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2012-2013 INVESTMENT PLAN UPDATE FOR THE ALTERNATIVE AND RENEWABLE FUEL AND VEHICLE TECHNOLOGY PROGRAM

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PREFACE

The increased use of alternative and renewable fuels supports California's commitment to curb greenhouse gas emissions, reduce petroleum use, improve air quality, and stimulate the sustainable production and use of biofuels within California. Alternative and renewable transportation fuels include electricity, natural gas, biomethane, propane, hydrogen, gasoline substitute fuels, and diesel substitute fuels. State investment is necessary to fill the gap and fund the differential cost of these emerging fuels and vehicle technologies.

Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007) created the Alternative and Renewable Fuel and Vehicle Technology Program. This statute, amended by Assembly Bill 109 (Núñez, Chapter 313, Statutes of 2008), authorizes the California Energy Commission to "develop and deploy innovative technologies that transform California's fuel and vehicle types to help attain the state's climate change policies." The Energy Commission must accomplish this, in part, by funding projects that provide for "a measurable transition from the nearly exclusive use of petroleum fuels to a diverse portfolio of alternative fuels that meet petroleum reduction goals and alternative fuel use goals." The Energy Commission has an annual program budget of roughly $100 million.

The statute also directs the Energy Commission to adopt an investment plan that describes how funding will complement existing public and private investments, including existing state and federal programs. Assembly Bill 1314 (Wieckowski, Chapter 487, Statutes of 2011) amended the statutes to clarify that the Energy Commission must produce an investment plan update each year. The Energy Commission must establish and consult with an advisory committee during the development of the investment plan update. The Energy Commission will use this investment plan update as a guide for awarding funds.

ABSTRACT

The *2012-2013 Investment Plan Update for the Alternative and Renewable Fuel and Vehicle Technology Program* guides the allocation of program funding and is prepared annually based on input and advice of the Assembly Bill 118 Advisory Committee. This *2012-2013 Investment Plan Update* covers the fourth year of the program and reflects laws, executive orders, and policies to reduce petroleum use, greenhouse gas emissions, and criteria emissions; increase alternative fuel use; and spur developing bioenergy sources in California. It details how the California Energy Commission, with input from stakeholders and the Advisory Committee, determines the program's goal-driven priorities coupled with project opportunities for funding. These priorities are consistent with the program's goal "to develop and deploy innovative technologies that transform California's fuel and vehicle types to help attain the state's climate change policies."

This *2012-2013 Investment Plan Update* provides funding recommendations based on alternative and renewable fuel and vehicle technology analyses and identified opportunities. As an update, the *2012-2013 Investment Plan Update* relies on the analysis developed in previous investment plans, most recently the *2011-2012 Investment Plan*. This document also draws on input from Advisory Committee members and other stakeholders during the development process for the *2012-2013 Investment Plan Update*.

Keywords: California Energy Commission, Alternative and Renewable Fuel and Vehicle Technology Program, alternative transportation fuels, investment plan, electric drive, hydrogen, biofuels, biomethane, biodiesel, renewable diesel, diesel substitutes, renewable gasoline substitutes, ethanol, natural gas, propane, innovative technologies, advanced fuels, workforce training, vehicle efficiency, sustainability, fueling stations, fuel production

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EXECUTIVE SUMMARY

Transportation fuels and vehicles are critical elements in California's economy and society. However, nearly 96 percent of all transportation energy that Californians consume comes from petroleum-based fuels. Depending on a single fuel type poses a number of significant challenges. The state's transportation sector accounts for nearly 40 percent of the state's greenhouse emissions. Assembly Bill 32 (Núñez, Chapter 488, Statutes of 2006) established a goal of reducing greenhouse gas emissions to 1990 levels by 2020, and Executive Order S-3-05 established a goal of reducing greenhouse gas emissions to 80 percent below 1990 levels by 2050. To meet these goals, significant changes to the state's fuel and vehicle profiles will be needed. Additionally, California's refineries have grown dependent on out-of-state and foreign crude oil imports, with foreign imports accounting for nearly half of California refineries' crude oil supplies. The *2007 State Alternative Fuels Plan* set a similar goal of increasing alternative fuels use to 26 percent of all fuel consumed by 2022.

The Alternative and Renewable Fuel and Vehicle Technology Program, created by Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007), is crucial in helping the state meet these and other policy goals. The Energy Commission is providing funding of up to $100 million annually, leveraging public and private investment to develop and deploy clean, efficient, and low-carbon alternative fuels and technologies. The program also provides a foundation for sustainable development and use of transportation energy as an economic stimulus creating California jobs and businesses by encouraging the invention and production of future transportation technologies and services.

Each year, the Energy Commission prepares and adopts an investment plan for the next fiscal year to guide the program funding priorities and opportunities, and describes how this funding will be used to support other public and private investments. The Energy Commission adopted the first investment plan, combining a total of $176 million in funds from fiscal years 2008-2009 and 2009-2010 in April 2009. The second investment plan for fiscal year 2010-2011 was adopted in August 2010, and the third investment plan covering fiscal year 2011-2012 was adopted in September 2011. This *2012-2013 Investment Plan Update for the Alternative and Renewable Fuel and Vehicle Technology Program* is the proposed funding guide for fiscal year 2012-2013.

For fiscal year 2012-2013, and all future fiscal years, Assembly Bill 1314 (Wieckowski, Chapter 487, Statutes of 2011) reduced the scope of the annual investment plan to an investment plan update. Accordingly, the *2012-2013 Investment Plan Update* represents a more concise document that relies on analyses and discussions included in the three previous investment plans.

On December 19, 2011, the Energy Commission conducted a workshop on the Benefits Report of the Alternative and Renewable Fuel and Vehicle Technology Program. As a part of this workshop, members of the Energy Commission's Advisory Committee were presented with a brief overview of the schedule and process for the *2012-2013 Investment Plan Update*, as well as early concepts on the scope of the investment plan. The initial staff draft of the *2012-2013 Investment Plan Update* was subsequently released on January 27, 2012, and the first Advisory Committee meeting was held on February 10, 2012. The meeting included feedback from 18

Advisory Committee members and 25 members of the public. A second Advisory Committee meeting was held on the revised staff draft investment plan update on April 19, 2012. The Energy Commission has also received more than 30 letters through its public docket, providing further guidance and recommendations.

The Context of the 2012-2013 Investment Plan

Since the first investment plan, the Energy Commission has invested about $204.2 million in projects that will support alternative and renewable fuels and advanced vehicle technologies, which are detailed in Table ES-1. These successful projects provide important feedback on opportunities and challenges facing alternative fuels and vehicles. Additionally, the Energy Commission has gained experience and knowledge from reviewing more than 350 proposals requesting nearly $1.3 billion from the ARFVT Program through 12 solicitations.

As part of the *2011 Integrated Energy Policy Report*, the Energy Commission prepared its first benefits report on the program. The report summarizes the investments made to date and identifies the anticipated benefits from the fuels and technologies supported by the program. While the Energy Commission does not assume credit for all the benefits, the report identifies a range of potential benefits from the fuels and technologies supported by the program. This includes an estimated range of 380.4 million to 1.2 billion gallons of petroleum fuel displaced by 2020, as well as a reduction of 2.7 million to 9.7 million carbon dioxide equivalent metric tonnes of greenhouse gas emissions. Based on a survey of grant recipients, the Energy Commission also estimates roughly 1,900 short-term jobs and nearly 3,500 long-term jobs will be directly generated by funded projects. This does not include other indirect jobs that may be created throughout the supply chain, such as jobs from the manufacturing of components or associated equipment.

Relevant policies and regulations have also helped guide the *2012-2013 Investment Plan Update*. The Low Carbon Fuel Standard, administered by the California Air Resources Board, maintains a goal of reducing average fuel carbon intensity by 10 percent in 2020. As the requirement becomes tighter each year, the economic value of lower-carbon alternative fuels increases. In January 2012, the California Air Resources Board also revised a series of regulations, known as the Advanced Clean Car package, that will have a significant impact on deploying advanced technology vehicles. Among these, changes to the Zero Emission Vehicle regulation provide greater incentives for manufacturers to expand their fuel cell vehicle deployments, and require higher volumes of zero- and transitional zero-emission vehicles in model year 2018 and beyond. Revisions to the Clean Fuels Outlet regulation focus primarily on ensuring adequate fueling infrastructure for fuel cell vehicles, with the responsibility for compliance shifting from the owners of retail gasoline outlets to the producers and importers of gasoline.

2012-2013 Investment Plan Update Funding Priorities

As in previous investment plans, the Energy Commission evaluates funding needs and priorities in the *2012-2013 Investment Plan Update* for a portfolio of fuels and technologies, as well as short-, medium- and long-term opportunities. The resulting funding allocations are intended to reflect the unique technological and market hurdles for each of these fuels and technologies, rather than any rank-order preference for the fuels and technologies. As

mentioned, the *2012-2013 Investment Plan Update* is the first "update," with funding allocations that reflect the program's experience to date, the analyses underpinning previous comprehensive investment plans, and more recent developments in the alternative fuels and vehicle technology markets. Table ES-1 summarizes the funding activities from previous years, as well as the proposed funding allocations for fiscal year 2012-2013.

Table ES-1: Summary of Previous, Upcoming, and Proposed Funding (in Millions)

Category	Funded Activity	Funded to Date (FYs 2008-2009, 2009-2010, 2010-2011*, 2011-2012*)	Remaining Funds From Previous Fiscal Years (FYs 2010-11*, 2011-2012)	FY 2012-2013 Investment Plan Update
Alternative Fuel Production	Biomethane Production	$35.3	$13.3	$20.0
	Gasoline Substitutes Production	$11.4	$12.5	
	Diesel Substitutes Production	$4.3	$11.9	
Alternative Fuel Infrastructure	Electric Vehicle Charging Infrastructure	$17.4	$7.0	$7.5
	Hydrogen Fueling Infrastructure	$18.7	$18.7	$11.0
	E85 Fueling Infrastructure	$5.0	$10.1	$1.5
	Upstream Biodiesel Infrastructure	$3.9	$3.1	-
	Natural Gas Fueling Infrastructure	$5.1	$9.6	$1.5
	Propane Fueling Infrastructure	-	0.5	-
Alternative Fuel and Advanced Technology Vehicles	Natural Gas Vehicle Deployment	$29.3	$6.3	$12.0
	Propane Vehicle Deployment	$1.7	$4.0	$2.0
	Light-Duty Electric Vehicle Deployment	$2.6	-	$5.0
	Medium- and Heavy-Duty Electric Vehicle Deployment	$4.0	-	-
	Medium- and Heavy-Duty Advanced Vehicle Technology Demonstration	$17.0	$16.9	$6.0
Emerging Opportunities	Innovative Technologies, Advanced Fuels, and Federal Cost-Sharing	-	$9.3	$5.0
Manufacturing	Manufacturing Facilities and Equipment	$25.9	$10.0	$20.0
Workforce Agreements	Workforce Development and Training	$15.0	$7.3	$2.5
Market and Program Development	Fuel Standards and Equipment Certification	$4.0	-	-
	Sustainability Studies	$1.5	$2.5	-
	Regional Planning	-	$2.0	$3.0
	Centers for Alternative Fuels and Advanced Vehicle Technology	-	-	$3.0
	Technical Assistance and Analysis	$2.1	$5.7	-
	Measurement, Verification, and Evaluation	-	$1.7	-
Total		$204.2	$152.4	$100.0

Source: California Energy Commission. *Only a portion of funds from FY 2010-2011 and FY 2011-2012 have been committed; the remainder will be committed in current or upcoming solicitations and agreements.

CHAPTER 1: Introduction

Californians rely on the transportation sector for many aspects of their lives, such as commuting to work, goods movement, and recreational activities. In 2010, there were about 27.5 million vehicles registered in the state. The same year, these vehicles consumed roughly 14.8 billion gallons of gasoline and 3.3 billion gallons of diesel.[1] Based on an average price of $3.00 per gallon, this represents a $46.5 billion expenditure in 2010 for petroleum-based fuel. While alternative fuels and alternative fuel vehicles represent a growing share of the market, California is still highly dependent on petroleum-based fuel. Petroleum-based fuels account for roughly 96 percent of all transportation energy consumed.[2] Furthermore, California's refineries have grown more dependent on foreign crude imports, which have grown to nearly half (47.7 percent) of California refineries' crude oil supplies in 2010.[3] To reduce this economic dependence, the *2007 State Alternative Fuels Plan* sets goals to displace petroleum by 15 percent by 2020 and increase alternative fuels use to 26 percent of all fuel consumed by 2022.

