CALIFORNIA
ENERGY COMMISSION

California Energy Commission

**COMMISSION REPORT**

# 2013-2014 Investment Plan Update for the Alternative and Renewable Fuel and Vehicle Technology Program

**Edmund G. Brown Jr., Governor**

**May 2013 | CEC-600-2012-008-CMF**

# California Energy Commission

Robert Weisenmiller, Ph.D.
**Chairman**

Karen Douglas, J.D.
David Hochschild
Andrew McAllister
Janea Scott
**Commissioners**

Charles Smith
**Project Manager**
**Primary Author**

Jim McKinney
**Program Manager**

John P. Butler II
**Office Manager**
**EMERGING FUELS AND TECHNOLOGIES OFFICE**

Randy Roesser
**Deputy Director**
**FUELS AND TRANSPORTATION**

Robert P. Oglesby
**Executive Director**

# ACKNOWLEDGEMENTS

The following Energy Commission staff members contributed to this report:

Jennifer Allen
Leslie Baroody
Jean Baronas
Jim Bartridge
Jared Cacho
Aida Escala
Andre Freeman
Reynaldo Gonzalez
Aleecia Gutierrez
Elizabeth John
Bill Kinney
Isaiah Larsen
Pilar Magaña
Tobias Muench
Hieu Nguyen
David Nichols
Tim Olson
Pat Perez
Larry Rillera
Lindsee Tanimoto
Eric VanWinkle

# 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, diesel substitute fuels, and other emerging fuel types. 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 2013-2014 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 2013-2014 Investment Plan Update covers the fifth 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 2013-2014 Investment Plan Update provides funding allocations based on alternative and renewable fuel and vehicle technology analyses and identified opportunities. As an update, the 2013-2014 Investment Plan Update relies on the framework and analyses developed in previous investment plans, most recently the 2012-2013 Investment Plan Update and the 2011-2012 Investment Plan. This iteration of the 2013-2014 Investment Plan Update follows the publication of three previous drafts, as well as three Advisory Committee public meetings held within the past year.

**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, sustainability, fueling stations, fuel production

Please use the following citation for this report:

Smith, Charles, Jim McKinney. 2013. *2013-2014 Investment Plan Update for the Alternative and Renewable Fuel and Vehicle Technology Program* Commission Report. California Energy Commission, Fuels and Transportation Division. Publication Number: CEC-600-2012-008-CMF.

# TABLE OF CONTENTS



# LIST OF TABLES

# 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 substantial rise in petroleum fuel prices over the last 10 years has created a significant impediment to economic growth. The *2007 State Alternative Fuels Plan* set a goal of increasing alternative fuels use to 26 percent of all fuel consumed by 2022. Additionally, the state's transportation sector accounts for nearly 40 percent of the state's greenhouse gas (GHG) 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.

More recently, the Governor's Zero Emission Vehicle Action Plan (pursuant to Executive Order B-16-2012) set goals of reaching 1 million zero-emission vehicles by 2020 and 1.5 million zero-emission vehicles by 2025. The draft *Vision for Clean Air*, developed by the California Air Resources Board, the South Coast Air Quality Management District, and the San Joaquin Valley Air Pollution Control District, also articulates key concepts that provide the foundation for how the state might meet its 2023 and 2032 air quality goals in conjunction with the state's 2050 GHG emission goal.

To meet all of these goals, significant changes to the state's fuel and vehicle profiles will be needed. 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 California 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. Assembly Bill 1314 (Wieckowski, Chapter 487, Statutes of 2011) reduced the scope of the annual investment plan to an update. Accordingly, the *2012-2013 Investment Plan Update* and *2013-2014 Investment Plan Update* represent more concise documents that rely on the framework and analyses included in previous investment plans, plus updates based on recent developments.

This document represents the final version of the *2013-2014 Investment Plan Update* as approved by the California Energy Commission. Statute requires the Energy Commission to produce an initial draft of the investment plan, concurrent with the Governor's draft budget

release in January, and a final version of the investment plan, concurrent with the Governor's revised budget released in May. On September 19, 2012, the Energy Commission conducted an Advisory Committee meeting and public workshop on the Alternative and Renewable Fuel and Vehicle Technology Program. As a part of this workshop, members of the Energy Commission's Advisory Committee presented their perspectives on how to address present and future funding needs for different alternative and renewable fuels. A second Advisory Committee meeting was held on December 4, 2012, to present an initial draft investment plan. A revised staff draft version of the *2013-2014 Investment Plan Update* was released on January 10, 2013, and a third Advisory Committee meeting was held on February 28, 2013. The Energy Commission has also continued to receive, review, and incorporate input from stakeholders via a public docket and ongoing outreach efforts. As of April 2013, more than 60 letters, presentations, and reports had been submitted to the public docket for the Energy Commission's consideration.

