards will require the automakers to invest heavily in advanced conventional technologies to improve fuel economy. These investments will also help to reduce GHG and criteria pollutant emissions, but further reductions will be necessary beyond what is possible through improvements in conventional technologies alone.

Most of the investments in these technologies are being made by the auto industries. Public funding is also helping the industries, but more work could be performed on concepts to reduce vehicle weight, improve aerodynamics, and find other approaches to improve vehicle fuel economy, especially for heavy-duty vehicles (that is, bottoming cycles, auxiliary power units).

Hydrogen and Fuel Cells: Federal and state governments have made substantial investments in this technology with the hope that the vehicles will be accepted in the market place. These zero-

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[31]However, a number of PHEV retrofits, including bolt-on modifications to the Toyota Prius, have been conducted by individual vehicle owners and some state/local funding agencies.

tailpipe emissions vehicles will provide significant GHG and petroleum reductions. Automakers are on the verge of introducing limit vehicles, but fuel infrastructure will be needed to support these vehicles. At these limited vehicle volumes the infrastructure investments will not be economical, and therefore public funding is necessary. AB 118 funding could be used to provide this infrastructure in limited areas where vehicles are likely to be demonstrated and sold.

Plug-In Hybrids and Battery Electric Vehicles: Considerable investments are being made in battery technologies for these vehicles, but substantial work is necessary to "prove" these vehicles in the marketplace. Will smart meters be necessary to encourage night charging? What is the impact on the electric grid? Will the vehicle designs incorporate large enough batteries to gain the GHG benefits of California's clean grid? Large-scale demonstrations of varying vehicle types and architectures will be needed to better understand their impacts and value proposition in a carbon-constrained world.

Introduction

During the process of developing California's *Alternative Fuels Plan* (Energy Commission 2007), industry working group meetings were held with representatives from the fuel and vehicle industries. These meetings determined the barriers to commercialization of alternative fuels and advanced vehicle technologies and what is needed to overcome these barriers. Stakeholders were also asked what funding would be needed to bring these technologies to the marketplace. Much of this work was summarized for each affected industry in AB 1007 *State Alternative Fuels Plan*. Also, some work was completed to account for other government funding available for developing these advanced transportation systems. For example, TIAX previously estimated the amount of funding the federal government was providing to the hydrogen and fuel cell program.

The outcome of the analysis performed as part of the *Alternative Fuels Plan* was a first look at the investments made in research and development (R&D), demonstrations, fuel production, infrastructure and incentives. The implementation of AB 118 requires an update and extension of the previous analysis. This information will help the Energy Commission continue to develop this *Investment Plan*. This plan needs to consider on-going investment in fuels and vehicle technologies so that the plan does not duplicate existing efforts. Just as important, the plan needs to build upon and leverage existing investments to maximize market commercialization and environmental benefits.

Method

TIAX reviewed the AB 1007 market information and developed spreadsheets/matrices that summarize the prior findings related to the types of funding and funding sources for each alternative fuel or advanced vehicle technology. A quick literature review was performed to supplement and update the previous information and data. Staff focused on funding and investments made by the federal government, individual states, and private industry into developing the following vehicle technologies: electric drive (including battery electric vehicles, plug in hybrid vehicles, and enabling technologies such as batteries and motors), hydrogen and fuel cells, improved vehicle efficiency (conventional hybrids, diesel, weight reduction, and aerodynamics), biofuels, and natural gas and propane. Staff broke down the funding and investments into the following categories: R&D, Demonstration, Infrastructure (fuel production, storage, distribution, and dispensing), and Incentives or Commercialization (Deployment). The results of this effort were summarized in tables and figures.

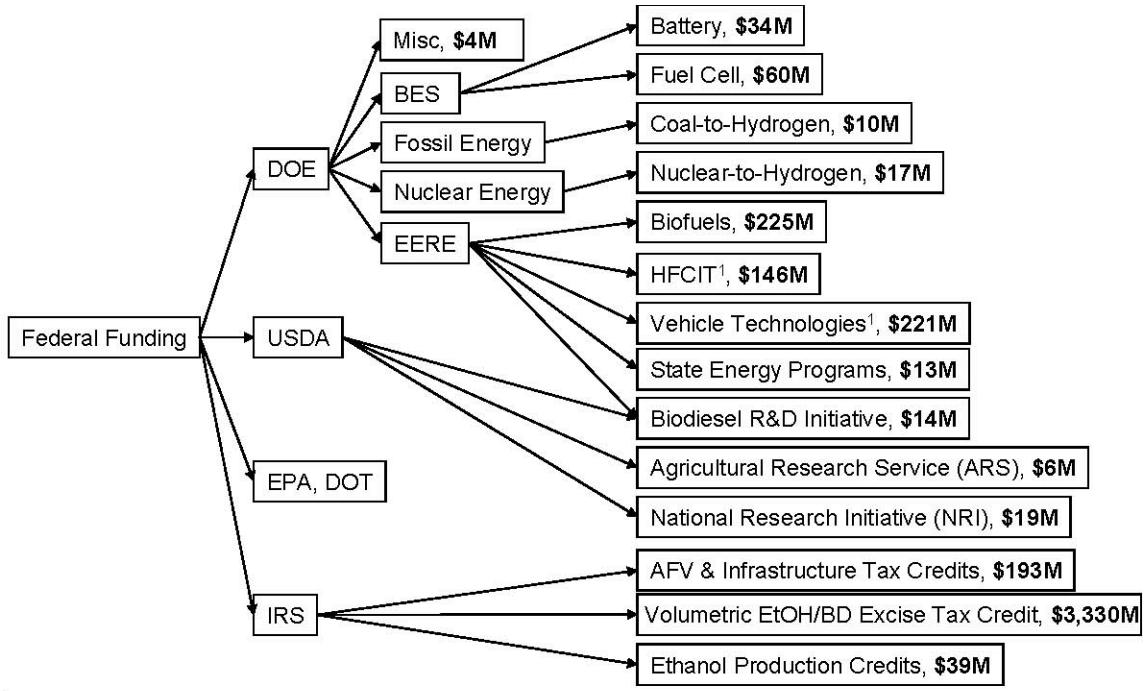
Staff also contacted key government and industry stakeholders to confirm our estimates of funding/investments. As part of this effort staff also asked the stakeholders to provide their perspective on the barriers and needs to overcome these barriers. Each stakeholder was also asked to identify—from his or her perspective—the best use of the AB118 funding to accelerate the introduction of advanced transportation technologies into the marketplace.

The data collection efforts were summarized in a PowerPoint presentation report and high-level conclusions were presented at the AB 118 *Investment Plan* Workshop held on September 2, 2008. (See attached presentation/reports.)

Results

Federal investment was determined for fiscal year 2009 from requested agency funding documents[32] as well as credits that staff project will be given by the Internal Revenue Service (IRS) based on the current tax code[33]. The FY 2009 budgets have not been appropriated yet by Congress and probably will not be appropriated until after the presidential election. However, the 2009 requested funding is reasonably consistent with prior funding levels authorized by Congress. Figure C-2 shows the agencies and their projected funding and credits for FY 2009.

Figure C-2. Federal Agencies Projected FY 2009 Funding and Credits



[1] A portion of the DOE hydrogen budget is included in the Vehicle Technologies budget.