The transportation sector is also the largest emitter of California's greenhouse gas (GHG) emissions, the emissions that contribute to global climate change. In 2006, Assembly Bill 32 (Núñez, Chapter 488, Statutes of 2006) established a goal of reducing 2020 GHG emissions to 1990 levels. In addition, Executive Order S-3-05 calls for a reduction in GHG emissions to 80 percent below 1990 levels by 2050. California must reduce the GHG emissions produced from the transportation sector to meet these goals, as transportation is responsible for nearly 40 percent of the state's GHG emissions.[4]

To help achieve these policies, the Legislature created the Alternative and Renewable Fuel and Vehicle Technology Program (ARFVT Program) in 2007 through Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007). The statute authorized the Energy Commission to develop and deploy alternative and renewable fuels and advanced vehicle technologies to help attain the state's climate change policies. The Energy Commission's ARFVT Program has a budget of about $100 million annually for projects that:

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1 Schremp, Gordon, Malachi Weng-Gutierrez, Ryan Eggers, Aniss Bahreinian, Jesse Gage, Ysbrand van der Werf, Gerald Zipay, Bob McBrider, Laura Lawson, Gay Yowell. 2011. *Transportation Energy Forecasts and Analyses for the 2011 Integrated Energy Policy Report*. California Energy Commission. CEC-600-2011-007-SD.

2 California Energy Commission, "California Petroleum Statistics & Data," http://energyalmanac.ca.gov/petroleum/index.html.

3 Schremp et al., *Transportation Energy Forecasts and Analyses for the 2011 Integrated Energy Policy Report.* California Energy Commission. CEC-600-2011-007-SD.

4 California Air Resources Board, *Climate Change Scoping Plan: A Framework for Change*, October 2008, http://www.arb.ca.gov/cc/scopingplan/document/psp.pdf.

- Reduce California's use and dependence on petroleum transportation fuels and increase the use of alternative and renewable fuels and advanced vehicle technologies.
- Produce sustainable alternative and renewable low-carbon fuels in California.
- Expand alternative fueling infrastructure and fueling stations.
- Improve the efficiency, performance, and market viability of alternative light-, medium-, and heavy-duty vehicle technologies.
- Retrofit medium- and heavy-duty on-road and nonroad vehicle fleets to alternative technologies or fuel use.
- Expand the alternative fueling infrastructure available to existing fleets, public transit, and transportation corridors.
- Establish workforce training programs and conduct public outreach on the benefits of alternative transportation fuels and vehicle technologies.

The ARFVT Program's statutes require that the Energy Commission prepare an annual investment plan to guide that year's funding decisions. Accordingly, the Energy Commission adopted its first investment plan (covering fiscal years [FYs] 2008-2009 and 2009-2010) in April 2009, its second investment plan (covering FY 2010-2011) in August 2010, and the third and most recent investment plan (covering FY 2011-2012) in September 2011. For FY 2012-2013, and all future fiscal years, Assembly Bill 1314 (Wieckowski, Chapter 487, Statutes of 2011) reduces the scope of the annual investment plan to an investment plan update. Accordingly, this *2012-2013 Investment Plan Update for the Alternative and Renewable Fuel and Vehicle Technology Program* (*2012-2013 Investment Plan Update*) represents a more concise document that relies on analyses and discussions included in the ARFVT Program's three previous investment plans.[5]

On December 19, 2011, the Energy Commission conducted a workshop on the Benefits Report of the Alternative and Renewable Fuel and Vehicle Technology Program. As a part of this workshop, members of the Energy Commission's Advisory Committee were presented with a brief overview of the schedule and process for the *2012-2013 Investment Plan Update*, as well as early concepts on the scope of the investment plan. The initial staff draft of the *2012-2013 Investment Plan Update* was subsequently released on January 27, 2012, and the first Advisory Committee meeting was held on February 10, 2012. The meeting included feedback from 18 Advisory Committee members and 25 members of the public. A second Advisory Committee meeting was held on the revised staff draft investment plan update on April 19, 2012. The Energy Commission has also received more than 30 letters through its public docket, providing further guidance and recommendations.

5 These previous investment plans are available on the Energy Commission's website at: http://www.energy.ca.gov/2011-ALT-1/background.html.

CHAPTER 2:
Context of the ARFVT Program

To maximize the impact of ARFVT Program funds, the Energy Commission considers its investments within the context of broader market forces and policy drivers. While the ARFVT Program's annual allocation of about $100 million is significant, this is less than the amount Californians typically spend on gasoline and diesel fuel each day. Additionally, individual Californians typically spend thousands of dollars each year on conventional vehicles that rely on gasoline and diesel. The ARFVT Program's investments alone will not be sufficient to significantly transform vehicle and fuel profiles of the transportation sector; the Energy Commission must rely on outside policies and investments to realize this goal.

Fortunately, there is a suite of state and federal policies that complement the goals of the ARFVT Program. This chapter identifies several of the key policy and regulatory drivers that are expected to have a significant impact on the fuels and vehicles in California's transportation sector, and how they inform ARFVT Program funding decisions. These include previous ARFVT Program investments, state policies that will support alternative fuels and advanced vehicles, and federal policies that establish targets for vehicle efficiency and renewable fuels.

Summary of ARFVT Program Funding

Earlier projects funded by the ARFVT Program have provided important feedback on opportunities and challenges facing alternative fuels and vehicles. The Energy Commission has received and reviewed more than 350 proposals requesting funds for nearly $1.3 billion. To date, the Energy Commission has invested about $204.2 million in projects that will support alternative and renewable fuels and advanced vehicle technologies. Table 1 summarizes the ARFVT Program awards made thus far by fuel type and supply phase, as well as the upcoming funding available from previous fiscal years and the proposed funding allocations for the *2012-2013 Investment Plan Update*.

Table 1: Summary of Previous, Upcoming, and Proposed Funding (in Millions)

Category	Funded Activity	Funded to Date (FYs 2008-2009, 2009-2010, 2010-11*)	Remaining Funds From Previous Fiscal Years (FYs 2010-11*, 2011-2012)	FY 2012-2013 Investment Plan Update
Alternative Fuel Production	Biomethane Production	$35.3	$13.3	$20.0
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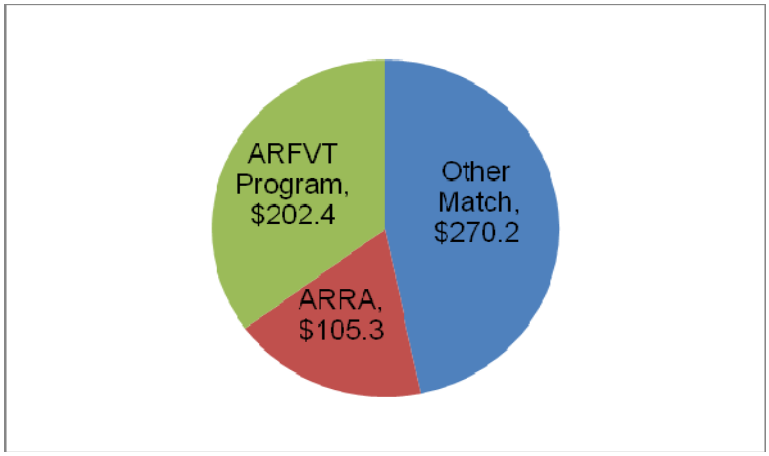
	E85 Fueling Infrastructure	$5.0	$10.1	$1.5
	Upstream Biodiesel Infrastructure	$3.9	$3.1	-
	Natural Gas Fueling Infrastructure	$5.1	$9.6	$1.5
	Propane Fueling Infrastructure	-	0.5	-
Alternative Fuel and Advanced Technology Vehicles	Natural Gas Vehicle Deployment	$29.3	$6.3	$12.0
	Propane Vehicle Deployment	$1.7	$4.0	$2.0
	Light-Duty Electric Vehicle Deployment	$2.6	-	$5.0
	Medium- and Heavy-Duty Electric Vehicle Deployment	$4.0	-	-
	Medium- and Heavy-Duty Advanced Vehicle Technology Demonstration	$17.0	$16.9	$6.0
Emerging Opportunities	Innovative Technologies, Advanced Fuels, and Federal Cost-Sharing	-	$9.3	$5.0
Manufacturing	Manufacturing Facilities and Equipment	$25.9	$10.0	$20.0
Workforce Agreements	Workforce Development and Training	$15.0	$7.3	$2.5
Market and Program Development	Fuel Standards and Equipment Certification	$4.0	-	-
	Sustainability Studies	$1.5	$2.5	-
	Regional Planning	-	$2.0	$3.0
	Centers for Alternative Fuels and Advanced Vehicle Technology	-	-	$3.0
	Technical Assistance and Analysis	$2.1	$5.7	-
	Measurement, Verification, and Evaluation	-	$1.7	-
Total		$204.2	$152.4	$100.0

Source: California Energy Commission. *Only a portion of funds from FY 2010-2011 have been committed; the remainder will be committed in current or upcoming solicitations and agreements.

Assembly Bill 118 directs the Energy Commission to leverage state public investments with private financing and other public funding sources (Figure 1). This leverage typically occurs at two points in implementing the ARFVT Program: developing the *Investment Plan*, and during the solicitation for project proposals. Outside contributions to the funded projects are about $375.5 million. So far, the largest public funds leveraged by the program have been the federal dollars available through the American Reinvestment and Recovery Act (ARRA) of 2009. The ARFVT Program funded nine projects totaling $36.5 million that received a total of $105.3 million in ARRA funding. California's air quality management districts (AQMDs) have also partnered in funding projects supported by the program, especially the South Coast, Bay Area, San Diego, and San Joaquin Valley AQMDs.

Figure 1: Project Funding Sources (In Millions)



Source: California Energy Commission.

As part of the *2011 Integrated Energy Policy Report*, the Energy Commission has prepared its first benefits report on the ARFVT Program.[6] The benefits report summarized the investments made by the ARFVT Program to date and identified the anticipated benefits from the fuels and technologies supported by the ARFVT Program. While the Energy Commission does not assume credit for all the benefits, the report identifies a range of potential benefits from the fuels and technologies supported by the ARFVT Program. This includes an estimated range of 380.4 million to 1.2 billion gallons of petroleum fuel displaced per year by 2020, as well as a reduction of 2.7 million to 9.7 million carbon dioxide equivalent metric tonnes of GHG emissions per year by 2020. For context, California's diesel and gasoline demand is expected to reach roughly 18 billion gallons per year by 2020, and the state's GHG emissions from the transportation sector under a "business as usual" case would be roughly 189.3 million carbon dioxide equivalent metric tonnes of GHG emissions per year by 2020.[7] Based on a survey of grant recipients, the

6 McKinney, Jim, Charles Smith, Andre Freeman, Pilar Magaña, Darcie Chapman. 2011. *Benefits Report for the Alternative and Renewable Fuel and Vehicle Technology Program*, Staff Draft Report. California Energy Commission, Fuels and Transportation Division. Publication Number: CEC-600-2011-008-SD. Available at: http://www.energy.ca.gov/2011publications/CEC-600-2011-008/CEC-600-2011-008-SD.pdf.

7 ARB, "Greenhouse Gas Inventory – 2020 Emissions Forecast," http://www.arb.ca.gov/cc/inventory/data/forecast.htm. This represents a "business as usual" case and

Energy Commission also estimates roughly 1,900 short-term jobs and nearly 3,500 long-term jobs will be directly generated by funded projects. This does not include other indirect jobs that may be created throughout the supply chain, such as jobs from the manufacturing of components or associated equipment.

Air Quality Improvement Program

The Air Quality Improvement Program (AQIP), administered by the California Air Resources Board (ARB), is the companion program to the Energy Commission's ARFVT Program. Like the ARFVT Program, the AQIP was established by AB 118 (Núñez, Chapter 750, Statutes of 2007) and provides up to $40 million per year through 2015 for clean vehicle and equipment projects that reduce criteria pollutants and GHG emissions. The AQIP is guided by an annual funding plan prepared by the ARB.

The AQIP has focused its funding primarily on providing vehicle deployment incentives. Light-duty plug in electric vehicles (PEVs), including both fully electric vehicles and plug-in hybrid electric vehicles, are eligible for incentives through the AQIP's Clean Vehicle Rebate Project (CVRP). Medium- and heavy-duty hybrid and fully electric trucks are also eligible for incentives through the AQIP's Hybrid and Zero-Emission Truck and Bus Voucher Incentive Program (HVIP). Table 2 shows the total amount of funding allocated by the ARB for the CVRP, the HVIP, and other activities funded by the AQIP during the program's first three fiscal years.[8] To date, the CVRP has reserved and issued rebates for more than 5,000 vehicles, while the HVIP has reserved and issued rebates for more than 1,000 trucks and buses to date. To help meet the demand for these funds, the Energy Commission provided $2 million to supplement the CVRP, as well as $4 million specifically for all-electric trucks under the HVIP, with funding from FY 2009-2010.