**Changes in the Lead Commissioner Report**

Based on continued review of industry needs, as well as input on previous drafts, a lead commissioner report version of the *2013-2014 Investment Plan Update* included several updates and modifications relative to the previous version. Among these are changes to certain funding allocations, with additional funding for emerging opportunities (increased by $1 million), regional alternative fuel readiness and planning (increased by $2 million), and centers for alternative fuels (increased by $2 million). These increases reflect the expanded number of worthy proposals that have expressed interest in the emerging opportunities category plus a need to prioritize projects that can expand the market demand for alternative fuels and advanced technology vehicles. This funding ($5 million total) was subtracted from the manufacturing category based on the large awards for manufacturing that were recently provided in previous fiscal years. Other modifications to the lead commissioner report provided added detail and justification for previous funding allocations. Finally, the lead commissioner report also updated information on program activities and other developments.

The lead commissioner report was adopted as an official commission report by the full California Energy Commission at a Business Meeting on May 8, 2013.

**The Context of the 2013-2014 Investment Plan Update**

Since the first investment plan in 2009, the Energy Commission allocated more than $450 million in program funding over five fiscal years and four investment plans. Based on these investment plans, the Energy Commission has issued grant agreements and proposed awards totaling more than $350 million for more than 220 projects (not including technical support agreements) that support alternative and renewable fuels and advanced vehicle technologies, which are detailed in Table ES-1. These projects provide important feedback to the Energy Commission on opportunities and challenges facing alternative fuels and vehicles, which help advise future funding decisions. Additionally, the Energy Commission has gained experience and knowledge from reviewing more than 500 proposals requesting more than $1.5 billion from the ARFVT Program through 16 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. 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 tons 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. An update to this benefits report will be developed as part of the *2013 Integrated Energy Policy Report*. In the interim, the Energy Commission continues to review the development and use of program metrics, which are integral parts of benefits assessment and reporting.

Relevant policies and regulations have also helped guide the *2013-2014 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 average carbon intensity value requirement becomes tighter each year, the economic value of lower-carbon alternative fuels will increase to reflect their lower carbon values. Assembly Bill 523 (Valadao, Chapter 183, Statutes of 2012), meanwhile, prohibits ARFVT Program funding for ethanol production that is derived from the edible plant portions of corn as of July 1, 2013. 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 effect 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. Also part of the Advanced Clean Car Package, 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 once the number of fuel cell vehicles reaches certain milestones. More recently, the Governor's *Zero Emission Vehicle Action Plan* identifies several critical strategies and actions to support the deployment of zero-emission vehicles, while the *Vision for Clean Air* outlines a vision for how the state can meet both its climate change and air quality goals.

### 2013-2014 Investment Plan Update Funding Priorities

As in previous investment plans, the Energy Commission evaluates funding needs and priorities in the *2013-2014 Investment Plan Update* for a suite of fuels and technologies, as well as short-, medium- and long-term opportunities. The *2013-2014 Investment Plan Update* includes funding allocations that reflect the program's experience to date, the analyses underpinning previous investment plans, and more recent developments in the alternative fuels and vehicle technology markets. Table ES-1 summarizes the funding agreements from previous years, as well as the proposed funding allocations for fiscal year 2013-2014. Table ES-2 outlines the funding allocations of the three most recent investment plans, in comparison to the proposed funding allocations for fiscal year 2013-2014.