Source: TIAX

Allocating these budgets to the various vehicle technologies and the various funding activities, gives the results shown in Figure C-3. As illustrated, current federal investment for biofuels far exceeds the other categories with an estimated $3.7 billion to be spent in FY 2009. Most of this is due the $0.51/gallon ethanol production credit. Incentives are also in place to accelerate commercialization of improved vehicle efficiency technologies (that is, hybrids and diesels) and natural gas and propane. Although incentives are authorized should vehicles come to market, it

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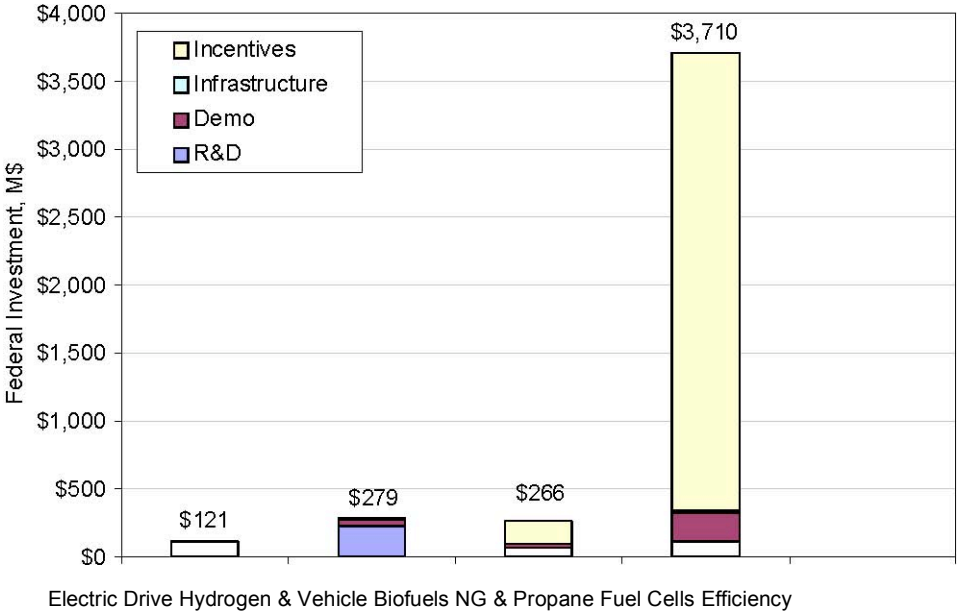
[32] DOE-EERE 2008, DOE-BES 2008, USDA 2008, CBO 2008, Holtz-Eakin 2005, Yacobucci 2008.

[33] Incentives, which include tax credits, are somewhat different from direct funding as they are forgone revenues instead of actual spending.

is anticipated that incentive payouts for electric drive or hydrogen and fuel cell technologies will be minimal due to lack of commercial product offerings. Similar levels of R&D and demonstration ("demo") funding is planned for electric drive, hydrogen and fuel cells, vehicle efficiency, and biofuels – ranging from $90M (vehicle efficiency) to $340M (biofuels). Little or no R&D, demo, or infrastructure funding is planned for natural gas or propane technologies.

Figure C-3. Estimated Annual Federal Investment in Advanced Vehicle Technologies

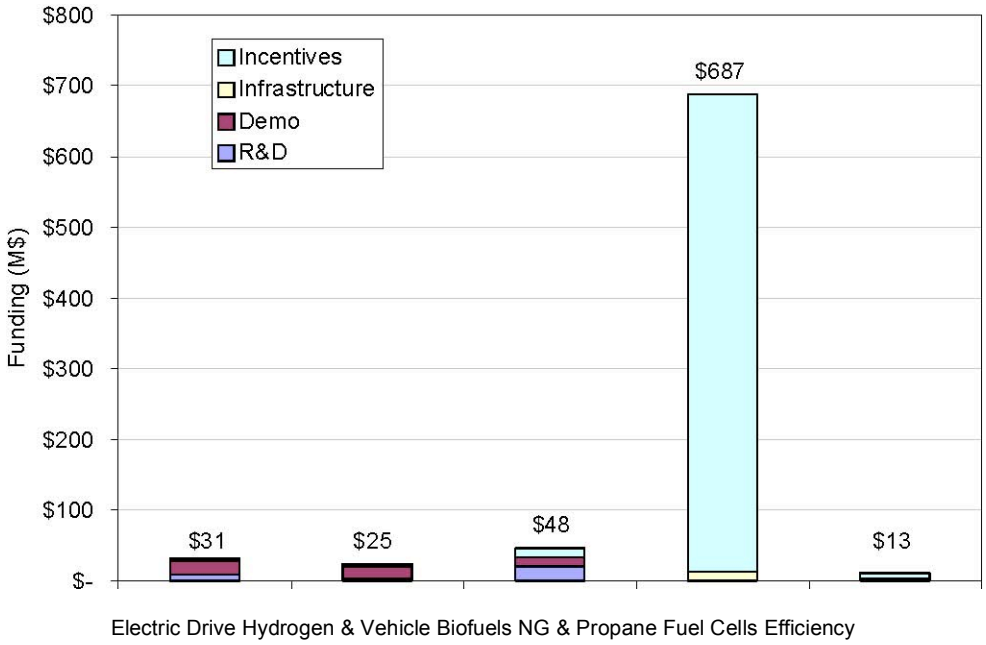


Source: TIAX

Staff reviewed state programs that funded or provided incentives to emerging vehicle technologies. Rather than perform a detailed study of each state's energy programs, staff estimated the spending/budgets based on the number of programs that states are undertaking. Staff found that the state programs tend to focus on biofuel production or infrastructure tax credits, alternative fuel tax credits, and limited R&D. Tax incentives mirror those of the federal government, so staff scaled these based on the average size of the investment and the number of states with similar programs. Staff did a fairly detailed study of California's transportation energy R&D programs and used this assessment as a proxy for the rest of the country. It was assumed that California's R&D, deployment and infrastructure budget is 20 percent of the rest of the states. Figure C-4 shows the results of this analysis.

As shown, the estimates of state investments for advanced technologies are very similar in emphasis to the federal government, with most of the investment directed towards incentives for biofuels production. However, the state funding tends to focus on incentives, demonstration, and infrastructure compared to the federal government, which focuses on R&D to a greater extent. Not surprising, the level of funding by the states is about 10 times less than the federal budgets.

Figure C-4. Estimated Annual State Investment In Advanced Vehicle Technologies



Source: TIAX

The private sector investment was estimated from *Global Trends in Sustainable Energy Investment 2008* (Boyle 2008). This report was prepared by the *Sustainable Energy Finance Initiative* (SEFI) and is the result of collaboration between the United Nations Environment Program and New Energy Finance (an energy investment research firm). This report offers detailed estimates of investments at different stages of the commercial pipeline from emerging technologies to those sold into the market place. Several technologies are identified in this report: biofuels, fuel cells, and energy storage. The report also provides detailed estimates of global investment in venture capital and private equity, public markets, asset finance, and merger and acquisitions. Merger and acquisitions estimates were not used in this study as they do not represent "new" investment in clean energy, but rather transfer of ownership.

The SEFI report provides estimates of global private sector R&D investments in clean energy, but does not segment this estimate into investment by individual technology. Also, ongoing R&D—like automakers' investment in higher efficiency vehicles—is likely not captured in the report.