Table 2: AQIP Funding Allocations (in Millions)

	FY 2009-10	FY 2009-10 (Energy Commission)	FY 2010-11	FY 2011-12	Total
CVRP	$4.1	$2	$5	$15	$26.1
HVIP	$20.4	$4	$19	$11	$54.4
Other	$4.5	-	$4.9	$2	$11.4
Total	$29	$6	$28.9	$28	$91.9

Source: Air Resources Board, California Energy Commission.

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does not incorporate the impacts of measures discussed in the ARB's *AB 32 Scoping Plan*. For more detail, see the ARB's *Final Supplement to the AB 32 Scoping Plan Functional Equivalent Document*, available at: http://www.arb.ca.gov/cc/scopingplan/document/final_supplement_to_sp_fed.pdf.

8 ARB, *AB 118 Air Quality Improvement Program Funding Plan for Fiscal Year 2011-2012*, July 21, 2011. Available at: http://www.arb.ca.gov/msprog/aqip/fundplan/final_approved_aqip_fy2011_funding_plan.pdf.

The Energy Commission's ARFVT Program and the ARB's AQIP provide opportunities for complementary funding strategies. For example, the Energy Commission has statutory authority from AB 118 to fund infrastructure projects for alternative and renewable fuels, while the ARB does not. While both agencies can fund vehicle technology development projects and commercial deployment projects for electric vehicles, the Energy Commission has focused a greater share of its funding on the former while the ARB has predominantly supported the latter. The Energy Commission also provides vehicle deployment incentives but primarily for natural gas and propane vehicles. Based on anticipated need, the Energy Commission partnered with the ARB's HVIP to provide a higher level of incentive for all-electric medium- and heavy-duty vehicles.

As with previous investment plans, the Energy Commission will adopt the *2012-2013 Investment Plan Update* in collaboration with the ARB's adoption of the *2012-2013 Funding Plan* for the AQIP. The Energy Commission will continue to work with the ARB to assess the funding needs for AQIP projects, especially the CVRP and HVIP. In a discussion document for the development of the *2012-2013 Funding Plan*, the ARB staff outlines the anticipated changes to the funding eligibility and amounts of the CVRP and HVIP.[9]

Low Carbon Fuel Standard

Executive Order S-01-07 established the Low Carbon Fuel Standard (LCFS) in January 2007, with a goal of reducing the carbon intensity of California's transportation fuels by 10 percent by 2020. In April 2009, the ARB adopted the LCFS regulation, and regulated parties (including fuel producers and importers) began filing quarterly progress reports in 2010. The first implementation year was 2011, when regulated parties had to reduce the carbon intensity of their transportation fuel by 0.25 percent. The Board approved proposed amendments to the LCFS regulation in December 2011, including major changes to the electricity provisions and the treatment of high carbon-intensity crude oil, and minor changes to the regulation's opt-in and opt-out provisions, credit trading, and vehicles' energy economy ratios. The 10 year LCFS schedule requires a gradual reduction in average carbon intensity for the first several years, followed by steeper reductions in the remaining years.[10] The LCFS measures the carbon

9 ARB, *AB 118 Air Quality Improvement Program (AQIP) FY 2012-13 Funding Plan Staff Discussion Document*, April 10, 2011. Available at: http://www.arb.ca.gov/msprog/aqip/meetings/AQIPdiscussion-final4-10-12.pdf.

10 On December 29, 2011, the U.S. District Court for the Eastern District of California issued several rulings in the federal lawsuits challenging the LCFS, one of which preliminary enjoined the ARB from enforcing the regulation during the pendency of the litigation. On April 23, 2012, the U.S. Court of Appeals for the Ninth Circuit stayed the District Court's injunction and ordered expedited briefing on the issues, allowing ARB to enforce the LCFS while the Court of Appeals considers the appeal. To the extent that stakeholders have requested guidance or biofuel producer registrations, or stakeholders or the Board has requested modifications to the regulation, ARB will continue its stakeholder and rulemaking processes.

intensity of regulated parties' fuels based on the lifecycle GHG emissions used to produce and distribute those fuels in grams of carbon dioxide-equivalent per megajoule of energy provided (gCO_2e/MJ). While the LCFS regulation is neutral toward specific fuel types, the ARB has developed a series of illustrative scenarios for compliance, each relying on steady increases in the use of low-carbon alternative fuels and vehicles.[11]

The Energy Commission expects the LCFS to have a significant early impact on the state's efforts to reduce GHG emissions by expanding demand for alternative fuels. The LCFS will provide an economic incentive for regulated fuel producers and importers to invest in the expanded deployment of a variety of low-carbon alternative fuels. Entities that are not automatically "regulated parties" may choose to "opt in" to the regulation, generating and selling credits. These credits may provide a key source of revenue to alternative fuel producers and distributors that will allow them to recoup the higher costs of their product. Accordingly, the prospect of LCFS credits should further support the projects and technologies funded by the ARFVT Program.

Renewable Fuel Standard

The Energy Policy Act of 2005 established the Renewable Fuel Standard Program (RFS), which was revised under the Energy Independence and Security Act of 2007 into the RFS2. The RFS2 mandates 36 billion gallons of renewable fuel to be blended into transportation fuels nationwide by 2022. Within this volume, the RFS2 also establishes four specific types of renewable fuel, each with its own target for 2022. Of the four types, the largest volume of renewable fuel is expected from cellulosic biofuel (15 billion gallons by 2022) and conventional, starch-derived biofuel (15 billion gallons by 2022). Regulated parties (such as refiners, importers, and blenders) have minimum yearly calculated blending obligations that gradually rise through 2022.

The RFS2 will allow for credits to be generated and traded by producers and distributors of alternative fuels. Companies can generate renewable identification number (RIN) credits for excess renewable fuels, which may be purchased or sold by other companies for compliance purposes. As a result, RIN credits can provide an additional stream of revenue for biofuel producers and distributors, and, like the LCFS, could provide support for projects and technologies funded by the ARFVT Program. Unlike the LCFS, the RFS2 is fuel-specific. It will support conventional and advanced biofuels but will not directly support alternative fuel vehicles, such as electric, fuel cell, or natural gas vehicles.

Zero Emission Vehicle Program

The Zero Emission Vehicle (ZEV) regulation was adopted in 1990 and has been modified several times since then. In March 2008, the ARB directed staff to begin redesigning the ZEV regulation requirements for model year 2015 and later vehicles, emphasizing battery electric

11 ARB, "LCFS Program Review Advisory Panel," http://www.arb.ca.gov/fuels/lcfs/workgroups/advisorypanel/advisorypanel.htm.

vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs), and fuel cell vehicles (FCVs).[12] In December 2009, the Board also directed its staff to consider shifting the focus of the ZEV regulation to include GHG emissions and criteria pollutants, and to incorporate the state's goal of reducing GHG emissions to 80 percent below 1990 levels by 2050.

ARB staff anticipates more than 1.4 million BEVs, PHEVs, and FCVs on the road by 2025, with 500,000 vehicles being either BEVs or FCVs.[13] In January 2012, the ARB revised to the ZEV regulation. For model year 2018 and following years, the revisions increased the required number of credits for ZEV regulation compliance, refocused the regulation away from partial zero-emission vehicles and advanced technology partial zero-emission vehicles (which are now considered fully commercialized), and modified the credits available for different vehicle types.

Clean Fuels Outlet Regulation

The Clean Fuels Outlet (CFO) Regulation is intended to ensure fueling infrastructure is available for the alternative fuel vehicles that might be required by ARB regulations. The CFO Regulation was amended by the ARB at a board meeting on January 27, 2012. To integrate the CFO Regulation with the ZEV regulation, the CFO Regulation now focuses solely on the fuels of zero emission vehicles. Given FCVs' dependence on publicly available fueling stations, the amended CFO Regulation would focus primarily on ensuring adequate hydrogen fueling infrastructure. (Electricity is not initially covered under the CFO Regulation, but the ARB will reevaluate the need to support workplace and public charging infrastructure in the future.) The responsibility for complying with the CFO Regulation also shifted from the owners of retail gasoline outlets to the producers and importers of gasoline.

As adopted, these amendments will help ensure hydrogen fueling stations are available for a growing number of FCVs once original equipment manufacturers (OEMs) project a regional volume of 10,000 FCVs or a statewide volume of 20,000 FCVs. In combination with state incentives for stations built prior to these trigger points, the regulation will assure hydrogen availability for customers as the market for FCVs grows and a sustained business case for hydrogen fuel is developed.

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12 "Battery electric vehicles" refers to vehicles that operate exclusively on electricity. "Plug-in hybrid electric vehicles" refers to vehicles that operate on a mixture of gasoline and electricity and plug in to recharge.

13 California Air Resources Board, *Staff Report: Initial Statement of Reasons, Advanced Clean Cars, 2012 Proposed Amendments to the California Zero Emission Vehicle Program Regulations*, December 7, 2011. Available at: http://www.arb.ca.gov/regact/2012/zev2012/zevisor.pdf.

CHAPTER 3: Alternative Fuels and Advanced Vehicle Technology Opportunities

The Energy Commission recognizes that all alternative fuel pathways have unique risks and benefits, and that no single fuel or vehicle technology may be applicable for all purposes. As a result, the Energy Commission evaluates funding opportunities for the ARFVT Program based on a portfolio of fuels and technologies, and short-, medium-, and long-term opportunities.

Previous fiscal years' investment plans provided a comprehensive narrative for each type of alternative fuel. The *2012-2013 Investment Plan Update* represents the first investment plan that will serve as an "update," according to statute.[14] The *2012-2013 Investment Plan Update* does not provide the same comprehensive walkthrough of the supply chain for each alternative fuel type. Instead, the *2012-2013 Investment Plan Update* focuses specifically on ARFVT Program updates, changes in the alternative fuel and advanced vehicle markets, changes to relevant policies and regulations, and how these affect the *2012-2013 Investment Plan Update's* funding allocations. A more comprehensive review of the alternative fuels and technologies discussed in this report is available in the *2011-2012 Investment Plan*, adopted by the California Energy Commission in September 2011.[15] The latter plan evaluates public and private funding that is already helping to develop and deploy alternative and renewable fuels and vehicle technologies, and assesses where remaining gaps exist and funding is needed. The resulting funding allocations are intended to reflect the unique technological and market hurdles for each of these fuels and technologies, rather than any rank-order preference for the fuels and technologies.

This chapter looks at the broader supply chain for all alternative fuels (ranging from fuel production, to fuel infrastructure, to alternative fuel vehicles) and focuses on the areas previously funded by the ARFVT Program. Any important updates that might affect these areas are discussed, as well as the proposed funding allocations for FY 2012-2013.

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14 AB 1314 (Wieckowski, Chapter 487, Statutes of 2011).

15 Smith, Charles, Miles Roberts, Jim McKinney. 2011. *2011-2012 Investment Plan for the Alternative and Renewable Fuel and Vehicle Technology Program,* Commission Report. California Energy Commission, Fuels and Transportation Division. Publication Number: CEC-600-2011-006-CMF. Available at: http://www.energy.ca.gov/2010-ALT-1/index.html.

Alternative Fuel Production and Supply

Biofuel Production and Supply

Biofuels, including gasoline substitutes, diesel substitutes, and biomethane, represent the largest category of alternative fuel use in California today.[16] Due to their compatibility with California's existing fleet of light-, medium- and heavy-duty vehicles, these low-carbon substitute fuels have the potential for immediate, high-volume impacts on California's fuel markets, which included roughly 14.8 billion gallons of gasoline and 3.3 billion gallons of diesel in 2010.

Ethanol is the best known example of these alternative fuels, with nearly 1.5 billion gallons of ethanol consumed by California vehicles in 2010. The vast majority of this is blended into reformulated gasoline (roughly 10 percent by volume), based on the state's oxygenate requirements for reformulated gasoline. In 2011, the U.S. Environmental Protection Agency (U.S. EPA) granted certain waivers to allow up to 15 percent ethanol in reformulated gasoline for use in model year 2001 and newer vehicles. This blend level is not currently certified for use in California vehicles. If this changes, however, the total amount of ethanol blended in California reformulated gasoline could grow dramatically.

While ethanol use in most of California's vehicles is limited to 10 percent, roughly 450,000 of California's vehicles (1.5 percent) are flex-fuel vehicles (FFVs), meaning they can use up to 85 percent ethanol (also known as E85) in their fuel.[17] In 2010, roughly 10 million gallons of E85 were sold, a small fraction of California's overall ethanol demand. This is largely due to the comparatively low number of FFVs, the higher price of E85 compared to gasoline (typically 10-25 percent higher on an energy equivalent basis), and the small number of stations that dispense E85.

Despite the significant current (and potential) ethanol demand by California vehicles, only a small portion of this ethanol is produced within the state. Currently California ethanol refiners are producing 170 million gallons each year out of a capacity of 241 million gallons.[18] The remainder is imported into California, primarily from ethanol production facilities in the Midwest. Nearly all ethanol currently produced and used within California is derived from corn.