**Table ES-1: Summary of Previous Awards and Proposed Funding (Dollars in Millions) as of 3-20-2013**

| Category | Funded Activity | Cumulative Awards to Date* | Projects to Date | 2013-2014 Investment Plan (Proposed) |
|---|---|---|---|---|
| **Alternative Fuel Production** | Biomethane Production | $49.9 | 13 | $23 |
| | Gasoline Substitutes Production | $26.4 | 10 | |
| | Diesel Substitutes Production | $21.0 | 11 | |
| **Alternative Fuel Infrastructure** | Electric Vehicle Charging Infrastructure | $24.9 | 29 | $7 |
| | Hydrogen Fueling Infrastructure | $18.2 | 3 | $20 |
| | E85 Fueling Infrastructure | $16.5 | 4 | - |
| | Upstream Biodiesel Infrastructure | $4.5 | 5 | - |
| | Natural Gas Fueling Infrastructure | $16.1 | 44 | $1.5 |
| **Alternative Fuel and Advanced Technology Vehicles** | Natural Gas Vehicle Deployment | $28.0** | 4*** | $12 |
| | Propane Vehicle Deployment | $2.4** | 4*** | - |
| | Light-Duty Electric Vehicle Deployment† | $7.1 | 3 | $5 |
| | Medium- and Heavy-Duty Electric Vehicle Deployment‡ | $4.0 | 1 | - |
| | Medium- and Heavy-Duty Advanced Vehicle Technology Demonstration | $42.8 | 25 | $15 |
| **Emerging Opportunities** | Emerging Opportunities | $9.0 | 3 | $4 |
| **Manufacturing** | Manufacturing Facilities, Equipment, and Working Capital | $52.0 | 19 | $5 |
| **Workforce Agreements** | Workforce Training and Development | $23.8 | 30 | $2 |
| **Market and Program Development** | Fuel Standards and Equipment Certification | $4.0 | 1 | - |
| | Sustainability Studies | $2.1 | 2 | - |
| | Regional Planning | $2.0 | 10 | $3.5 |
| | Centers for Alternative Fuels and Advanced Vehicle Technology | - | - | $2 |
| **Total** | | $351.9 | 221 | $100 |

*Includes all projects and agreements that have been approved or are anticipated for approval at an Energy Commission Business Meeting.
**Does not include reserved incentives that have yet to be claimed.

***Includes the Energy Commission's ongoing vehicle deployment incentives.
†Includes $6.5 million transferred to the Air Resources Board's Clean Vehicle Rebate Project.

‡Includes $4 million transferred to the Air Resources Board's Hybrid Truck and Bus Voucher Incentive Program.

Source: California Energy Commission

**Table ES-2: Summary of Three Most Recent Investment Plan Allocations (in Millions)**

| Category | Funded Activity | 2010-2011*,** | 2011-2012** | 2012-2013* | 2013-2014 (Proposed) |
|---|---|---|---|---|---|
| **Alternative Fuel Production** | Biofuel Production and Supply | $17.5 | $24 | $18.0 | $23 |
| **Alternative Fuel Infrastructure** | Electric Charging Infrastructure | $2.4 | $7.5 | $6.75 | $7 |
| | Hydrogen Fueling Infrastructure | $10.3 | $8.5 | $9.9 | $20 |
| | E85 Fueling Infrastructure | $5.2 | $5 | $1.35 | - |
| | Diesel Substitutes Infrastructure | $1.1 | - | - | - |
| | Natural Gas Fueling Infrastructure | $1.6 | $8 | $1.35 | $1.5 |
| **Alternative Fuel and Advanced Technology Vehicles** | Natural Gas Vehicle Incentives | $10.3 | $12 | $10.8 | $12 |
| | Propane Vehicle Incentives | $2.4 | $4 | $1.8 | - |
| | Light-Duty Electric Vehicle Deployment | - | - | $4.5 | $5 |
| | Medium- and Heavy-Duty Advanced Vehicle Technology Demonstration | $16.5 | $8.5 | $5.4 | $15 |
| **Emerging Opportunities** | Emerging Opportunities | $6.3 | $3 | $4.5 | $4 |
| **Manufacturing** | Manufacturing Facilities, Equipment, and Working Capital | $6 | $10 | $18 | $5 |
| **Workforce Agreements** | Workforce Training and Development Agreements | $0.8 | $6.5 | $2.25 | $2 |
| **Market and Program Development** | Regional Alternative Fuel Readiness and Planning | - | $1 | $2.7 | $3.5 |
| | Centers for Alternative Fuels and Advanced Vehicle Technology | - | - | $2.7 | $2 |
| | Sustainability Studies | $0.6 | - | - | - |
| | Marketing and Outreach | $2 | | - | - |

| | | | | | |
|---|---|---|---|---|---|
| | Technical Assistance and Analysis | $2.7 | $2 | - | - |
| | Measurement, Verification, and Evaluation | $1 | - | - | - |
| **Total** | | $86.7 | $100 | $90 | $100 |

*All funding allocations for this year were evenly reduced from their original amount, due to insufficient program funds.