To supplement the SEFI data, we used several other reports. Both the National Science Foundation (NSF) (NSF 2008) and the *National Institute of Standards and Technology* (NIST) (Auerswald 2005) track statistics on R&D. Based on these three reports and limited research on the size of the fuel cell, battery, and biofuels industries.[34] Staff made estimates of the VC investment. The author made several key assumptions to estimate private investments for each technology category. For corporate R&D, the author used the NIST and NSF reports to estimate that about 10 percent of the total private R&D budget is directed towards improving vehicle efficiency. For emerging technologies, staff used the results of the SEFI report for VC funding and compared this to federal R&D requests. Corporate R&D was estimated based on averaging the contribution of VC investment to total investment and federal investment to total investment. The results are shown in Table C-1.

[34] PWC 2008, Makower 2008, RFA 2008.

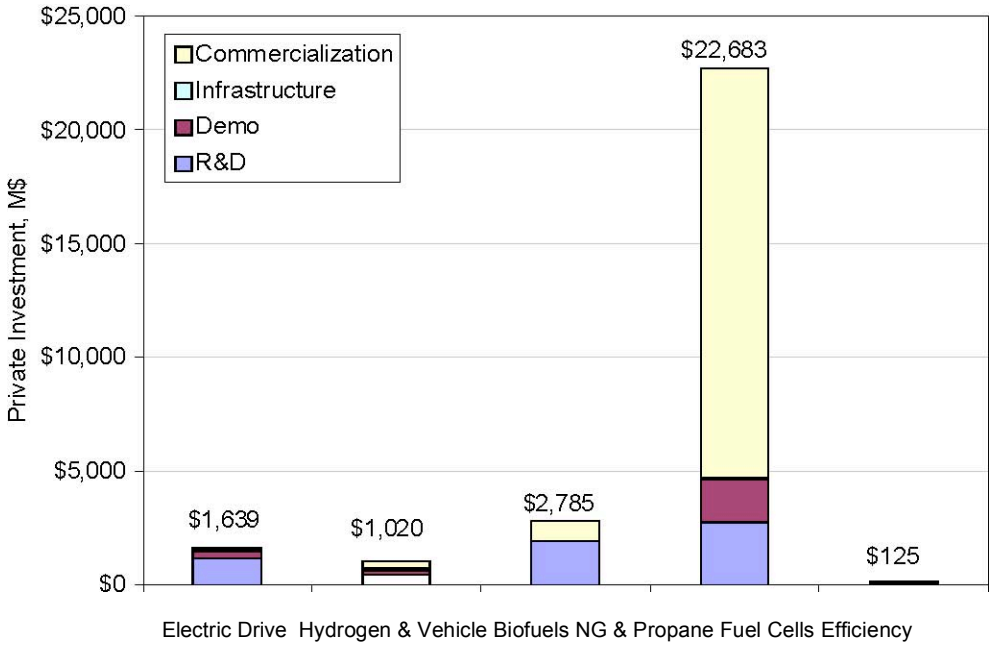
Table C-1. Estimated Annual Private R&D Funding For Advanced Vehicle Technologies ($ Millions)

	Estimates from the Literature			Corporate R&D Estimates				
Technology	VC Funding[1]	Federal R&D[2]	Corporate R&D[1]	Using VC sectoral ratio		Using Corp:Fed R&D Ratio		Avg (VC & Fed)
				% of Total	Est.	Ratio	Est.	
Biofuels	$298	$323	?	8.1%	$789	1.38	$446	$618
Fuel Cells	$164	$298	?	4.4%	$434	1.38	$412	$423
Batteries & Motors	$300	$104	?	8.1%	$795	1.38	$143	$469
Total (Global, ALL Clean Energy Sectors)	$3,700	$7,100	$9,800					

Source: TIAX

Figure C- 5 shows our estimate of the private sector investment for the various technologies by R&D, demonstration, infrastructure, and commercialization. Again, biofuels dominate the investment landscape by about a factor of 10 or more than any of the other technologies. This is driven mostly by the private investment in Generation I (starch-based) biofuel production facilities. R&D and demonstration are focused on Generation II cellulosic biofuels.

Figure C-5. Estimated Annual Private Investment In Advanced Vehicle Technologies



Source: TIAX

Finally the authors reviewed the results of the literature review and investment estimates with several stakeholders. Table C-2 shows the individuals we interviewed during this review. Generally, the stakeholders agreed that the estimates look reasonable, although they focused mostly on their respective budgets or knowledge of the industry. The authors also asked the stakeholders for their perspective on how additional funding provided by AB 118 should be invested. Overall the stakeholders emphasized helping the emerging technologies get through the transition period from R&D to a commercial product. Most see this as a major barrier to advanced vehicle commercialization. They support getting vehicle and fuel infrastructure technologies into the marketplace by funding demonstrations and tax incentives, and by streamlining permitting and licensing. This funding could be used to create an "early mover" advantage to manufacturers and suppliers introducing new vehicle and fuel technologies. Other key points emphasized for state funding were:

- Focus funding on deployment rather than basic R&D for most technologies
- Fund multiple technologies to hedge bets and recognize technologies are not mutually exclusive
- Collaborate with state and national partnerships, OEMs, and the federal government on planning, testing, codes and standards, and vehicle and infrastructure demonstrations.

Table C-2. List of Stakeholders Contacted

DOE EERE • Vehicle Technologies Program – Patrick Davis; Acting Program Manager – Phil Patterson, Chief Analyst – Rogelio Sullivan, Hybrids and Materials Team Leader • Office of Hydrogen, Fuel Cells, and Infrastructure Technologies – Sunita Satyapal; Acting Program Manager / Hydrogen Storage Team Lead – Fred Joseck; Systems Analysis Team Lead • Office of the Biomass Program – Valri Lightner; Strategic Planning, DFO / Integrated BioRefinery Team Lead – Valerie Reed, PhD; Conversion Technologies / Outreach Platforms Team Lead National Labs • National Renewable Energy Laboratory – Dale Gardner; Renewable Fuels Science and Technology Director • National Energy Technology Laboratory – Geo Richards; Focus Area Leader for Energy System Dynamics	USDA • Rural Development – Mike Kossey; Special Assistant to the Administrator of the USDA's Utilities Program Other Organizations • Chevron Technology Ventures LLC – Puneet Verma; Biofuels and Hydrogen Program Manager • Southern California Edison – Dean Taylor; Electric Transportation • Great Plains Institute – Rolf Nordstrom; Executive Director • American Council on Renewable Energy (ACORE) – Bill Holmberg; Chairman of the Biomass Coordinating Council • American Honda Motors – Ben Knight, Vice President North America Research & Development

Source: TIAX

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APPENDIX D: Important References for Program Development

Several important references and complementary programs have been considered for the development of the Alternative and Renewable Fuel and Vehicle Technology Program. The State Alternative Fuels Plan, the Public Interest Energy Research (PIER) Transportation Program, the Alternative Fuels Incentive Program and the Air Resources Board's (ARB)'s AB 118 Air Quality Improvement Program (AQIP) are all important and useful references for this program because they have recently addressed or will address aspects for the increased use of alternative fuels and vehicle technologies and have provided or will provide incentives for those purposes. In addition, the staff-prepared summary *Identifying Complementary Funding Sources* describes the evaluation of strategic alliances, funding partnerships, and stakeholder funding and needs as an important, ongoing part of the gap analysis and the funding plan development for the program.