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16 As used in this and previous investment plans, "gasoline substitutes" refers to any liquid fuel that can directly displace gasoline in internal combustion engines, including ethanol and renewable drop-in gasoline substitutes. Similarly, "diesel substitutes" refers to any liquid fuel that can significantly displace diesel, including biodiesel, renewable diesel, and renewably derived dimethyl ether (assuming fuel system modifications). These definitions differ from similar terms used by the ARB under the LCFS, which are broader and include fuels such as electricity, natural gas, and hydrogen.

17 Schremp et al. 2011. *Transportation Energy Forecasts and Analyses for the 2011 Integrated Energy Policy Report.* California Energy Commission. CEC-600-2011-007-SD.

18 Ibid.

California has an in-state production capacity of roughly 84.5 million gallons per year. In 2010, California vehicles consumed about 5.4 million gallons of biodiesel, the majority of which is believed to derive from in-state production. In the past, soybean oil has been used for 30 to 60 percent of California's biodiesel supply. Like ethanol, the majority of California's consumed biodiesel is blended with conventional fuel at low levels (typically ranging from 5 to 20 percent biodiesel, depending on available distribution infrastructure and vehicle warranty provisions). However, unlike ethanol, there is no required minimum blend level with conventional fuel, and as a result, California demand for biodiesel has not been as significant as ethanol.

Renewable gasoline and renewable diesel, consisting of drop-in liquid fuels that are compatible with gasoline and diesel vehicles and infrastructure, also hold the potential to expand into the existing fleet of California vehicles. Unlike ethanol and biodiesel, these drop-in fuels are functionally identical to gasoline and diesel fuel. This means that they can be used in existing vehicles at higher blend levels and do not require specialized distribution and retail infrastructure. These fuels are still in early phases of commercialization and are not yet broadly available.

There is also a growing opportunity to incorporate renewable fuels into the aviation sector. The Federal Aviation Administration allows the commercial use of any fuel that meets American Society for Testing Materials (ATSM) standards that were developed in 2011. Several government entities, including U.S. Department of Defense, U.S. Department of Energy (U.S. DOE), the U.S. Environmental Protection Agency, and the U.S. Department of Agriculture, have funded projects to develop renewable jet fuel, and numerous airlines worldwide have begun incorporating renewable jet fuel into their flights. Within California, there is significant volume potential for renewable aviation fuel, roughly 3 billion gallons of conventional jet fuel annually.[19] Additionally, the majority of this fuel is distributed through a small number of primary airports, which makes it easier to integrate large volumes of renewable fuels.

California has an array of feedstocks available for alternative and renewable fuels. The *FY 2011-2012 Investment Plan* summarizes the most significant feedstocks available within and beyond the state. This includes sufficient waste-based feedstock volumes to displace anywhere from 2.7 billion to 3.1 billion gallons of conventional fuels.[20]

The Energy Commission has invested and allocated a significant portion of the ARFVT Program's funding toward expanding California's in-state production of low-carbon alternative fuels. Using funds from the first and second ARFVT Program investment plans, about $45 million has been allocated for 17 projects that will develop, demonstrate, and deploy next-generation technologies for biofuel production within California. These include projects that use a wide variety of feedstocks, including waste-based resources, algae, and crops that can be grown on marginal lands. These also include the first in-state production of ethanol from

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19 Ibid.

20 California Energy Commission, *2011-2012 Investment Plan for the Alternative and Renewable Fuel and Vehicle Technology Program*. See Table 21, page 79.

sorghum, sugar beets, and cellulosic processes. Commercial-scale biomethane production from waste-based resources comprised the majority of the project funds. The Energy Commission staff's estimated average carbon intensity for these projects is shown in Table 3, based on the projects' similarities to pathways described in the LCFS regulation.[21] These values are well below the average carbon intensity of first-generation corn-based ethanol and soy-based biodiesel. (The carbon intensity values for California Reformulated Gasoline Blendstocks for Oxygenate Blending and diesel fuel in Table 3 do not account for amendments to the LCFS regulation from December 2011.)[22]

Table 3: Descriptions and Estimates of GHG Emissions for Funded Biofuel Production Projects

Fuel	Description of GHG Emission Estimates	GHG Emission Estimates (gCO_2e/MJ)[23]
California Reformulated Gasoline	(Displaced by ethanol projects)	95.86
Diesel	(Displaced by biomethane and diesel substitute projects)	94.71
Biomethane	Based on LCFS values for landfill and dairy gas feedstocks to produce compressed natural gas.	12.0
Diesel Substitutes	Based on LCFS values for non-soy, waste-based feedstocks for biodiesel and renewable diesel.	15.0
Ethanol	Based on applicants' supplied values for agricultural waste feedstocks, domestic sugar beet feedstocks, and sweet sorghum.	25.0[24]

Source: Air Resources Board Low Carbon Fuel Standard lookup tables; California Energy Commission.

Based on survey data from grant awardees, as well as details of their plans for the potential expansion, the 17 funded projects have the potential to annually displace 124 million to 632 million gallons of petroleum-based fuels by 2020 and reduce annual GHG emissions by 1.3 million metric tons to 6.7 million metric tons by 2020. The lower, more conservative estimate for biofuel production represents roughly 15 percent of the *Bioenergy Action Plan*'s goal of meeting 40 percent of California's biofuel demand with in-state supply by 2020.[25]

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21 For more details on the LCFS regulation's carbon intensity values, see the illustrative LCFS scenarios available at the ARB's LCFS Advisory Panel page, http://www.arb.ca.gov/fuels/lcfs/workgroups/advisorypanel/advisorypanel.htm.

22 ARB, "Regulatory Advisory – Low Carbon Fuel Standard (LCFS) Supplemental Regulatory Advisory 10-04B," http://www.arb.ca.gov/fuels/lcfs/123111lcfs-rep-adv.pdf.

23 Includes any appropriate impacts from indirect land use change, as determined by the LCFS.

24 This estimate reflects a combination of applicants' supplied values when comparative fuel pathways could not be found in the LCFS. As such, they are subject to revision.

25 O'Neill, Garry, John Nuffer. 2011. *Draft 2011 Bioenergy Action Plan*. California Energy Commission, Efficiency and Renewables Division. Publication Number: CEC-300-2010-012-SD.

With remaining funds from the second and third *Investment Plan*, the Energy Commission has provided $37.7 million in a recent solicitation (PON-11-601) for projects that will support biofuel production.[26] This includes roughly $11.9 million for diesel substitutes, $12.5 million for gasoline substitutes, and $13.3 million for biomethane. The solicitation can be augmented to increase the total funding (for any fuel types) by up to an additional $30 million. To be eligible, gasoline substitute and diesel substitute production projects must have lifecycle carbon intensities substantially lower than California-produced ethanol from Midwest corn (for gasoline substitutes) or soy-based biodiesel (for diesel substitutes). Biomethane production projects must use prelandfill waste-based biomass sources.[27]

Additionally, projects are scored based on several criteria, including sustainability criteria, which consist of GHG reduction, petroleum reduction, natural resource impact, feedstock sourcing, and sustainability certification. Projects score higher based on their usage of waste-based feedstocks, reduced impacts on natural resources, and use of marginal or abandoned land. Together, the sustainability criteria comprise roughly one-quarter of the possible scoring points. [28]

For FY 2012-2013, the Energy Commission intends to allocate $20 million for production of gasoline substitutes, diesel substitutes, biomethane, and renewable aviation fuels. This funding will emphasize fuels that can be produced from lower carbon, sustainably derived feedstocks, as well as drop-in fuels that can use existing infrastructure. Unlike in previous investment plans, this allocation will not be divided between specific types of fuels. This will help ensure that funds go to the highest scoring project proposals (not just the highest scoring within a particular fuel type) and reduce the number of partially funded awards. The evaluation criteria used for funding new projects will be similar to those used in the recent biofuel production solicitation. Also similar to the previous solicitation, the Energy Commission may place a funding cap on each proposed project, depending on the commercialization phase. (Early development projects, for instance, may be capped lower than full-scale commercial deployment projects.) Existing in-state producers are eligible and encouraged to apply for project funding that can support the reduction of their products' carbon intensity, a transition to advanced conversion technologies, the use of waste-based feedstocks, and the production of marketable coproducts.

The Energy Commission will also consider funding activities that can connect alternative fuels suppliers to guaranteed consumers. The uncertainty of demand has been a challenging obstacle for potential biofuel producers. Similarly, the production of in-state fuels may depend on the

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26 More information on this solicitation can be found at: http://www.energy.ca.gov/contracts/PON-11-601/.

27 While ARFVT Program funding for biomethane has been restricted to prelandfill projects to date, the Energy Commission remains interested in the potential for capturing landfill gas for treatment into biomethane. This may be the subject of future stakeholder inquiries and workshops, especially in the development of the *2013-2014 Investment Plan Update*.

28 Ibid. For more detail on the scoring criteria, see Addendum 1.

added value of lower carbon alternative fuels. The LCFS and RFS2 mandates, as well as any cap-and-trade regulation, may have critical roles in providing this incremental value.

Table 4: Alternative Fuel Production and Supply Funding Allocation

Biofuel Production and Supply	$20 Million

Source: California Energy Commission.

Alternative Fuel Infrastructure

Electric Vehicle Charging Infrastructure

Ensuring adequate charging infrastructure is critical in encouraging the deployment of PEVs. Residential chargers for single-family and multifamily dwellings represent the most convenient method of charging for most vehicle owners. This also represents the first preferred strategy for charging, since most residential charging is expected to be done overnight, when overall electricity demand is lowest. Level 1 charging, using a typical 120-volt, household outlet, may satisfy many PEV owners. This rate of charging may provide only 4 to 5 miles of vehicle range per hour spent charging (or roughly 40 to 45 miles of range per eight hours charged). Level 2 chargers (240 volt) will likely be preferable for owners of PHEVs and BEVs, as both can replenish 12 to 15 miles of vehicle range per hour charged.[29] However, the cost of the added equipment and installation for this level of charging can range from several hundred to several thousand dollars.[30]

In urban areas and population centers, not every household will have access to a dedicated parking space, and a much higher proportion of the population lives in multiunit dwellings. This is particularly challenging in California, where consumers in early adopter regions (such as San Francisco and Los Angeles) are less likely to have a garage than consumers in other areas. Roughly half of California residents do not live in a home with a garage, and the number is closer to 62 percent in Los Angeles and 80 percent in San Francisco.[31] The role of charging infrastructure within multiunit dwellings is complex, and solutions must be diverse. Several electric utilities and local governments are developing and implementing different projects to determine the best ways to ensure adequate charging opportunities for PEV owners in multi-unit dwellings.

After residential charging, workplace charging and fleet charging represent the second highest priority for expanding charging infrastructure. Workplace charging typically takes place after an employee's arrival at their employer's building, several hours ahead of the day's typical peak electricity demand. Fleet-owned PEVs typically charge at night, and most have regular, predictable driving routes (though some may vary).

Additional charging opportunities may also be required as consumers adjust to a new technology. Deploying commercial and public charging stations will allow PEV owners to feel more comfortable relying on the electric range of their vehicles. The Energy Commission continues to assess the need for public chargers, as government support for public charging infrastructure will likely be necessary until there are sufficient numbers of PEVs to provide a

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29 Electrification Coalition, *Electrification Roadmap, Revolutionizing Transportation and Achieving Energy Security*, November 2009.

30 California Energy Commission, *2011-2012 Investment Plan for the Alternative and Renewable Fuel and Vehicle Technology Program*.

31 Ibid.

business case for the installers of public charging stations. Public charging may also increase the on-peak demand for electricity (depending on time of use) and may need to be paired with smart grid integration, energy storage, and/or renewable electricity generation to reduce impacts to the grid. Overall, the Energy Commission staff estimates the grid-level impacts from PEV charging to be relatively minor, with an annual electricity demand of roughly 1,834 gigawatt hours by 2020 (out of a systemwide total of 316,066 gigawatt hours). Peak electricity demand from PEV chargers is also estimated to be minor by 2020, at 78 megawatts (out of a systemwide total of nearly 69,000 megawatts).[32]

Fast chargers, which can fully recharge a BEV in 15 to 30 minutes at about 440 volts, are an opportunity for encouraging customer interest and confidence with BEVs. Due to the uncertain market for fast chargers, public partners (including federal, state, and local agencies) have had an important role in planning fast charger deployment. Early plans for fast chargers have focused on fast chargers in urban regions, followed by connecting corridors. About 100 fast chargers are planned to be installed California, and more installations must balance vehicle owners' demands with grid reliability and cost issues. However, recent interest in fast chargers by BEV automakers might increase additional installations.

Currently, there is no single universal standard for fast chargers. One standard, known as CHAdeMO, is being used by early market BEVs such as the Nissan Leaf and the Mitsuibishi i-MiEV. Another standard, still under development by SAE International, is commonly known as the Combo Charger. Several major OEMs (including BMW, Chrysler, Ford, and General Motors) support this standard. The Energy Commission supports charging infrastructure that can support either (and preferably both) of these standards. The Energy Commission will continue to monitor and evaluate the potential impacts of these stations on the local distribution system.