**Certain funding allocations for this year were modified at a subsequent Business Meeting to reflect the listed amounts.

Source: California Energy Commission

# CHAPTER 1: Introduction

On October 8, 2012, the average retail price of regular gasoline in California reached a new all-time high: $4.67 per gallon. While this record was immediately attributable to a series of temporary refinery incidents, the biggest factor has been the substantial rise in petroleum prices since the start of the previous decade. In 2001, the average national price for a gallon of gasoline was $1.83 but nearly doubled to $3.53 per gallon by 2011.[1] In 2011, the typical American household spent about 8.4 percent of the median family budget on transportation fueling, the highest share of household income in 30 years.[2] Despite this, California remains highly dependent on petroleum-based fuels, which supply roughly 96 percent of all of the state's transportation energy.[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 GHG emissions, the emissions that contribute to global climate change. In 2010, about 27.5 million vehicles in California consumed roughly 14.8 billion gallons of gasoline and 3.3 billion gallons of diesel.[4] 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.[5]

To help achieve these policy goals, the Legislature created the Alternative and Renewable Fuel and Vehicle Technology Program (ARFVT Program) 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 approximately $100 million annually for projects that:

---

[1] U.S. Department of Energy, "Historical Gasoline Prices, 1929-2011," http://www1.eere.energy.gov/vehiclesandfuels/facts/2012_fotw741.html. Both of these prices are inflation-adjusted to 2011 dollars.

[2] *Chicago Tribune*, "Gas Takes Its Biggest Bite Out of Family Budget in 30 Years," December 19, 2011.

[3] California Energy Commission, "California Petroleum Statistics & Data," https://ww2.energy.ca.gov/almanac/petroleum_data/fuels_watch/index_cms.html

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

[5] 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 non-road 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 California Energy Commission prepare an annual investment plan update to guide that year's funding decisions. Accordingly, the Energy Commission adopted its first investment plan (covering fiscal years 2008-2009 and 2009-2010) in April 2009, its second investment plan (covering fiscal year 2010-2011) in August 2010, the third investment plan (covering fiscal year 2011-2012) in September 2011, and the fourth and most recent investment plan (covering fiscal year 2012-2013) in May 2012. Assembly Bill 1314 (Wieckowski, Chapter 487, Statutes of 2011) reduced the scope of the annual investment plan to an update. As a result, the *2012-2013 Investment Plan Update* and this *2013-2014 Investment Plan Update* represent more concise documents that rely on the framework and analyses included in previous investment plans, plus updates based on more recent developments.[6]

This document represents the final version of the *2013-2014 Investment Plan Update* as approved by the California Energy Commission. Statute requires the Energy Commission to produce an initial draft of the investment plan, concurrent with the Governor's draft budget release in January, and a final version of the investment plan, concurrent with the Governor's revised budget released in May. On September 19, 2012, the Energy Commission conducted an Advisory Committee meeting and public workshop on the Alternative and Renewable Fuel and Vehicle Technology Program. As a part of this workshop, members of the Energy Commission's Advisory Committee presented their perspectives on how to address present and future funding needs for different alternative and renewable fuels. A second Advisory Committee meeting was held on December 4, 2012, to present an initial draft investment plan. A revised staff draft version of the *2013-2014 Investment Plan* Update was released on January 10, 2013, and a third Advisory Committee meeting was held on February 28, 2013. The Energy Commission has also continued to receive, review, and incorporate input from

[6] These previous investment plans are available on the Energy Commission's website https://ww2.energy.ca.gov/transportation/arfvtp/earlier_investment_plans.html

stakeholders via a public docket and ongoing outreach efforts.[7] As of April 2013, more than 60 letters, presentations, and reports had been submitted to the public docket for the Energy Commission's consideration.

A lead commissioner report version of the *2013-2014 Investment Plan Update* was posted on April 24, 2013. This lead commissioner report was subsequently adopted as an official commission report by the full California Energy Commission at a Business Meeting on May 8, 2013.