The Energy Commission and the ARB prepared and adopted the plan in December 2007. It presents a five-part strategy[35] to:

- Promote alternative fuel blends with gasoline and diesel in the near- and mid-term and stimulate innovation through the development of the Low-Carbon Fuel Standard;
- Maximize alternative fuels in early adopter market niches, such as heavy-duty vehicles, fleets, off-road vehicles, and ports in the near- and mid-term;
- Transportation technologies, such as electric drive and hydrogen fuel cells, in the mid- to long-term;
- Maximize the use of mass transit and encourage smart growth and land use planning to help reduce vehicle miles traveled and vehicle hours traveled, and encourage improvements in vehicle efficiency to improve fuel economy; and
- Achieve the maximum feasible vehicle improvements to reduce the total energy needed to power California's transportation sector.

The full fuel cycle analysis concludes that alternative fuels can provide substantial greenhouse gas (GHG) emission reduction benefits. Depending on the fuel pathway chosen, fuels such as ethanol, natural gas, liquefied petroleum gas, electricity, and hydrogen have certain advantages over conventionally produced gasoline and diesel fuels. In addition, the use of blends, such as renewable diesel, biomass-to-liquids, and gas-to-liquid, can have significant short-term advantages. The full fuel cycle analysis however, must be refined and updated to address sustainability issues and land use conversion impacts of biofuels. The Commission has committed funding to update the data and re-evaluate the *Full Fuel-Cycle Analysis* for biofuels and for other alternative and renewable fuels and has already begun this process.

The plan also sets alternative fuel use goals of 9 percent by 2012, 11 percent by 2017, and 26 percent by 2022, excluding aviation and rail. These goals were developed using a scenario approach as each alternative fuel was evaluated assuming a business-as-usual, moderate, and aggressive case. The cases differ by the assumptions made about technology maturity, vehicle and infrastructure availability, fuel supply, and fuel type. These cases were based on assessments about the potential market expansion of each alternative fuel and substantial research and discussions with the alternative fuel industries and other stakeholders.

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[35] Near-term: 2008 – 2012, mid-term: 2012 – 2017, long-term: 2017 – 2022.

Generally, the conservative or business-as-usual case assumes market conditions with limited technological advancements or innovation, limited product availability, cost constraints, and slow infrastructure expansion, resulting in modest market growth.

The moderate case assumes increased technology innovation to remove barriers unique to the vehicle and fuel combination, and expanded product availability and significant reduction in vehicle and infrastructure costs, leading to anticipated market growth.

The aggressive case assumes a market where all barriers to competitiveness and use are removed; substantial cost reductions occur ensuring the alternatives are fully competitive with, or, in some cases, enjoy price advantages compared to the conventional fuels; a full range of vehicle product offerings are widely available; and infrastructure expansion keeps pace with the growing alternative fuel vehicle population.

The moderate growth case represents a plausible description of the market circumstances, technology advances, investment requirements, and government incentives necessary for alternative fuels to fulfill the petroleum reduction and proportionate GHG emission reduction goals. The maximum feasible alternative fuel use results for each fuel in the moderate case are shown in Table D-1.

Table D-1. Moderate Case-Maximum Feasible Fuel Results

Mile Stone Year	2012		2017		2022	
	Fuel Use	GHG avoided	Fuel Use	GHG avoided	Fuel Use	GHG avoided
Propane	47.7	<0.1	173	0.1	282	0.2
Natural Gas	306.1	1.5	518	2.5	885	4.4
E-10 GGE (MW Corn)	1394	3.8	1354	3.8	1327	3.6
E-85 GGE (CA Poplar)	83	0.7	434	3.9	738	6.6
Hydrogen	40	0.3	80	0.6	440	4.4
Electricity	86	2.1	187	5.1	376	6.7
XTLs	320	0	530	0	630	0
Renewable Diesel	130	1	310	2.4	530	4.2
Dimethyl Ether	13	0	62	0	101	0
Total	**2360**	**10**	**3565**	**18**	**5220**	**30**
Fuel Use is measured in million gasoline gallon equivalent (GGE).						
GHG is measured in million metric tons per year.						

Source: California Energy Commission *State Alternative Fuels Plan*

These results show that although each fuel has increasing petroleum reduction potential through the 2022 timeframe, several fuels do not have a corresponding potential for GHG reduction. GHG reduction, air quality improvement, waste biofuels production, and petroleum reduction are all important policy drivers in determining priorities and funding opportunities in this *Investment Plan*.

The "GHG-avoided" values displayed are extrapolations from the *Full Fuel Cycle* results using the California-modified GREET model. These values and the inputs for the GREET model will be updated regularly in the future, but these values can now serve as benchmark expectations for GHG-avoided from the particular alternative of renewable fuel evaluated (GHG-avoided by fuel units, that is gasoline gallon equivalent [GGE]). In this way, GHG reduction benefit can be measured by fuel units, and this factor can serve as a basis for criteria weighting in the evaluation of proposals or provide additional increments of funding for GHG avoided, and other such verified attributes.

The Public Interest Energy Research (PIER) Transportation Program

The California Legislature intended to have AB 118 (Nunez) Alternative and Renewable Fuel and Vehicle Technology Program (AB 118 Program) closely coordinate with the existing PIER Transportation Program as much as possible. It is both logical and extremely valuable for this coordination to take place so that the state's transportation planning, research, activities, and resources can focus on advancing the fuels and vehicle technologies along the research, development and commercialization continuum, in the most informed and cost-efficient manner.

The Legislature created the PIER Program in 1996 when it enacted Assembly Bill (AB) 1890 (Brulte, Chapter 854, Statutes of 1996) California's utility restructuring legislation. This law required that $62.5 million be collected annually from the three investor-owned electric utilities and deposited in the Public Interest Energy Research and Development Account, to be invested by the Energy Commission for energy-related research, development, and demonstration (RD&D) efforts not adequately provided by competitive and regulated markets. In doing so, administration of public interest RD&D was shifted from California's investor-owned utilities to state government, a major change intended to ensure an appropriate role for public interest energy research in a newly competitive energy marketplace.

The Legislature explicitly defined the meaning of public interest energy RD&D. These three principles, contained in Public Resources Code Section 25620 et seq, have guided the Energy Commission's investments since the PIER Program's inception:

- Provide environmentally sound, safe, reliable, and affordable energy services and products.
- Support RD&D not adequately provided by competitive or regulated energy markets.
- Advance energy science and technology to the benefit of California's ratepayers.

While much of the initial RD&D carried out focused primarily on electricity-related applications, in 2004 the Energy Commission was given authority to expand the scope of its public interest RD&D efforts. Assembly Bill (AB) 1002 (Wright, Chapter 932, Statutes of 2000) granted the CPUC the authority and discretion to determine the appropriate funding levels for natural gas, energy efficiency, and public interest RD&D activities. On August 19, 2004, the CPUC adopted Decision 04-08-010 that established the funding level for natural gas public interest RD&D, identified the Energy Commission as the administrator of the natural gas funds, and established the administrator's responsibilities.

On July 21, 2005, Governor Arnold Schwarzenegger signed Senate Bill (SB) 76 (Committee on Budget and Fiscal Review, Chapter 91, Statutes of 2005) which stated that "funds deposited in the Public Interest Research, Development, and Demonstration Fund may be expended for projects that serve the energy needs of both stationary and transportation purposes if the research provides a natural gas (NG) ratepayer benefit."