On May 23, 2012, Governor Brown issued an Executive Order directing the Energy Commission, ARB, and the California Public Utilities Commission to work with the Plug-in Electric Vehicle Collaborative and California Fuel Cell Partnership to develop the infrastructure that will accommodate zero-emission vehicles from 2015 through 2025.[33] Along with the Executive Order, the Governor announced a settlement by the California Public Utilities Commission with NRG Energy, Inc., that will support the further construction of at least 200 fast chargers and a minimum of 10,000 other chargers in at least 1,000 locations around the state. This will vastly expand the availability of fast chargers, residential chargers, and workplace chargers throughout the state, primarily within the service territories of investor-owned utilities. Details regarding the implementation of this new initiative are still under development. The Energy Commission will coordinate with NRG Energy, Inc., on the deployment of this charging infrastructure. In the interim, the Energy Commission will

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32 California Energy Commission, "Mid-Case Preliminary Demand Forecast Forms," http://www.energy.ca.gov/2012_energypolicy/documents/2012-02-23_workshop/mid_case/

33 Office of Governor Edmund G. Brown Jr., "Governor Brown Announces $120 Million Settlement to Fund Electric Car Charging Stations Across California," http://gov.ca.gov/news.php?id=17463.

continue to assess and determine whether and how additional ARFVT Program funds for charging infrastructure should be allocated.

To date, the ARFVT Program has provided about $17.4 million in funding for 4,375 residential and public charger installations, about a 344 percent increase over the existing number of stations in 2009-2010.[34] Due to these investments, and other similar incentives provided by other public entities, California now possesses the largest network of charging infrastructure in the country. The Energy Commission is also providing $2 million to support streamlining regional permitting, installation, and inspection of charging infrastructure, as well as preparing regional infrastructure installation plans. Using funds from the *2011-2012 Investment Plan,* an additional $7 million will be available based on a recent solicitation for a variety of charging infrastructure types. For FY 2012-2013, the Energy Commission will reserve $7.5 million for charger installations, strategies for extending electric drive range, and supporting activities, and will continue to review the need and opportunities for further charging infrastructure funding in the future.

Hydrogen Fueling Infrastructure

Based on automaker surveys, the number of FCVs in California is expected to significantly increase from about 350 in 2011 to 53,000 by 2017. The CFO Regulation includes one upper-bound scenario that includes as many as 124,000 FCVs by 2020.[35] Based on estimates developed for the Energy Commission's *Integrated Energy Policy Report*, this number of vehicles could displace 67.6 million gallons per year of gasoline by 2020.[36] Adequate fueling infrastructure, however, must be available for these vehicles to launch successfully into the market. Working with automakers, the California Fuel Cell Partnership, and the ARB, the Energy Commission has identified anticipated regions of early FCV deployment.

Given the high upfront cost of hydrogen fueling infrastructure, public funding for these stations is necessary until FCVs can support their growth and continued operation. Currently, there are only six publicly available fueling stations within California. Several of these existing stations are no longer state-of-the-art, provide very limited fueling capacity, and offer only low-pressure refueling. The ARB has provided funding for five additional stations, scheduled to be on-line this year. With funds allocated from the *2008-2010 Investment Plan*, the Energy Commission has awarded $15.7 million in ARFVT Program funding for a total of 11 stations: 8 new, and 3 upgrades. Once completed, this will bring the total number of hydrogen fueling stations in California to 19 in 2012. Also using funds from the *2008-2010 Investment Plan*, the Energy

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34 McKinney, Jim, Charles Smith, Andre Freeman, Pilar Magaña, Darcie Chapman. 2011. *Benefits Report for the Alternative and Renewable Fuel and Vehicle Technology Program*, Staff Draft Report. California Energy Commission, Fuels and Transportation Division. Publication Number: CEC-600-2011-008-SD.

35 California Air Resources Board, *Staff Report: Initial Statement of Reasons, Advanced Clean Cars, 2012 Proposed Amendments to the Clean Fuels Outlet Regulation*, December 8, 2011. Available at: http://www.arb.ca.gov/regact/2012/cfo2012/cfoisor.pdf.

36 California Energy Commission, 2011. *2011 Integrated Energy Policy Report***.** Publication Number: CEC-100-2011-001-CMF.

Commission provided funding for the developing hydrogen retail standards. This work, done under contract by the California Department of Food and Agriculture's Division of Weights and Measures, is critical to allowing hydrogen to be sold as a retail fuel on a per-kilogram basis.

The Energy Commission issued a second solicitation for hydrogen infrastructure projects that ended in March 2012. This solicitation will include $18.7 million, which (based on previous solicitations' project costs) should be adequate for 12 to 18 additional hydrogen fueling stations and bring the total number of public retail hydrogen stations in California to between 31 to 37.

Based on the automakers' survey, the California Fuel Cell Partnership anticipates a need for about 45 stations in critical regions by the end of 2014 for the successful expansion of FCVs, and about 68 stations by the end of 2015. The latter assumes the need for 46 stations to allow for a roughly 8 minute travel time to stations within the key deployment clusters, as well as 22 additional stations for connector locations, destination locations, and the development of new clusters.[37]

In addition to station coverage, station capacity in high-demand areas will be a critical part of hydrogen station deployment. To date, the Energy Commission has funded stations with nominal capacities ranging from 180 kilograms per day to 240 kilograms per day (though functional capacity may vary). As increasing numbers of FCVs are deployed into early adopter clusters, these clusters may require new stations with larger capacities and accelerated dispensing rates.

In the coming years, sustained capital will be required for expanding new hydrogen stations and the continued operation of existing hydrogen stations. The ARB's proposed amendments to the CFO regulation would require major gasoline importers and refiners to support the installation and operation of hydrogen stations once the number of FCVs reaches 20,000 statewide (or 10,000 within a single air basin). Simultaneously, there are ongoing efforts among hydrogen stakeholders to identify other means of financing the stations' long-term expansions and operations. Under both of these approaches, however, short-term funding for the expansion of hydrogen fueling stations will be needed leading up to FCVs' commercial launch.[38] For this reason, the Energy Commission will provide $11 million for expanding light-duty FCV access to hydrogen fueling stations.

A critical issue for hydrogen station developers and operators is how to cover negative operating expenses for new stations in the early years of operation, preceding the wide-scale commercial sales of FCVs in 2014 and 2015. The Energy Commission modified its recent $18.7 million solicitation to provide for partial operating cost recovery for new stations. Accordingly,

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37 McClory, Matt. "AB 118 PON-11-609 Bidders Workshop: OEM Workgroup Recommendations." Presented at the February 22, 2012, California Energy Commission Application Workshop for Solicitation PON-11-609, Hydrogen Fuel Infrastructure. Available using WebEx Player at: http://www.energy.ca.gov/contracts/PON-11-609/PON-11-609_workshop_webex.wrf.

38 For more details on this need, see the larger discussion of hydrogen fueling infrastructure in the *2011-2012 Investment Plan* (pages 57-60).

for FY 2012-2013, the Energy Commission will consider a capped level of funding for the continued operations and maintenance of new stations, while supporting a long-term goal of self-sufficiency for station owners to cover these costs. This may be particularly important for stations with a lower early throughput of vehicles.

As with previous allocations to this category, the Energy Commission will work closely with automakers and other stakeholders to identify the most critical needs for hydrogen fueling infrastructure. This funding will not exclude stations that can serve multiple uses, such as non-road applications or transit projects, as long as those stations also support the expansion of light-duty FCVs.

E85 Fueling Infrastructure

E85 is a blend of 85 percent ethanol and 15 percent gasoline and is used predominantly in light-duty vehicles. Only certain vehicles, known as FFVs, possess the necessary engine modifications to accommodate the use of E85 (as well as conventional gasoline). Modification costs are sufficiently low that U.S. automakers have produced FFVs since 1993, primarily to take advantage of the credit allowed toward meeting their corporate average fuel economy (CAFE) standards. (However, these credits will be phased out by 2020.) As of 2010, there were about 450,000 FFVs in use in California. Most of these vehicles are not fueled with E85, due to limited retail availability and the lower cost of gasoline on an energy basis.

By early 2011, there were 57 retail stations in California that offered E85 in addition to conventional fuels, from fewer than 20 stations two years ago. Similarly, California sales of E85 have risen significantly over the past four years, from less than 500,000 gallons per year in 2007 to nearly 10 million gallons per year in 2010.

The primary barrier to establishing new E85 fueling stations is the upfront cost. Costs for installing a new underground storage tank, dispenser, and related appurtenances range between $50,000 and $200,000 per site. This is a significant cost, especially because most conventional gasoline fueling stations are no longer owned by oil companies. To date, the Energy Commission has funded two projects that, when completed, will add 85 new E85 fueling stations, using $5 million in ARFVT Program funds from the *2008-2010 Investment Plan*. The project partners will provide $14.1 million for these projects, and the U.S. Department of Energy will contribute an additional $6.9 million. While still continuing, the build-out of these stations is proceeding slowly. An additional $10.1 million for E85 fueling stations, from both the *2010-2011 Investment Plan* and *2011-2012 Investment Plan*, will be part of an upcoming solicitation for alternative fuels infrastructure. Assuming a similar ratio of funding, this $10.1 million will be sufficient funding for an additional 150-200 E85 fueling stations.

In addition to availability, E85 must be competitively priced against gasoline to make its use more attractive to potential customers. Depending on the compliance pathways selected for the LCFS and the RFS2, regulations may encourage the subsidy of E85 to sufficiently allow it to compete with gasoline for use in FFVs. E85 possesses roughly 75 percent of the energy density of gasoline (E10); so, to have a comparable cost per mile, E85 must be priced at roughly 75 percent of gasoline prices. On average, however, recent E85 prices have ranged from 5 to 20

percent *higher* than gasoline on an energy equivalent basis. This price differential may increase following the end of the Volumetric Ethanol Excise Tax Credit in December 2011, which provided a 38-cent-per-gallon tax credit to blenders of E85.

Given the Energy Commission's existing agreements and allocations for E85 fueling stations, the slow progress in developing previously funded stations, and the current challenge of E85 to compete with gasoline prices, the Energy Commission is reviewing the ongoing need and value of expanded support for additional E85 fueling installations. For the *2012-2013 Investment Plan Update*, the Energy Commission is reserving $1.5 million to support the continued expansion of E85 fueling opportunities.

Upstream Biodiesel Fuel Infrastructure

Biodiesel currently represents the largest volume diesel substitute in California's fuel market. It is most commonly blended with conventional diesel at levels ranging from 5 percent to 20 percent. However, biodiesel is not purely compatible with conventional diesel and requires unique bulk storage and rack infrastructure in early distribution phases. Terminal blending racks are used to store bulk volumes of unblended fuels and dispense blended fuels for trucks to deliver to retail, fleets, and farm customers.

For the most part, California terminal racks are not modified to accept diesel substitute fuels. California has more than 100 rack-terminals and several plants, most of which require modifications to dispense biodiesel. The relatively poor or marginal blending economics for biodiesel have made it difficult for terminal operators to justify such modifications. The lapse of the Biodiesel Mixture Excise Tax Credit in December 2011, which provided a tax incentive of $1 per gallon of pure biodiesel, will further hamper the expansion of this infrastructure.

Based on earlier projects proposed to the ARFVT Program, infrastructure modification costs are estimated to be $500,000 to $3 million per site. To date, the Energy Commission has provided $3.9 million for modifications to fuel terminals and blending facilities that will reduce the cost of dispensing biodiesel. An additional $3.1 million for upstream biodiesel infrastructure will be available in an upcoming solicitation using funds from the *2010-2011 Investment Plan*. However, given the anticipated growth of renewable diesel, as well as the uncertain economics for the continued growth of biodiesel, the Energy Commission does not intend to reserve funding for upstream diesel substitutes infrastructure in the *2012-2013 Investment Plan Update*.

Natural Gas Fueling Infrastructure

Fueling infrastructure for natural gas vehicles in California includes combinations of public or private accessibility and compressed natural gas (CNG) or liquefied natural gas (LNG) dispensing (Table 5). A few public stations serve light-duty natural gas passenger vehicles; however, most natural gas is dispensed for private fleets at private stations.

Table 5: Natural Gas Fueling Stations

	Publicly Accessible Stations	Private Access Stations
CNG	140	424
LNG	13	19

Source: California Natural Gas Vehicle Coalition, U.S. DOE Alternative Fuels and Advanced Vehicles Data Center

The costs for these stations vary according to the station's size and ability to dispense CNG or LNG. Using funds from the *2008-2010 Investment Plan*, the Energy Commission has invested $5.1 million across seven projects for installing 20 new stations or upgrades to existing stations in the state. This includes 16 CNG stations, 3 LNG stations, and 1 combined CNG and LNG station. Each of these installations was targeted to match the fueling needs of particular fleets and natural gas customers. While slower than anticipated, the installation of these stations is proceeding steadily.