[7] The Energy Commission encourages all public comments on the *2013-2014 Investment Plan Update* to be submitted to the Energy Commission's docket. To submit comments electronically, please include your name (or the name of your organization) in the name of the attached file. Additionally, in the subject line of your comments, please include the docket number "12-ALT-2" and indicate "2013-2014 Investment Plan Update." Comments should be sent as either a Microsoft Word® document or a Portable Document File (PDF) to the Energy Commission email (docket@energy.ca.gov.)

# CHAPTER 2: Context of the ARFVT Program

To maximize the effect 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, it is a modest sum in the context of an annual $1.9 trillion state economy and is less than the amount Californians typically spend on gasoline and diesel fuel each day. Additionally, individual Californians spend thousands of dollars each year on the purchase and maintenance of conventional vehicles that rely on gasoline and diesel. The ARFVT Program's investments alone are not sufficient to significantly transform vehicle and fuel profiles of the transportation sector; the Energy Commission must also rely on outside policies and investments to realize this goal. The ARFVT Program is just one element in the State of California's suite of policies, regulations, and investments intended to transform the state's transportation system to an alternative fuel, low-carbon future.

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

## Summary of ARFVT Program Funding

Since adoption of the first investment plan in 2009, the Energy Commission allocated about $450 million in program funding over five fiscal years and four investment plans. Based on these investment plans, the Energy Commission has issued grant agreements and proposed awards totaling more than $350 million for more than 220 projects (not including technical support agreements) that will support alternative and renewable fuels and advanced vehicle technologies, which are detailed in Table 1. These successful projects provide important feedback to the Energy Commission on opportunities and challenges facing alternative fuels and vehicles, which help advise future funding decisions. Additionally, the Energy Commission has gained experience and knowledge from reviewing more than 500 proposals requesting more than $1.5 billion from the ARFVT Program through 16 solicitations. Nearly all of these proposals have included match funding from the applicant (typically in-line with the amount of funding requested from the ARFVT Program), which highlights the commitment of the project developers as well as the unmet need for funding in this arena. Currently, private sector and other public agency match funding is totaling about $2 for each dollar of ARFVT Program funding.

Table 2 outlines the funding allocations of the three most recent investment plans, in comparison to the proposed funding allocations for fiscal year 2013-2014.

**Table 1: Summary of Previous Awards and Proposed Funding (Dollars in Millions) as of 3-20-2013**

| Category | Funded Activity | Cumulative Awards to Date* | Projects to Date | 2013-2014 Investment Plan (Proposed) |
|---|---|---|---|---|
| **Alternative Fuel Production** | Biomethane Production | $49.9 | 13 | $23 |
| | Gasoline Substitutes Production | $26.4 | 10 | |
| | Diesel Substitutes Production | $21.0 | 11 | |
| **Alternative Fuel Infrastructure** | Electric Vehicle Charging Infrastructure | $24.9 | 29 | $7 |
| | Hydrogen Fueling Infrastructure | $18.2 | 3 | $20 |
| | E85 Fueling Infrastructure | $16.5 | 4 | - |
| | Upstream Biodiesel Infrastructure | $4.5 | 5 | - |
| | Natural Gas Fueling Infrastructure | $16.1 | 44 | $1.5 |
| **Alternative Fuel and Advanced Technology Vehicles** | Natural Gas Vehicle Deployment | $28.0** | 4*** | $12 |
| | Propane Vehicle Deployment | $2.4** | 4*** | - |
| | Light-Duty Electric Vehicle Deployment† | $7.1 | 3 | $5 |
| | Medium- and Heavy-Duty Electric Vehicle Deployment‡ | $4.0 | 1 | - |
| | Medium- and Heavy-Duty Advanced Vehicle Technology Demonstration | $42.8 | 25 | $15 |
| **Emerging Opportunities** | Emerging Opportunities | $9.0 | 3 | $4 |
| **Manufacturing** | Manufacturing Facilities, Equipment, and Working Capital | $52.0 | 19 | $5 |
| **Workforce Agreements** | Workforce Training and Development | $23.8 | 30 | $2 |
| **Market and Program Development** | Fuel Standards and Equipment Certification | $4.0 | 1 | - |
| | Sustainability Studies | $2.1 | 2 | - |
| | Regional Planning | $2.0 | 10 | $3.5 |
| | Centers for Alternative Fuels and Advanced Vehicle Technology | - | - | $2 |
| **Total** | | $351.9 | 221 | $100 |

*Includes all projects and agreements that have been approved or are anticipated for approval at an Energy Commission Business Meeting.
**Does not include reserved incentives that have yet to be claimed.
***Includes the Energy Commission's ongoing vehicle deployment incentives.