In 2006, Senate Bill (SB) 1250 (Perata, Chapter 512, Statutes of 2006) reauthorized funding for the PIER Program from 2007 to 2011 and sharpened the Energy Commission's research priorities and included a transportation element to the existing program.

Specifically, SB 1250 indicated that the general goal of the program is to develop, and help bring to market, energy technologies that provide increased environmental benefits, greater system reliability, and lower system costs, and that provide tangible benefits to electric utility customers through the following investments:

- Advanced transportation technologies that reduce air pollution and greenhouse gas emissions beyond applicable standards, and that benefit electricity and natural gas ratepayers.
- Increased energy efficiency in buildings, appliances, lighting, and other applications beyond applicable standards, and that benefit electric utility customers.

- Advanced electricity generation technologies that exceed applicable standards to increase reductions in GHG emissions from electricity generation, and that benefit electric utility customers.
- Advanced electricity technologies that reduce or eliminate consumption of water or other finite resources, increase use of renewable energy resources, or improve transmission or distribution of electricity generated from renewable energy resources.

Transportation research was implemented beginning in 2007 by inviting a group of volunteers to provide expert input and guidance within the context of applicable legislation, policies, trends, and drivers to Energy Commission staff. This Transportation Research Planning Group (TRPG) had the following members:

JanAnne Sharpless	Former Energy Commission Commissioner
Patricia Monahan	Union of Concerned Scientists
Jim Woolsey	Booz Allen Hamilton
George Mozurkewich	Former Ford Scientist
Bill Reinert	Toyota Motor Sales
Ron Stoltz	Sandia National Laboratory
Roland Hwang	National Resources Defense Council
Theo Fleisch	British Petroleum
Paul MacCready	AeroVironment

The TRPG concluded its work in September, 2007 by recommending the following general areas of public interest transportation research:

- Land Use, Sustainability, and Infrastructure
- Life-Cycle Analysis
- Alternative Fuels
- Battery Technology
- Alternative Powertrains
- Vehicle Chassis
- Vehicle Subsystem Efficiency

Based on this and other input, the PIER Transportation Subject Area was organized into three areas of research focus:

<u>Vehicle Technologies</u>

The Vehicle Technologies focus area identifies opportunities to promote improved fuel efficiency and energy savings through innovations in vehicle components, systems and platforms. Additionally, research in this area must reduce vehicle grams of CO_2 per kilometer beyond proposed standards. Research topics in this area include:

- Energy Efficiency
  - Active Components
  - Passive Components
- Vehicle Lightweighting (Weight Reduction)
- Natural Gas Vehicles
- Plug-in Hybrid Electric Vehicles

<u>Alternative Fuels</u>

The Alternative Fuels research area seeks to reduce consumption of petroleum-based fuels in transportation through advancement of a variety of renewable and non-renewable alternative

fuels and production opportunities. This research area also includes low carbon fuels and beneficial in-state resource development. Research topics in this area include:

- Resource and Upstream (Biomass Production and Feedstock Transporting)
- Fuel Processing and Conversion
- Distribution and Fuel Infrastructure

Transportation Systems

The Transportation Systems focus area will conduct research to identify and quantify complex interrelationships that characterize our modern transportation systems. Examples of these interrelationships include those among our built environment, roads and fueling. Others include infrastructure and goods movement. Still more will emerge as we contemplate shifting more of our transportation energy needs from petroleum to the electricity system. Transportation systems research will provide tools, methods and information needed to avoid shifting transportation energy problems from one sector to another, thereby defining pathways to permanent and verifiable carbon reductions within these systems. Research topics in this area include:

- Land Use and Sustainability
- Goods Movement
- Electric Fuel

The PIER Transportation Subject Area is producing research roadmaps within the focus areas, including natural gas vehicles, alternative fuels, vehicle technologies and plug-in hybrid electric vehicles.

The roadmaps are essential for defining the opportunities, direction, and priorities for the PIER Transportation Subject Area. The roadmap objectives are:

- To identify gaps in ongoing research.,
- To facilitate collaborations with other research institutions, state agencies and utilities.
- To define short-, mid-, and long-term goals, timeframes, budgets, and activities.
- To balance timeframes and risk and provide the greatest public benefit.
- To define success metrics.

The first roadmap for natural gas vehicles has been completed, and the roadmap for alternative fuels is expected to be completed in the first quarter of 2009. Roadmaps for plug-in hybrid electric vehicles and vehicle sub-system efficiency will also be completed early next year.

The natural gas vehicle research roadmap was developed with input from industry, state government, national laboratory and environmental stakeholders. The natural gas vehicle roadmap has identified the following areas for funding:

Table D-2. Initial Budget Estimates and Recommended Sequence (By Category) For Priority PIER Natural Gas Vehicle Transportation RDD&D Actions

Engine Development and Vehicle Integration Recommendations	
Integrate available natural gas engines into more models and applications by OEMs (all classes)	> $1 million
Develop a broader range of heavy-duty NGV engine sizes and applications	> $1 million
Develop a broader range of HDVs with improved engine economics, efficiency, and emissions	> $1 million
Develop NGV versions of off-road applications	~ $1 million
Develop a variety of hybrid natural gas HDVs	~ $1 million
Develop engine technology optimized for HCNG fuel	~ $1 million
Develop NGV HCCI engine technology	> $1 million
Fueling Infrastructure and Storage Recommendations	
Develop legacy fleet engine controls and/or fueling infrastructure upgrades to accommodate fuel variability	~ $1 million
Research an improved composite tank safety device / installation protocol to avoid rupture in localized fire	≤ $500k
Develop improved handling, reliability, and durability of LNG dispensing and on-board storage	≤ $500k
Develop on-board low-cost, lightweight, conformable, and compact CNG storage at lower-pressure / higher-density	> $1 million
Provide GPS guidance to NGV fueling station locations/details statewide	<$500k
Develop the next generation of home refueling for light-duty NGVs	~ $1 million
Technical and Strategic Studies Recommendations	
Revitalize the NGV Technology Forum	< $500k
Updating the roadmap through a Roadmap Advisory Council	< $500k

*"Estimated cost" reflects the estimated cumulative funding from all sources for a given project. It is expected that PIER would seek cost-sharing from industry stakeholders and other funding entities and would not support the program entirely on its own.

Source: *Natural Gas Vehicle Research Roadmap* Consultant Report, CEC-500-2008-044D, September 2008

While the research roadmaps are being developed, staff has worked with stakeholders, particularly the Air Resources Board, to identify and fund research projects that are consistent with the research focus areas. Table D3 summarizes PIER Transportation projects funded to date.

Table D-3. PIER Transportation Projects Funded Through December, 2008.