In a recent solicitation, the Energy Commission provided a combined $9.6 million for natural gas fueling infrastructure from the *2010-2011 Investment Plan* and *2011-2012 Investment Plan.* Based on the previous solicitation, this funding is expected to support about 30 new or upgraded stations. As with the previous solicitation, this funding will target sites with the potential for high volumes of fuel throughput. To help ensure the continued viability of these stations (and other new stations), several organizations have emphasized a need for further focusing on natural gas vehicle deployments, rather than expanded infrastructure.[39] Additionally, the relatively slow pace in deploying the stations funded to date warrants reevaluation of funding for this category. For FY 2012-2013, the Energy Commission will provide $1.5 million to continue support for natural gas fueling infrastructure.

Propane Fueling Infrastructure

Infrastructure for propane vehicle fueling can expand relatively quickly, as existing propane dispensing stations can be used for vehicle fueling through the addition of fuel capacity, a tank pump, and metering equipment. With the addition of this equipment, virtually any propane tank/station in California can be retrofitted to meet a propane vehicle's needs. Additionally, many fuel suppliers have indicated that they are willing to enter into a contract to install fueling equipment and stations for propane fleets at no charge, given the fleet has a minimum monthly throughput. Based on information contained in applications for the DOE's Clean Cities program, coupled with propane working group information, the Energy Commission estimates that the cost of a fueling station is $35,000 to $50,000 for a 2,000-gallon storage tank, and $75,000 to $150,000 for a 30,000-gallon tank, including four dispensers.

In the *2011-2012 Investment Plan*, the Energy Commission allocated $500,000 to expand propane fueling infrastructure, specifically as a pilot project within Northern California. This infrastructure allocation will be part of a broader effort in that region that integrates vehicle

39 Comments submitted by the California Natural Gas Vehicle Coalition, Energy Commission Docket Number 10-ALT-1, April 4, 2011. Comments submitted by Clean Energy, Energy Commission Docket Number 10-ALT-1, March 25, 2011.

deployment, infrastructure development, and workforce development. The effort is also intended to serve as a visible model for the opportunities of propane as a vehicle fuel in rural communities that may have limited access to other alternative fuels. Additionally, schools represent a significant opportunity for propane infrastructure funding, based on their limited available funds and high usage rates. Such funding could support propane school buses that have been funded by the ARFVT Program and other programs in previous years.

Funding for propane infrastructure under the previous investment plan was intended to target a specific regional need. Unless additional funding demand materializes, the Energy Commission will not provide additional funding to support propane infrastructure for FY 2012-2013 but will continue to assess this opportunity in future years.

Table 6: Alternative Fuel Infrastructure Funding Allocation

Charging Infrastructure	$7.5 Million
Hydrogen Fueling Infrastructure	$11 Million
E85 Fueling Infrastructure	$1.5 Million
Natural Gas Fueling Infrastructure	$1.5 Million

Source: California Energy Commission

Alternative Fuel and Advanced Technology Vehicles

Natural Gas and Propane Vehicles

Natural gas and propane are becoming popular alternative fuels with consumers and fleet owners interested in purchasing vehicles that comply with California's emissions standards, lower fuel costs, and further the state's objectives of reducing petroleum dependence and GHG emissions. While government and public fleets represent the majority of vehicle owners, the number of vehicles owned by commercial owners has steadily increased over the period.[40] In conversations with vehicle manufacturers, fleet owners, and infrastructure suppliers, the Energy Commission has also heard a growing interest in natural gas and propane vehicles as means of avoiding higher petroleum fuel costs. The price of natural gas in particular has fallen significantly over the past few years on news of expanded domestic supply potential and has become all the more attractive compared to rising gasoline and diesel costs.

Additionally, these vehicles have the potential to realize immediate and long-term petroleum and GHG emission reductions. Converting from diesel fuel to natural gas reduces a vehicle's lifecycle carbon emissions from medium- and heavy-duty vehicles by up to 15 to 20 percent. If using pure waste-derived biomethane, this reduction can increase to more than 80 percent. Conventional propane offers a modest GHG emission reduction; however, the development and growth of renewable propane (which can be used as a propane substitute) can further increase this reduction.

As part of the ARFVT Program, the Energy Commission provides buy-down incentives to fleets and other consumers for new on-road natural gas and propane vehicles that will directly benefit California's economy by expanding the use of domestically produced nonpetroleum fuels that are lower-cost alternatives to gasoline and diesel and have lower carbon emission characteristics. The level of incentive depends on the expected fuel displacement and GHG benefits mostly estimated by the weight class for each vehicle. The incentive level is intended to strike a balance between the incentive needed to induce the purchase of an alternative fuel vehicle and the cost of the incentive's resultant petroleum and GHG benefit to the state. The Energy Commission has completed one round of incentive funding and will soon release the second round. In the first Program Opportunity Notice (PON-10-604), the Energy Commission approved a combined allocation of $14.54 million from the *2008-2010 and the 2010-2011 Investment Plans,* of which $10.19 million went to light-, medium-, and heavy-duty natural gas vehicles; $2.35 million for light- and medium-duty propane vehicles; and $2 million for propane school buses. These funds will ultimately provide incentives for nearly 1,000 vehicles.

For the second PON, the Energy Commission approved an allocation in the *2011-2012 Investment Plan* of $12 million for light-, medium-, and heavy-duty natural gas vehicles, $1 million for light-duty propane vehicles, and $3 million for medium- and heavy-duty propane vehicles.

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40 Schremp et al. 2011. *Transportation Energy Forecasts and Analyses for the 2011 Integrated Energy Policy Report. California Energy Commission*. CEC-600-2011-007-SD.

In addition to new natural gas and propane vehicles, cost-efficient repowering of existing vehicle chassis with new natural gas or propane engines and retrofit of existing engines with natural gas or propane fueling systems could contribute to achieving the state's petroleum reduction, climate change, and air quality objectives and may be considered for Energy Commission funding support. Similar opportunities also exist for local vessels, such as tug boats and ferries. Before expanding funding eligibility to include these applications, the Energy Commission must better understand the cost of repowering or retrofitting, the parameters within which repowering and retrofitting make economic sense, the potential market for and volume of repowers and retrofits, the petroleum reduction potential, and how repowering and retrofitting could fit into the incentive buy-down model and how completed work could be efficiently verified.

Based on the demand for natural gas vehicle incentives to date, as well as the continuing stated interest in the vehicles, the Energy Commission intends to maintain its previous funding level from the *2011-2012 Investment Plan* of $12 million for natural gas vehicle incentives in FY 2012-2013. Once deployed, these vehicles will also provide the opportunity for further integration of low-carbon biomethane into the transportation market. The Energy Commission is also interested in providing measured support for propane vehicles as a means of reducing petroleum dependence and improving air quality in regions that may have limited access to alternative fuels. However, to date, there has been comparatively low demand for propane vehicle incentives under the Energy Commission's buy-down incentive program. For FY 2012-2013, the Energy Commission will provide $2 million to support the deployment of propane vehicles and seeks input on the market potential of propane vehicles, their GHG emission reduction potential, and ways to expand short-term consumer interest in the vehicles.

Light-Duty PEVs

Over the past several years, a new generation of electric vehicles has entered the market, most prominently in the light-duty sector. In-state sales of fully electric BEVs (such as the Nissan Leaf) and partially electric PHEVs (such as the Chevrolet Volt and Toyota Prius Plug-in) have already started to increase, and varying scenarios indicate the possibility of hundreds of thousands (or perhaps millions) of these vehicles on California's roads by 2020.[41] The ARB's ZEV regulation is critical to expanding the supply of these vehicles.

The primary barriers to expanding light-duty PEVs' entrance in the market are charging infrastructure, battery capacity, and high incremental upfront costs. The Energy Commission, with the support of other state and local agencies, is funding projects through the ARFVT Program to reduce the first barrier (as discussed in a previous section). Investments into battery development are occurring at multiple levels; however, the federal government has taken the most aggressive steps in this area. The American Recovery and Reinvestment Act of 2009 provided roughly $1.5 billion toward battery manufacturing facilities, and the U.S. Department

41 For example, the California PEV Collaborative has indicated a range of 500,000 to 1,000,000 PEVs by 2020. Based on phone conversation with Joshua Cunningham, Plug-in Electric Vehicle Collaborative, November 29, 2011.

of Energy in 2011 provided an additional $50 million (including $19.6 million within California) toward developing advanced battery cells and design technologies for electric drive batteries. To help address the third barrier, the ARB provides incentive funding for light-duty PEVs through the Clean Vehicle Rebate Program (CVRP).

To date, the CVRP has issued more than $17 million in incentives for more than 5,000 vehicles. This includes funding from the CVRP's FY 2009-2010 allocation of $3.7 million, the FY 2010-2011 allocation of $4.7 million, the FY 2011-2012 allocation of $15 million, and an additional $2 million from the Energy Commission to cover anticipated shortfalls. By the end of FY 2010-2011, rebates for the Nissan Leaf BEV (at $5,000 each) had totaled about 87 percent of all rebates and roughly 84 percent of all rebates by dollar amount.[42] For FY 2011-2012, the ARB reduced the per-vehicle incentive level for future applications. For example, the rebate amount for a BEV been lowered to $2,500, and the rebate amount for a PHEV has been lowered to $1,500.

A federal tax credit of up to $7,500 for PEVs is also available. Within California, local regions may also provide further incentives for PEVs. Additional PEV incentives include access to the high-occupancy vehicle lanes through 2015, free or reserved parking in some cities, reduced insurance rates by many providers, and the availability of reduced electricity rates.

Based on historical CVRP data, anticipated OEM production volumes, and the new eligibility of the Chevrolet Volt and Toyota Plug-in Prius PHEVs, the demand for CVRP rebates is likely to outstrip existing funding availability before summer 2012. The ARB anticipates providing a range from $13 million to $17 million for the CVRP in FY 2012-2013. Depending on the relative demand for rebates under the CVRP and HVIP, the ARB may also consider redirecting some funding from HVIP to CVRP. However, even with these added funds, the demand for rebates may exceed available funding through the end of calendar year 2012. According to the ARB's discussion document for the development of the *2012-2013 Funding Plan*, manufacturers' planned production volumes for clean vehicles range between 15,000 and 20,000 during FY 2012-2013.[43]

This may entail new strategies for ensuring the sustainability of incentives, to the extent necessary to support the successful rollout of early PEVs in California. In anticipation of a possible temporary shortfall, the Energy Commission will reserve $5 million for possible use by the ARB to sustain these incentives in FY 2012-2013.

Medium- and Heavy-Duty Advanced Technology Vehicles

Precommercial-Scale Projects

A growing number of medium- and heavy-duty vehicle suppliers have begun incorporating advanced vehicle technologies into their offerings. These technologies vary significantly,

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42 California Center for Sustainable Energy, *Clean Vehicle Rebate Project: Fiscal Year 2009-2011 Final Report*, October 18, 2011. Available at: http://energycenter.org/index.php/incentive-programs/self-generation-incentive-program/sgip-documents/doc_download/838-fy-2009-2011-cvrp-final-report.

43 ARB, *AB 118 Air Quality Improvement Program (AQIP) FY 2012-13 Funding Plan Staff Discussion Document*.

ranging from hybrid electric drive in diesel vehicles, to electric drive vehicles with natural gas range extenders, to fuel cell buses. In each case, however, the qualities of the technology must be matched to the duty cycles of the customer's vehicle. For this reason, using advanced technologies may be limited to certain niche market applications where the payback period is most attractive. As technologies evolve, the opportunity for broader deployment of these technologies will arrive, allowing them to expand into new applications.

The Energy Commission has been involved in developing and demonstrating these technologies for several years. In January 2010, the Energy Commission, through its Public Interest Energy Research (PIER) Program, provided $3 million to sponsor the California Hybrid, Efficient, and Advanced Truck (CalHEAT) Research Center. This center will develop a roadmap, with industry input, to commercialize advanced technologies for medium- and heavy-duty vehicles by 2020. The project also includes vehicle demonstrations for parcel delivery trucks and Class 8 trucks.

Around the same time, the Energy Commission's ARFVT Program issued a solicitation for projects that would advance the commercialization of advanced medium- and heavy-duty vehicle technologies. This solicitation, originally using funds from the *2008-2010 Investment Plan*, was expanded to also use a portion of the funds allocated to this category in the *2010-2011 Investment Plan.* From the 50 proposals originally received, 8 projects totaling $12 million were selected for funding. These proposals included projects that will develop and demonstrate the medium- and heavy-duty applicability of a range of technologies, including hydraulic hybrid technology, multifuel microturbines, range-extended battery electric drive, and next-generation natural gas engines. As these projects move forward, they will prove the ability of these technologies to meet the needs of real-world commercial users and thereby expand their market potential.