[†]Includes $6.5 million transferred to the Air Resources Board's Clean Vehicle Rebate Project.
[‡]Includes $4 million transferred to the Air Resources Board's Hybrid Truck and Bus Voucher Incentive Program.

Source: California Energy Commission

**Table 2: Summary of Three Most Recent Investment Plan Allocations (in Millions)**

| Category | Funded Activity | 2010-2011*,** | 2011-2012** | 2012-2013* | 2013-2014 (Proposed) |
|---|---|---|---|---|---|
| **Alternative Fuel Production** | Biofuel Production and Supply | $17.5 | $24 | $18.0 | $23 |
| **Alternative Fuel Infrastructure** | Electric Charging Infrastructure | $2.4 | $7.5 | $6.75 | $7 |
| | Hydrogen Fueling Infrastructure | $10.3 | $8.5 | $9.9 | $20 |
| | E85 Fueling Infrastructure | $5.2 | $5 | $1.35 | - |
| | Diesel Substitutes Infrastructure | $1.1 | - | - | - |
| | Natural Gas Fueling Infrastructure | $1.6 | $8 | $1.35 | $1.5 |
| **Alternative Fuel and Advanced Technology Vehicles** | Natural Gas Vehicle Incentives | $10.3 | $12 | $10.8 | $12 |
| | Propane Vehicle Incentives | $2.4 | $4 | $1.8 | - |
| | Light-Duty Electric Vehicle Deployment | - | - | $4.5 | $5 |
| | Medium- and Heavy-Duty Advanced Vehicle Technology Demonstration | $16.5 | $8.5 | $5.4 | $15 |
| **Emerging Opportunities** | Emerging Opportunities | $6.3 | $3 | $4.5 | $4 |
| **Manufacturing** | Manufacturing Facilities, Equipment, and Working Capital | $6 | $10 | $18 | $5 |
| **Workforce Agreements** | Workforce Training and Development Agreements | $0.8 | $6.5 | $2.25 | $2 |
| **Market and Program Development** | Regional Alternative Fuel Readiness and Planning | - | $1 | $2.7 | $3.5 |
| | Centers for Alternative Fuels and Advanced Vehicle Technology | - | - | $2.7 | $2 |
| | Sustainability Studies | $0.6 | - | - | - |
| | Marketing and Outreach | $2 | | - | - |
| | Technical Assistance and Analysis | $2.7 | $2 | - | - |
| | Measurement, Verification and Evaluation | $1 | - | - | - |
| **Total** | | $86.7 | $100 | $90 | $100 |

*All funding allocations for this year were evenly reduced from their original amount, due to insufficient program funds. *
*All funding allocations for this year were evenly reduced from the original amount, due to reduced appropriation.

Source: California Energy Commission

As part of the *2011 Integrated Energy Policy Report*, the Energy Commission prepared its first benefits report on the ARFVT Program.[8] The benefits report summarized the investments made by the ARFVT Program to date and identified the anticipated range of benefits from the fuels and technologies supported by the ARFVT Program. This includes a 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 tons 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 tons of GHG emissions per year by 2020.[9]

An update to this benefits report will be developed as part of the *2013 Integrated Energy Policy Report*. The Energy Commission continues to review how ARFVT Program investments, results, and benefits can be assessed and communicated to stakeholders. Technical support and program evaluation agreements with the National Renewable Energy Laboratory, UC Davis Institute for Transportation Studies, and the RAND Corporation all have provisions for critical review and guidance on how the Energy Commission can best measure and convey ARFVT Program investments, results, and benefits. The Energy Commission also continues to review the development and use of program metrics, which are integral parts of benefits assessment and reporting.

## 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 provide GHG cobenefits. The AQIP is guided by an annual funding plan prepared by ARB. The *AQIP Funding Plan for Fiscal Year 2013-2014* is expected to be presented for approval at a June 2013 meeting of 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 Project (HVIP).