Project Title	Focus Area	Contractor	Contract Amount	Match Funds
Field Demonstration of 0.2 Grams Per Horsepower-Hour (g/bhp-hr) Oxides of Nitrogen Natural Gas-Fired Engine	Vehicle Technologies	California Air Resouces Board	$ 225,000	$ 250,000
Using Gasoline, Diesel, and Compressed Natural Gas Vehicles, Characterize the Significance of Lube Oil in Particulate Matter Formation	Vehicle Technologies	California Air Resouces Board	$ 100,000	$ 354,652
Using the California Fleet, Conduct Physicochemical and Toxicological Assessment of Particulate Matter Emissions	Vehicle Technologies	California Air Resouces Board	$ 225,000	$ 477,950
Determining the Volatility of Ultrafine Particulate Matter Emissions from Compressed Natural Gas Vehicles	Vehicle Technologies	California Air Resouces Board	$ 350,000	$ -
Automotive Thermoelectric HVAC Development and Demonstration Project	Vehicle Technologies	US Department of Energy	$ 2,000,000	$ 5,500,000
Plug-in Hybrid Electric Vehicle Research Center	Vehicle Technologies	UC Davis	$ 3,000,000	$ -
Heavy-Duty Vehicle Emissions and Fuel Consumption Improvement	Alternative Fuels	California Air Resouces Board	$ 150,000	$ 200,000
Purification and Liquefaction of Biomethane Landfill Gas for Transportation Fuel	Alternative Fuels	Gas Technology Institute	$ 998,000	$ -
Environmental and Societal Benefits to Electrifying Transportation: Plug-In Hybrids Environmental Study	Transportation Systems	Electric Power Research Institute	$ 79,098	$ -
Totals			**$ 7,127,098**	**$ 6,782,602**

Source: California Energy Commission

Coordination between PIER Transportation and the AB 118 Program

A substantial part of PIER Transportation's mission is to fill a technology pipeline for implementation through the AB 118 Program. PIER solicitations for alternative fuels and vehicle technologies research will include selection criteria that favor approaches that are consistent with the State Alternative Fuels Plan, and are consistent with AB 118 Program investment plans.

The close coordination of these two important Energy Commission programs began with regularly scheduled coordination meetings, coordinating the collaborative and complimentary aspects of the two programs, and Emerging Fuels and Vehicle Technology Office staff have been included in roadmap development and proposal scoring. The PIER program has recently supported areas of research that complement the commercialization and deployment project opportunities for the AB 118 Program. Specifically, the PIER Transportation Program:

- Established the Plug-In Hybrid Electric Vehicle Research Center at UC Davis Institute for Transportation Studies ($3 million for three years), will be integral to the planning and consideration for the deployment of PHEVs and therefore critical for the AB 118 Program and its efforts in providing incentives for deployment of those vehicles.
- Supported the crucial work now underway (funding of $1 million) for the ongoing evaluation of the full-fuel cycle assessment work in the Emerging Fuels Office that forms much of the basis for the Air Resources Board's finalizing of the Low-Carbon Fuel Standard, and is the analytical basis to evaluate AB 118 project proposals, and to

better assure and measure potential GHG reductions in the transportation sector, as a whole.

- Supported the investigation of low-pressure gaseous fuel storage tanks with the University of Missouri (funding of $1 million) using an adsorption technology using briquettes made from waste corn-cob material. If proven and commercialized, this technology could prove to be revolutionary for the on-board storage of natural gas and hydrogen for light-, medium- and heavy-duty vehicles. The potential for this technology to substantially reduce the costs of high-pressure refueling systems can vastly improve the economics of establishing natural gas and hydrogen infrastructure.

These two critical Energy Commission transportation programs will continue to both inform and take guidance from the other as the AB 118 Program commences. The expected outcome of carefully coordinating these two programs will be a smoother, more focused transition from innovative concepts through development, demonstration, commercialization, and deployment of fuels and vehicle technologies necessary to the cleaner, low-carbon transportation system in the future.

Alternative Fuels Incentive Program

The 2006 Budget Act (AB 1811) directed ARB and the Energy Commission to prepare a plan to spend $25 million to assist in the development of specific measures reducing air pollution and GHG emissions through the Alternative Fuel Incentives Program (AFIP). The projects funded through the AFIP are consistent with administration policies, including recommendations identified in Executive Order S-06-06, the Climate Change Action Plan, and the Bioenergy Action Plan. Additionally, the funds have been allocated for meaningful demonstrations of technologies and not for long-term research. In choosing which projects to fund, the ARB focused on projects that would materially move commercialization of an alternative or renewable fuel forward or that would remove barriers to increased use of these fuels. Specifically, ARB identified alternative fuel infrastructure, biofuel production, and incentives to support the near-term introduction of viable zero-emission or near-zero emission technologies (such as plug-in hybrids and fuel cell buses) as the key areas to focus funding. The AFIP funds were allocated as shown in Table D-4.

Table D-4. Alternative Fuels Incentives Allocation

Alternative Fuel Incentives Program Summary of Allocations	
Alternative Fuel Infrastructure	$5.4 million
Biofuels Production	$6.0 million
Plug-in Hybrids	$5.0 million
Fuel Cell Transit Buses	$2.0 million
Alternative Fuel Vehicle Incentives	$1.5 million
Consumer Education/Outreach	$1.6 million
Research and Testing	$3.2 million
Total Funding:	**$24.7 million**

Source: Program Summary, ARB Approval May 2007.

By June 2007, ARB encumbered all the funds. Recipients must spend these funds by June 30, 2009. A detailed characterization of the specific projects funded in the AFIP will be useful to the AB 118 Program. Some of those project details are:

E-85 Infrastructure

Statewide there are 34 retail E-85 stations, 12 fleet E-85 stations, 6 electric vehicle fleet station upgrades, and 1 biodiesel 99 percent (B99) retail station now under development.

Recommendation: Currently retail E-85 station development is adequate. However, funding for both retail and fleet alternative fuel stations of other types will be requested and necessary. Considering the fleet needs and the larger volume throughput, fleet-fueling facilities offer excellent funding opportunities for all alternative fuels. Retail facilities tied to specific concentrations of alternative fuel vehicles should be considered wherever possible.

Biofuels Production

Biodiesel production dominated this funding category with six projects using cooking oil and vegetable oils (canola, palm, or soy). Four projects funded will generate biogas, either as a gas (from manure) or for liquefied natural gas (LNG) production (from landfills) for the transportation market. Ethanol projects proposed from corn were not recommended for funding since they were considered not to be competitive.

Recommendation: It is likely that biofuels production facilities would be proposed for funding, and so the featuring of biofuels, especially those from waste residues and feedstocks, seems a sound policy as the full fuel cycle and land-use impacts are further evaluated.

Plug-In Hybrids

The seven projects recommended for funding all directly relate to "preparing the market" for light-duty PHEVs, EVs, and medium-duty PHEVs, and all fill identified gaps to smooth the transition to PHEVs and EVs.

Recommendation: Additional support of commercialization will be needed in the areas of vehicle technology and charging infrastructure.

Fuel Cell Transit

Two funded projects will demonstrate fuel cell buses in transit districts. The $1,379,000 project for the City of Burbank will feature a battery-dominant fuel cell system, which may prove to be an evolutionary advancement for the technology. The other project provides $630,000 to the Bay Area Zero-Emission Bus Advanced Demonstration supporting placement of up to 12 new fuel cell buses for service.

Recommendation: Transit will continue to be an important area to demonstrate and deploy alternative and renewable fuels and advanced vehicle technologies. The *Investment Plan* should emphasize the need for a broad array of advanced technologies in addition to fuel cell systems.

Alternative Fuel Vehicle Incentives

This category is expected to be completely subscribed by the end of 2008.

Recommendation: Additional support is needed to encourage the purchase of alternative and renewable fuel vehicles that are currently available to consumers and expected to be available in the near term.

Consumer Education and Outreach

Four projects were recommended for funding in this important "preparing the market" category. Most notable is a $1 million project for a public relations campaign for alternative fuels and vehicles and a grant of $400,000 to San Diego's Ecocenter, a facility for educating more than 10,000 school children per year that is co-located with an alternative fuel station that dispenses natural gas, propane, E-85, and biodiesel, and provides for electric charging, all at the same location.