More recently, the Energy Commission's ARFVT Program issued a second solicitation for pre-commercial demonstration projects in August 2011. This solicitation included $16.9 million in available funds from the *2010-2011 Investment Plan's* remaining allocation for this category and the *2011-2012 Investment Plan*. To streamline the administration of the new projects, the Energy Commission sought applications from not-for-profit technology entities, each of which could submit multiple projects. Of the 7 applications (including 30 individual projects), the Energy Commission proposed to provide the maximum $16.9 million toward 4 applications (with 11 individual projects). The funded projects focus primarily on incorporating hybrid, plug-in hybrid, and all-electric drive technologies into medium- and heavy-duty vehicles.[44]

Given the number and variety of advanced vehicle technology projects for the medium- and heavy-duty sector that the Energy Commission has funded thus far (and will fund in the near future), the Energy Commission continues to seek input from Advisory Committee members and stakeholders on whether and how to refine further investments into this category. As an example, several stakeholders have identified the potential use of all-electric trucks for drayage

44 For more information, see the revised Notice of Proposed Award (dated March 8, 2012) at: http://www.energy.ca.gov/contracts/PON-10-603_Revised_NOPA.pdf.

and goods movement. In particular, the combination of air quality concerns and high volume of goods movement make the South Coast region and San Joaquin Valley potential hotspots for demonstrating electric truck technology. For FY 2012-2013, the Energy Commission will reserve up to $6 million to promote the demonstration of medium- and heavy-duty advanced vehicle technologies, with a special focus on high-value applications.

Commercial-Scale Projects

Building on the successes of previous demonstration projects, California has seen more commercialized medium- and heavy-duty vehicles that use hybrid electric drive, hybrid hydraulic, and fully electric drive technologies. As with alternative fuel medium- and heavy-duty vehicles, these technologies have a high incremental upfront cost, with the promise of lower fuel costs over the vehicle's lifetime. To help defray these costs, the ARB provides up to $30,000 in incentives for advanced technology vehicles under the HVIP. The ARB provided $19.4 million to the HVIP under the *2010-2011 Funding Plan*, and $18.1 million under the *2011-2012 Funding Plan*. To date, the program has provided incentives for more than 1,000 vehicles of all technology types.

To date, the HVIP has primarily funded hybrid trucks. The maximum voucher of $30,000, while enough to stimulate interest in this technology, is generally not sufficient to stimulate interest in purely electric trucks. To prompt early interest in purely electric medium- and heavy-duty vehicles, the Energy Commission provided $4 million in supplemental incentives for the HVIP to provide a higher incentive for these vehicles. Using these funds, the ARB provided incentive funding for 155 electric trucks. These early incentives will be critical in generating early market interest in the vehicles, and in helping the manufacturers reach commercial scales of production.

The Energy Commission supports the continued deployment for medium- and heavy-duty electric trucks, many of which are now being produced within the state. In a discussion document for the ARB's *2012-2013 Funding Plan*, the ARB notes that the HVIP is considering a higher incremental incentive for all-electric vehicles. This higher incentive will be comparable to the combined incentive of ARB and Energy Commission funding for electric trucks in the previous fiscal year. The HVIP also has a significant amount of funding remaining from previous fiscal years that can ensure these incentives (roughly $20 million), in addition to the range of $5 million to $11 million proposed in the *2012-2013 Funding Plan*.[45] Given these developments, the Energy Commission does not anticipate a need to supplement this funding, but will continue to collaborate with the ARB on the appropriate means for continuing these vehicle incentives.

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45 ARB, *AB 118 Air Quality Improvement Program (AQIP) FY 2012-13 Funding Plan Staff Discussion Document*.

Table 7: Alternative Fuel and Advanced Technology Vehicles Funding Allocation

Natural Gas Vehicle Incentives	$12 Million
Propane Vehicle Incentives	$2 Million
Light-Duty PEV Incentives	$5 Million
Medium- and Heavy-Duty Advanced Technology Vehicle Demonstrations	$6 Million

Source: California Energy Commission.

Emerging Opportunities

The previous sections of the *Investment Plan* focus on high-priority investments related to specific fuels and vehicles. However, not all emerging opportunities fit into these funding allocations. For this reason, the Energy Commission has maintained a small funding allocation that is not specifically tied to any single fuel or technology type.

With funds from the *2010-2011 Investment Plan*, the Energy Commission reserved a combined $6.7 million for innovative technologies, advanced fuels, and federal cost-sharing projects.[46] The *2011-2012 Investment Plan* included an additional $3 million for any of these activities and outlined numerous examples of the types of opportunities that may exist.

Numerous companies and groups have approached the Energy Commission with suggestions for projects that could be funded under this broader allocation. However, the unique and time-sensitive nature of each of these projects has made it challenging to develop a uniform competitive solicitation. The Energy Commission will investigate methods to develop such a solicitation and encourages public input on the matter.

In the interim, the Energy Commission has identified several opportunities to partner with federal funding programs that can expand the development and deployment of alternative fuels and technologies within the state. The Energy Commission is in ongoing discussions to provide funding for the Joint Center for Artificial Photosynthesis (JCAP), an energy innovation hub sponsored by the U.S. DOE. The JCAP may receive up to $122 million in federal funds (subject to Congressional appropriations) to identify and develop a method to produce alternative fuels directly from sunlight using a process similar to natural photosynthesis. The U.S. DOE is also preparing to launch a new energy innovation hub focused on batteries and energy storage, with an investment of up to $120 million in federal funds. California has been a successful candidate for several battery research projects sponsored by the U.S. DOE in the past, and this may be an opportunity to build on those previous successes.

There are also opportunities to support the deployment of alternative fuels and technologies within California in partnership with the U.S. Department of Defense. In particular, the U.S. Air Force has announced plans to replace all of the current fleet of general purpose vehicles at the Los Angeles Air Force Base with PEVs. This is the first step in implementing a larger Department of Defense plan to establish strategies for large-scale integration of PEVs. The deployed PEVs will also have a higher GHG emission reduction potential than conventional PEVs. The deployed PEVs may also be well-suited to demonstrate the potential benefits of vehicle-to-grid applications for grid reliability.[47] Depending on future decisions by the U.S. Air Force and Department of Defense, partnership and cofunding from the ARFVT Program could

46 While the *2010-2011 Investment Plan* originally allocated a combined $8 million for these activities, only $6.72 million was ultimately available, due to reduced program funds.

47 U.S. Air Force, "Los Angeles AFB to Go Electric," http://www.af.mil/news/story.asp?id=123270249.

help encourage the demonstration and deployment of alternative fuel vehicles and technologies at additional military facilities within California.

The Energy Commission will reserve $5 million in ARFVT Program funding for FY 2012-2013 to support these and other emerging opportunities. These funds may be combined with the previously reserved $9.7 million from previous investment plans.

Table 8: Emerging Opportunities Funding Allocation

Emerging Opportunities	$5 Million

Source: California Energy Commission.

Manufacturing

California's advanced technology manufacturing companies have had tremendous success in raising capital for precommercialization and early commercialization activities. In particular, California has held a significant advantage in raising venture capital and private equity for electric drive technologies. According to Next 10, California attracted about 60 percent of global investments (or $840 million) into related sectors in 2010. The number of jobs associated with California's electric drive industry grew to about 1,790 by January 2010, a 142 percent increase from 1995. Of these jobs, 59 percent are in manufacturing positions and 14 percent are focused on research and development.[48] In addition to these direct jobs, each created job has the potential for a multiplier effect. Specifically, within the general manufacturing sector, a working paper from the Economic Policy Institute estimated that every 100 direct manufacturing jobs support an additional 291 indirect jobs in the economy. This ratio increases to 464 indirect jobs for every 100 direct jobs when focused specifically on automobile parts.[49]

Based on a survey of all grant awardees, the projects funded through the ARFVT Program will add roughly 1,900 direct jobs over the next year and 3,482 direct jobs in the next 1-5 years. Respondents reported the highest number of jobs in manufacturing and construction, driven heavily by the Energy Commission's investments into biofuel production facilities, infrastructure facilities, and the production of batteries and electric drive vehicle components. In addition to jobs data, survey respondents also estimated more than 800 California businesses would participate in these projects, with more than 560 of those identified as small businesses (with 200 or fewer employees).

In a 2009 report, CALSTART identified three primary barriers for clean transportation investment economics: 1) insufficient investment in technology development and deployment; 2) tight credit markets and a lack of risk capital; and 3) volatile oil prices. Policy, market, and financial support can help overcome these barriers. In particular, the ARFVT Program can help address the first two. The report also identified 195 clean transportation technology manufacturers, developers, and supporting institutions operating in California.

To hasten the contributions of alternative fuels and advanced vehicle technologies toward business and economic development, the Energy Commission has also provided funds for manufacturing facilities and equipment. Using $25.9 million from the *2008-2010 Investment Plan*, the Energy Commission provided grant funding for 12 projects to help finance manufacturing facilities that make complete vehicles, batteries, electric propulsion systems, and other components in California. (While this is a large investment, more than $80 million in funding was requested, indicating significant unmet demand). Among the funded projects, the following are examples of California manufacturing supported by the ARFVT Program:

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48 Next 10, *Powering Innovation: California is Leading the Shift to Electric Vehicles From R&D to Early Adoption*, December, 2011. Available at: http://next10.org/next10/pdf/EV%20Report_2011_final.pdf.

49 Economic Policy Institute, *Updated Employment Multipliers for the U.S. Economy (Working Paper)*, August 2003. Available at: http://www.epi.org/page/-/old/workingpapers/epi_wp_268.pdf.

- Boulder Electric Vehicles, located in Colorado, will establish a new manufacturing line in Los Angeles for all-electric-drive medium- and heavy- duty vehicles for California markets. The company will also leverage its existing supply network in Southern California for vehicle components.
- Electric Vehicles International relocated from Mexico to Stockton in November 2009, with the intent to participate in the ARFVT Program. The Energy Commission provided grant funds for the company to develop, test, and improve its production processes.
- Quallion will use predominantly local suppliers to develop a pilot automated manufacturing line in Sylmar, reducing its battery manufacturing costs. The company anticipates becoming the largest provider of lithium modules in the United States.
- Coulomb Technologies, based in Campbell, received funding to develop and manufacture its Charge Point Communication Processor for electric vehicle charging infrastructure. The project incorporates remote control of charging that can help shift charging to off-peak periods, reduce stress on the grid, and allow chargers to take better advantage of time-sensitive renewable power.

While these projects are gradually coming on-line, the Energy Commission continues to hear intense interest in critical support for expanding ARFVT Program funding for manufacturing facilities, equipment, and working capital. Numerous companies have spoken with Energy Commission staff about their interest in expanding or relocating manufacturing facilities within California. The persistently slow economy and its impact on capital markets continue to be a challenge for these emerging vehicle manufacturers.

In the *2011-2012 Investment Plan*, the Energy Commission allocated $10 million for alternative fuel and advanced vehicle technology manufacturing projects. The solicitation for this allocation is expected in early 2012. To sustain funding required by the alternative vehicle manufacturing sector, the solicitation may include provisional language that would allow for the encumbrance of additional funding above the $10 million. To supplement the previous $10 million, the Energy Commission may allocate $20 million for FY 2012-2013 for manufacturing facilities, equipment, and working capital. By providing capacity for these anticipated funds in the upcoming solicitation, the Energy Commission can ensure that the FY 2012-2013 funds may be encumbered and expended to meet project needs as quickly as possible.

Table 9: Manufacturing Funding Allocation

Manufacturing Facilities, Equipment, and Working Capital	$20 Million

Source: California Energy Commission.

Workforce Development and Training

Workforce development and training are critical to the Energy Commission's efforts to advance California's clean transportation market. Training is required to respond to new technology, improve efficiencies, minimize waste, and reduce production costs. Skilled workers are needed to manufacture low-emissions vehicles and components, produce alternative fuels, build fueling infrastructure, service and maintain fleets and equipment, and inform ongoing innovation and refinement to increase market acceptance.

To date, the Energy Commission has allocated $22.5 million in program funding to support workforce development and training for the ARFVT Program. The Energy Commission established interagency agreements for administering these funds with California's top workforce training agencies, including the Employment Development Department (EDD) at $7.2 million, the California Community Colleges Chancellor's Office (CCCCO) at $4.5 million, and the Employment Training Panel (ETP) at $10.3 million.

These workforce development and training interagency agreements have been structured to address workforce needs specific to alternative fuel and low-emission vehicles, as a portion of the partner agency's broader workforce projects. The EDD and ETP interagency agreements deliver workforce training, while the EDD and CCCCO interagency agreements provide workforce training development support activities. These activities include surveying industry training needs, assessing existing training programs and resources, developing curriculum and training materials, instructor training, and regional industry cluster support planning grants.

EDD and ETP have awarded 8 regional workforce training grants, 4 regional industry cluster planning grants, and 12 direct employer training contracts to deliver training for more than 5,300 individuals to date. Also as shown in Table 10, the grants and contracts awarded through the interagency agreements have also secured more than $13 million in nonstate matching funds. These initial results are based on funds from the first investment plan, covering FYs 2008-2009 and 2009-2010. The Energy Commission recently amended the EDD and ETP interagency agreements to encumber the funds allocated in the two most recently approved investment plans (covering FYs 2010-2011 and 2011-2012).

Table 10: Workforce Training Delivery Data

Partner Agency	Allocations for Workforce Training Delivery (in Millions)	Match Contributions to Date (in Millions)	Trainees to Be Trained	Businesses Assisted to Date	Municipalities Assisted to Date
ETP	$5.4	$5.8	4,327	78+	12+
EDD	$3.8	$7.5	999	36+	
Total	$9.2	$13.2	5,326	114+	12+

Source: California Energy Commission.

To continue and build on these successes, the Energy Commission intends to provide additional funding for workforce development and training in the *2012-2013 Investment Plan Update*. This allocation is based on the workforce training demand and opportunities that have been

identified by partner agencies. The allocation includes an additional $2 million to ETP to meet the workforce training demand anticipated in FY 2012-2013, and an additional $500,000 to EDD. Half of the allocation to EDD will be used to support workforce training needs assessment, performed by EDD's Labor Market Information Division. The remaining half will support the continuation and/or expansion of previously funded career pathways pilot projects.

Using previously funded resources, the Energy Commission will continue to work with the CCCCO to assess workforce training needs and available resources on a statewide basis, along with the development and dissemination of curriculum materials, training materials, and instructor training. These resources will help train the workforce required to support the development, deployment, and adoption of alternative fuels and vehicles throughout California's transportation market. In addition, the CCCCO's Centers of Excellence will conduct reviews to determine the clean transportation industry's workforce training needs, as well as statewide market emphases and regional alternative fuel and/or vehicle preference. The information obtained through the Centers of Excellence research will inform the ongoing development and refinement of the ARFVT Program's workforce training effort.

Table 11: Workforce Development and Training Funding Allocation

Workforce Development and Training	$2 Million
Workforce Needs Assessment	$0.25 Million
New Entrant Planning and Pilot Project	$0.25 Million

Source: California Energy Commission.

Market and Program Development

Standards and Certification

As new fuels and technologies are developed, standards and certifications must be researched and adopted for the fuels, vehicles, and fueling infrastructure. The Energy Commission continues to assess possible needs for funding in this area. Previous funding from the *2008-2010 Investment Plan* is going toward developing "type-approved" retail fuel dispensers for hydrogen (so it can be sold as a retail fuel on a per-kilogram basis) as well as fuel quality standards for hydrogen and biodiesel blends. This will be accomplished via a $4 million agreement with the California Department of Food and Agriculture's Division of Measurement Standards. Until further needs for this category are identified, the Energy Commission will not likely allocate further funding for this activity.

Sustainability Studies

The Energy Commission was the first major government energy agency in the country to make transportation energy project funding decisions based on specific sustainability goals and evaluation criteria. The Energy Commission is required to "establish sustainability goals to ensure that alternative and renewable fuel and vehicle projects, on a full fuel-cycle assessment basis, will not adversely impact natural resources, especially state and federal lands." In response to this statutory directive, the Energy Commission developed several sustainability goals to identify and promote transportation-related GHG reduction projects that are exemplary in sustainability and environmental performance, and that can serve as national and international models.

To date, the Energy Commission has funded forest biomass sustainability research to implement the sustainability work plan developed by the Energy Commission for the Interagency Forestry Working Group.[50] This group aims to develop consistent definitions and standards for sustainable woody biomass from California's 40 million acres of private and public forests. Substantial technical and scientific field work is needed to establish sustainability definitions and standards for the emerging woody biomass fuels industry.

An additional allocation of $500,000 for sustainability studies and research from the *2011-2012 Investment Plan* will provide additional support to ensure California's switch to low-carbon fuels users sustainable resources. In particular, the Energy Commission remains open to the possibility of funding research issues identified by the LCFS Sustainability Working Group. The Energy Commission does not currently see any need for additional funding from FY 2012-2013 for sustainability studies but will continue to evaluate alternative fuel markets for opportunities where such work might be needed.

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50 The California Natural Resources Agency and the California Environmental Protection Agency convened the Interagency Forestry Working Group to develop consistent metrics for forest carbon accounting and sustainability definitions and standards for the energy and climate change programs at the California Air Resources Board and California Energy Commission.

Regional Alternative Fuel Readiness and Planning

Based on early interest from the electric drive community, the Energy Commission issued a solicitation for regional plans to support PEV readiness. Using funds from the *2010-2011 Investment Plan* and *2011-2012 Investment Plan*, the Energy Commission has awarded roughly $200,000 each for eight regions to help develop strategic plans for charging infrastructure, establish "best practices" for PEV-ready building and public work guidelines, and streamline the processes of charging infrastructure permitting, installation, and inspection. Statewide planning and coordination of workplace charging may also help employers statewide to coordinate and communicate. The Energy Commission may provide additional funding to support the implementation of these plans at the local level.

Similar needs for other alternative fuels are also anticipated. Particularly in early deployment regions, local entities may need support in preparing for the installation of hydrogen fueling infrastructure. The readiness of these communities will help ensure that hydrogen fueling stations can quickly progress from planning phases to installation and operation. Additionally, regional planning support may also be appropriate for medium- and heavy-duty natural gas vehicles. These activities will help promote outreach and education efforts and coordinate natural gas fueling infrastructure.[51] If successful, these efforts can encourage additional fleets to transition from diesel trucks to natural gas trucks. Some regions are also considering regional plans to support the future deployment of zero-emission medium- and heavy-duty trucks.[52] The Energy Commission is reserving $3 million for regional readiness in the *2012-2013 Investment Plan Update* and seeks public input on the needs and best means for providing such funds.

Centers for Alternative Fuels and Advanced Vehicle Technology

There are also opportunities to develop and expand alternative fuels and advanced vehicle technologies through collaboration with existing and new centers throughout the state. These centers can serve multiple purposes, such as identifying strategic opportunities to develop and demonstrate advanced technology vehicles, providing a neutral site for individual companies to collaborate on technology demonstrations, centralizing the attention of fleet managers that are interested in alternative fuels and advanced vehicles, and integrating vehicle technology development with workforce training efforts. Additionally, centers can provide a cohesive platform for seeking outside funds, whether from the private sector (such as venture capital) or public sector (such as the U.S. Department of Energy). The Energy Commission will provide $3 million to support the development and/or expansion of such centers in the *2012-2013 Investment Plan Update*.

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51 Comments submitted by the California Center for Sustainable Energy, Energy Commission Docket Number 10-ALT-1, May 10, 2011.

52 Comments submitted by the Gateway Cities Council of Governments and Los Angeles Metropolitan Transportation Authority, Energy Commission Docket Number 10-ALT-1, June 21, 2011.

Technical Assistance and Analysis

The Energy Commission will need continuous updates of the status of vehicle technology and fuels, market analyses, financing trends, and other factors that attract the introduction and growth of alternative and renewable fuels in California. These updates would help the Commission monitor the progress of funding decisions and develop future annual investment plans. Ongoing refinement of analytical methods, such as full fuel-cycle analysis models, will be needed to evaluate the potential GHG emission and other environmental impacts of new fuel and vehicle technology options. This technical assistance and analytical work may include grants or contracts for the following:

- Ongoing technical support necessary to establish the life-cycle-scale GHG emissions for new and emerging alternative fuel pathways that have not yet been analyzed in the LCFS program or through the Energy Commission's existing contract with Life Cycle Associates. The program will need additional technical and training support with the California Greenhouse Gases, Regulated Emissions (GREET), and Energy Use in Transportation model as it is expanded and updated to include new climate-changing gases, new fuel pathways, and sustainability parameters such as water impacts.
- Full fuel-cycle analysis for new fuel pathways to help small companies develop and demonstrate the carbon intensity of their alternative and renewable fuels.
- Studies on the effects of alternative fuels on engines and vehicles, including recreational boats and other marine vehicles.
- Technical assistance with evaluation of new technologies, and verification of claims made by program applicants.
- An expansion of the California Biomass Collaborative's work to identify and quantify all California biomass feedstocks available for fuel production.

For FY 2012-2013, the Energy Commission anticipates the ability to fund these and related activities using funds provided to the Alternative and Renewable Fuel and Vehicle Technology Program specifically for technical assistance and analysis. This is outside of the $100 million provided for in this *2012-2013 Investment Plan Update.*

Measurement, Verification and Evaluation

The Energy Commission is also responsible for program measurement, verification, and evaluation (MV&E) efforts. State law requires the Energy Commission to evaluate the program's efforts in the biennial *Integrated Energy Policy Report*. The goals of MV&E are to provide accountability and ensure effective administrative and financial performance of the program and its funding recipients. The Energy Commission will examine: 1) the expected benefits of the projects in terms of air quality, petroleum use reduction, GHG emissions reduction, technology advancement, and progress toward achieving these benefits; 2) 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; 3) key obstacles and challenges to meeting these identified goals through funded projects; and 4)

recommendations for future actions. In the early years, these activities will be funded through a $1.7 million previous allocation for MV&E from the *2010-2011 Investment Plan*. The Energy Commission issued a request for proposals to administer this work in December 2011 and expects to have an executed contract for the work by June 2012. As with funding for technical assistance and analysis projects, the Energy Commission expects to provide any needed FY 2012-2013 funding for this category using funds that are separate from the *2012-2013 Investment Plan Update.*

Table 12: Market and Program Development Funding Allocation

Regional Alternative Fuel Readiness and Planning	$3 Million
Centers for Alternative Fuels and Advanced Vehicle Technology	$3 Million

Source: California Energy Commission.

CHAPTER 4:
Funding Allocations

Table 13: Summary of Proposed Funding Allocations for FY 2012-2013

	Project/Activity	Proposed Funding Allocation for FY 2012-2013
Alternative Fuel Production	Biofuel Production and Supply	$20 Million
Alternative Fuel Infrastructure	Electric Charging Infrastructure	$7.5 Million
	Hydrogen Fueling Infrastructure	$11 Million
	E85 Fueling Infrastructure	$1.5 Million
	Natural Gas Fueling Infrastructure	$1.5 Million
Alternative Fuel and Advanced Technology Vehicles	Natural Gas Vehicle Incentives	$12 Million
	Propane Vehicle Incentives	$2 Million
	Light-Duty PEV Incentives	$5 Million
	Medium- and Heavy-Duty Advanced Vehicle Technology Demonstration	$6 Million
Emerging Opportunities	Innovative Technologies, Advanced Fuels, and Federal Cost-Sharing	$5 Million
Manufacturing	Manufacturing Facilities, Equipment, and Working Capital	$20 Million
Workforce Development and Training	Workforce Development and Training Agreements	$2.5 Million
Market and Program Development	Regional Alternative Fuel Readiness and Planning	$3 Million
	Centers for Alternative Fuels and Advanced Vehicle Technology	$3 Million
	Total Available	**$100 Million**

Source: California Energy Commission.

GLOSSARY

AQIP	Air Quality Improvement Program
AQMD	Air Quality Management District
ARB	Air Resources Board
ARFVT Program	Alternative and Renewable Fuel and Vehicle Technology Program
ARRA	American Recovery and Reinvestment Act
ASTM	American Society for Testing and Materials
BEV	battery electric vehicle
BMW	Bavarian Motor Works
CAFE	corporate average fuel economy
CalHEAT	California Hybrid, Efficient, and Advanced Truck
CCCCO	California Community Colleges Chancellor's Office
CFO	Clean Fuels Outlet
CNG	compressed natural gas
CVRP	Clean Vehicle Rebate Program
E10	Ethanol 10 – 10% ethanol, 90% gasoline
E85	Ethanol 85 – 85% ethanol, 15% gasoline
EDD	Employment Development Department
ETP	Employment Training Panel
FCV	fuel cell vehicle
FFV	flex-fuel vehicles
FY	fiscal year
g CO_2e/MJ	grams carbon dioxide equivalent per megajoule
GHG	greenhouse gas
GREET	Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation
HVIP	Hybrid and Zero-Emission Truck and Bus Voucher Incentive Program
LCFS	Low Carbon Fuel Standard
LNG	liquefied natural gas
NGV	natural gas vehicle
OEM	original equipment manufacturer
PEV	plug-in electric vehicle
PHEV	plug-in hybrid electric vehicle
PIER	Public Interest Energy Research
PON	Program Opportunity Notice
RFS2	Renewable Fuel Standard Program
RIN	Renewable Identification Number
U.S. DOE	United States Department of Energy
U.S. EPA	United States Environmental Protection Agency
ZEV	zero emission vehicle