Recommendation: Additional support is needed for a more aggressive media campaign and for the development of a broader educational curriculum.

Research and Testing

Six projects were funded; four of these involve the emissions and multimedia assessment[36] of biodiesel. This activity is quite important given the current needs for biodiesel standardization and evaluation of its fate of storage and emissions profile. The other two projects are for the development of a certification and test procedure for PHEVs and for research and development of biofuel refueling equipment.

Recommendation: Additional research and testing for alternative and renewable fuels and advanced vehicle technologies may be required as the program proceeds. As further needs arise during the AB 118 Program, those needs will be coordinated with the Energy Commission PIER Transportation Program and the appropriate staff of the ARB.

The following is a summary of areas where incentives were provided from the AFIP and identifies how many applications were received, how much match funding was proposed, and the amount of requested funding . This does not include the amounts allocated to research and testing from the AFIP.

Alternative Fuels Incentive Program (AFIP) Summary

A. E-85 (and other alternative fuels) Infrastructure

Available Funds	$7 Million
Allocated	$5.3 Million (10 of 36 proposals)

[36] The assessment of the fuels impact on air, water, soil, and its characteristics of age in storage on fuel quality.

Match $2.7 Million
Total Applied $26 Million (26/7)

B. Biofuels-startup-small facilities
Available Funds $5 Million
Allocated $6 Million + $1Million (10 of 50 proposals)
Match $452 Million
Total Applied $43 Million (43/5)

C. PHEVs (& AFVs)
Available Funds $5 Million
Allocated $5 Million (7 of 78 proposals)
Match $7.5 Million
Total Applied $56 Million (56/5)

D. Transit Bus
Available Funds $2 Million
Allocated $2 Million (2 of 8 proposals)
Match $17 Million
Total Applied $9.7 Million (9.7/2)

E. AFV Incentive Disbursement
Available Funds $1.5 Million
Allocated $1.5 Million (1 of 4 proposals)
Match $20,000
Total Applied $1.5 Million (1.5./1.5)

F. Consumer Education & Outreach
Available Funds $1.6 Million
Allocated $1.6 Million (4 of 36 proposals)
Match $257,000
Total Applied $23.3 Million (23.3/1.6)

Applied=$159.5 Million on $22.1 Million Available

Identifying Complementary Funding Sources

As identified in the AB 118 statute, the Energy Commission has begun to carefully identify and evaluate complementary funding sources and revenue streams for programs created under the statute as it determines priorities and opportunities for program funding The *State Alternative Fuels Plan* (AB 1007, Pavley, Chapter 371, Statutes of 2005) adopted by the Energy Commission and Air Resources Board, identified the need for a fund to provide state incentives in the range of $100 million to $200 million per year to increase alternative fuel development and use to help fulfill multiple policy goals to reduce petroleum dependency, curb greenhouse gas emissions, cut criteria pollutants, and develop in-state sources of biofuels. The alternative fuels plan noted state incentives would be needed in addition to the Low-Carbon Fuel Standard regulations and extension of federal tax incentives to stimulate a $40 billion market investment by 2022 and $100 billion thru 2050 to meet the policy goals.

The Energy Commission could be managing up to $120 million per year under AB 118 programs for more than seven years or an approximate total of $900 million. The challenge is to use this amount to stimulate a $100 billion market investment, compelling Commission staff to explore revenue streams, identify potential co-funders, and develop strategic partnerships.

The Energy Commission staff identified two primary revenue streams (government incentives/programs and private investment), gathered information on investment objectives and interviewed 30 organizations to understand funding and financing priorities. This initial analysis requires additional work to clarify amounts of investment and other revenue stream characteristics.

Government revenue streams include federal tax credits, fuel subsidies, and other incentives that were created or extended by the Energy Independence and Patriot Act of 2007 and the 2008 Farm Bill. The total amount of incentives allocated for alternative and renewable fuels and vehicle technology is estimated at $5 billion through 2012 for the entire United States. Federal tax incentives are spent on a first-come, first-served basis, so aggressive efforts may channel investments to California that exceed the state's proportional share of the U.S. population (California represents 12 percent of the U.S. population). In addition, programs managed by the U.S. Department of Energy (USDOE), U.S. Environmental Protection Agency, and U.S. Department of Agriculture contribute an average of $200 million in annual funding, primarily for research projects and biofuel development. USDOE provided dedicated alternative fuels funding under the "Clean Cities" program, which California excelled at securing, but this program has subsided in funding and has rarely exceeded $2 million per year for the entire country the last few years.

California state government incentives are managed primarily by the ARB and the Energy Commission. ARB provides incentives under the following programs:

- The Carl Moyer Program funds heavy-duty engine retrofits, replacements, and new vehicle/equipment purchase to reduce criteria pollutants and toxics. Annually, up to $140 million is available through 2015 to fund clean vehicles and equipment.
- Proposition 1B Goods Movement Emission Reduction Program will provide up to $1 billion to reduce emissions from freight movement along California's trade corridors.
- California Transportation Commission funding from fuel and sales tax to fund highway, road, and bridge improvements. Some funding has been allocated alternative fuel projects proposed by local government recipients. Lest than 1 percent of the $2 billion allocated in FY 2008-09 will be spent on alternative fuel projects.

- Proposition 1B bond will provide $200 million to the Lower Emission School Bus Program to replace and retrofit older school buses to reduce criteria pollutants and toxics as well as improve safety. About 40 percent of the past Lower Emission School Bus Program funding has been used for alternative fueled buses.. Historically, less than 5 percent of all school bus replacement funding has been used for alternative fuels.
- Zero-Emission Vehicle (ZEV) program combines regulations requiring automakers to fulfill production levels of plug-in hybrid (58,000) and fuel cell (7500) vehicles by 2015 with consumer purchase rebates. Rebates average $2 million per year.
- Hydrogen Highway infrastructure program proposes a $7 million allocation in FY 2008-09 for hydrogen fueling stations.
- Alternative Fuels Incentive Program – Funding provided on a one time basis ($25 million in FY 2006-07) to provide incentives for a variety of starting projects, including E-85 stations, certification programs, plug-in hybrid purchases, and other alternative fuel vehicles and infrastructure.
- AB 118 Air Quality Improvement Fund to provide an estimated $50 million per year for over seven years beginning in FY 2008-09 to reduce criteria pollutants. An unspecified amount of the funds could be used for alternative fuel and vehicle projects that address air quality improvements. ARB staff's preliminary AQIP funding ideas for FY 2009-10, shared at its November 2008 public workshop, are shown on the next several pages. ARB staff plans to present its AQIP funding plan for FY 2009-10 to its Board for approval in April 2009.

Some local and regional governments have developed funding sources through local taxes and assessments. The South Coast Air Quality Management District ($70 million - $100 million per year)and the San Pedro Bay ports of Los Angeles and Long Beach ($2.2 billion over five years) allocate funding for a variety of air quality improvement programs. Approximately $ 270 million has been allocated for alternative fuels projects.

A bilateral source of government investment is the North American Development Bank, which can provide up to half of the project financing for any single environmental improvement and clean energy project located within 60 miles of the U.S.-Mexico border. Total financing available in any single year has not exceeded $50 million.

AB 118 Air Quality Improvement Program (AQIP)[37]
Preliminary Funding Ideas for Fiscal Year (FY) 2009-2010

Discussion Document for November 5 and 6, 2008 Public Workshops

ARB staff is developing a proposed Air Quality Improvement Program (AQIP) Funding Plan for Fiscal Year (FY) 2009-10. The Funding Plan is each year's plan for expending AQIP funds, and includes funding allocations, the administering agency (or potential administering agency) and general criteria for each project category. Staff plans to bring the FY 2009-10 Funding Plan to the Board for its consideration in Spring 2009.

This discussion document provides staff's preliminary funding ideas for FY 2009-10, a step in the development of the Funding Plan. These preliminary ideas are intended to elicit public comment and input.

Background

AB 118 (Núñez, Chapter 750, Statutes of 2007) provides ARB with approximately $50 million annually for the AQIP upon appropriation by the Legislature. The purpose of the program is specified in Health and Safety Code, Section 44274(a):

> *The primary purpose of the program shall be to fund projects to reduce criteria air pollutants, improve air quality, and provide funding for research to determine and improve the air quality impacts of alternative transportation fuels and vehicles, vessels, and equipment technologies.*

AQIP may fund a wide variety of air quality projects, including low-emission vehicles and equipment, research, and workforce training. Statute lists eight broad project types which are eligible for funding:

1. On- and off-road equipment projects.
2. Projects to reduce off-road gasoline exhaust and evaporative emissions.
3. Research projects to determine the air quality impacts of alternative fuels.
4. Projects that augment the University of California's agricultural experiment station and cooperative extension programs for research to increase sustainable biofuels production and improve the collection of biomass feedstock.
5. Incentives for consumers to replace lawn and garden equipment.
6. Incentives for medium- and heavy-duty vehicles and equipment mitigation including:
    a. Lower emission school bus programs.
    b. Electric, hybrid, and plug-in hybrid on- and off-road medium- and heavy-duty equipment.
    c. Regional air quality improvement and attainment programs implemented by the state or districts in the most impacted regions of the state.
7. Workforce training initiatives related to advanced energy technology designed to reduce air pollution.
8. Incentives to reduce emissions from high emitting light-duty vehicles.

[37] AQIP Preliminary FY 09-10 Funding Ideas for Discussion at November 2008 Workshops.

Implementation Priorities

The following implementation considerations are shaping staff's FY 2009-10 funding proposals:

- Funding is unlikely to be directed to all eight project categories in any single funding cycle. If a category does not receive funding in one year, it could still be considered for funding in future years.
- ARB staff is considering directing a significant portion of AQIP funding towards on-the-ground vehicle and equipment project categories that provide an immediate emission reduction benefit. We anticipate the following broad distribution of funds:
  - 65-85 percent of funds for clean vehicle/equipment deployment projects.
  - 10-30 percent of funds for advanced technology demonstration projects.
  - 0-10 percent of funds for research and workforce training projects.
- ARB staff is considering directing significant funding toward a few key project categories instead of spreading a small amount of funding across many categories.

Guiding Principles for Vehicle and Equipment Deployment Projects

At a public workshop on August 19, 2008, ARB staff presented the following guiding principles for selecting eligible vehicle and equipment project categories for FY 2009-10:

- Attain Ambient Air Quality Standards: Projects should help California meet federal ambient air quality standards by spurring deployment of technologies to meet our State Implementation Plan (SIP) "black box" commitments. Early deployment is critical to ensure significant technology penetration by 2024. Projects should also help achieve the state air quality standards, reduce toxic air contaminant emissions, and complement California's efforts to meet its climate change goals.
- Ready for Deployment: Projects should be cost-effective and be ready for immediate on-the-ground deployment. Technologies that could help meet SIP "black box" commitments but which are not ready for deployment may be considered for funding as demonstration projects.
- Modify Consumer Choice: Incentives should be focused on inducing vehicle and equipment purchases that would not otherwise have occurred.
- Consider Funding Need: Project types that do not have access to other incentive program funds, such as Carl Moyer Program and Goods Movement Emission Reduction Bond Program funds, would be prioritized. Eligible project categories should also not overlap with those AB 118 projects being funded by the California Energy Commission.

Prioritizing Categories

ARB staff applied the guiding principles to the vehicle and equipment project categories listed in the matrix below to help identify potential deployment and demonstration projects for FY 2009-10 AQIP funds.

Table D-5. Prioritization Matrix for Vehicle and Equipment Project Categories

Vehicle Types → Guiding Principles ↓	Heavy-Duty Natural Gas Vehicles / Equipment	Hybrid Med- & Heavy-Duty Vehicles	Hybrid Off-Road Equipment	Zero-Emission Light-Duty Vehicles	Non-Plug-In Hybrid Light-Duty Vehicles	Plug-In Hybrid Light-Duty Vehicles	Fuel Cell Light-Duty Vehicles	Fuel Cell Buses	Others?
Helps meet black box commitments	◆	◆	◆	◆	◆	◆	◆	◆	
Ready for deployment*	◆	◆		◆	◆				
Incentive needed to spur purchase	◆	◆	◆	◆		◆	◆	◆	
No other significant funding source		◆	◆	◆	◆	◆	◆	◆	

Lawnmower replacement, car scrap, research, and workforce training project categories will be evaluated separately.
* Project categories not yet ready for deployment could be considered for funding as demonstration projects.

Source: ARB Air Quality Improvement Program

Two categories emerge as meeting all four of the guiding principles: medium- and heavy-duty hybrid vehicles and light-duty zero emission vehicles. The categories that do not meet the "ready for deployment" criterion are being further evaluated for funding as demonstration projects to help move them closer to being ready for deployment. Based on this analysis, ARB staff developed the preliminary AQIP funding targets for FY 2009-10 listed in the table below.

Table D-6. Preliminary FY 2009-10 AQIP Funding Targets

Project Category	Funding Amount	Additional Details
Incentives for the Purchase of New Medium- and Heavy-Duty Hybrid Trucks	$25-30M	Provide ~$20,000-30,000/ vehicle for new vehicle purchases via voucher or rebate (exact amount to be determined)
Incentives for the Purchase of New Zero-Emission and Plug-In Hybrid Light-Duty Vehicles	$2-5M	Provide up to $5,000/vehicle to consumers via rebate or voucher (following Alternative Fuel Incentive Program model)
Demonstration of Zero and Near Zero Emission Vehicles and Equipment Examples of possible project categories: • On-road heavy-duty vehicle technologies (such as fuel cell buses) • Fuel cell forklifts • Advanced technology agricultural equipment • Near zero-emission lawn and garden equipment • Diesel particulate filters for locomotives • Hybrid tugboat conversion • Additional stakeholder suggestions	$5-15M	ARB staff is proposing to hold ad hoc stakeholder workgroup meetings over the next few months to help evaluate and prioritize demonstration projects for inclusion in the FY 2009-10 Funding Plan.
Other Categories Being Investigated: • Workforce training to support deployment of new hybrid trucks • Lawn and garden equipment replacement • Air quality research • Additional stakeholder suggestions	$0-5M	To be determined
Continuation of Loan Program for Clean On-Road Heavy-Duty Trucks (funded in FY2008-09)	$0-10M	Details and funding level to be determined based on initial implementation of FY2008-2009 truck loan program.
TOTAL	**$32-65M**	

Source: ARB Air Quality Improvement Program

Appendix D References

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