---

[8] 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 online. http://www.energy.ca.gov/2011publications/CEC-600-2011-008/CEC-600-2011-008-SD.pdf

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

Table 3 shows the total amount of funding allocated by ARB for the CVRP, the HVIP, and other activities funded by the AQIP during the program's first three fiscal years.[10] As of March 2013, the CVRP has provided more than $44 million toward rebates for more than 10,000 zero-emission vehicles and more than 9,000 plug-in hybrid electric vehicles. The HVIP has provided vouchers for nearly 1,300 vehicles to date, including 348 zero-emission trucks. The Energy Commission has allocated a total of $10.5 million to the AQIP to augment incentive funding for zero-emission cars and trucks.

**Table 3: AQIP Funding Allocations (in Millions)**

| | 2009-10 | 2010-11 | 2011-12 | 2012-13** | Total |
|---|---|---|---|---|---|
| CVRP | $4.1 | $7* | $16.2 | $28.5* | $55.8 |
| HVIP | $20.4 | $23* | $11 | $0 | $54.4 |
| Other | $3.5 | $4.8 | $1.7 | $6 | $16 |
| Total | $28 | $34.8 | $28.8 | $30 | $126.2 |

*Includes Energy Commission transfers of $6.5 million to CVRP and $4 million to HVIP.

**Includes revisions proposed by ARB in March 2013.

Source: Air Resources Board, California Energy Commission

The Energy Commission's ARFVT Program and 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 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 ARB has predominantly supported the latter. The Energy Commission also provides vehicle deployment incentives, but primarily for natural gas and propane vehicles. As with previous investment plans, the Energy Commission will adopt the *2013-2014 Investment Plan Update* in collaboration with ARB's adoption of the *2013-2014 AQIP Funding Plan*.

## 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

[10] ARB, Assembly Bill 118 Air Quality Improvement Program Funding Plan For Fiscal Year 2012-13, Appendix A: Status Update on Assembly Bill 118 AQIP Projects, July 21, 2011. Available online. https://ww2.arb.ca.gov/resources/documents/aqip-formal-regulatory-documents

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.[11] The LCFS measures the carbon intensity of regulated parties' fuels based on the lifecycle GHG emissions used to produce, distribute, and use 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 portraying a combination of steadily increasing levels of low-carbon alternative fuels and vehicles that could meet the LCFS objectives.[12]

The Energy Commission expects the LCFS to have a significant early effect 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 an additional source of revenue to alternative fuel producers that will allow them to recoup the higher costs of their product.

## Renewable Fuel Standard

The federal 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, can provide support for projects and

---

[11] 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.

[12] ARB, *Low Carbon Fuel Standard 2011 Program Review Report*, December 8, 2011. Available online http://www.arb.ca.gov/fuels/lcfs/workgroups/advisorypanel/20111208_LCFS%20program%20review%20report_final.pdf.

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 December 2009, the Board directed staff to incorporate the state's goal of reducing GHG emissions to 80 percent below 1990 levels by 2050 in the next ZEV regulatory revisions. The amendments to the ZEV regulation adopted in January 2012 increase the requirements for ZEVs between 2018 and 2025 and refocus the regulation away from partial zero-emission vehicles and advanced technology partial zero-emission vehicles (that are now considered fully commercialized).[13] ARB staff anticipates more than 1.4 million battery electric vehicles (BEV), plug-in hybrid electric vehicles (PHEV), and fuel cell vehicles (FCV) on the road by 2025, with 500,000 vehicles being either BEVs or FCVs.[14]

## 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. ARB amended the CFO Regulation 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 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 for any given year that ARB anticipates a regional volume of 10,000 FCVs and 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.

## Vision for Clean Air: A Framework for Air Quality and Climate Planning

The *Vision for Clean Air* is a joint effort between ARB, the South Coast Air Quality Management District, and the San Joaquin Valley Air Pollution Control District. The project takes a coordinated look at strategies to meet California's multiple air quality and climate change goals

---

[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 online. http://www.arb.ca.gov/regact/2012/zev2012/zevisor.pdf.

[14] "Battery electric vehicles" refers to vehicles that operate exclusively on electricity from a battery. "Plug-in hybrid electric vehicles" refers to vehicles that operate on a mixture of gasoline and electricity and plug in to recharge.

well into the future. It is intended to demonstrate the magnitude of transformation needed to meet the state's aggressive goals to reduce greenhouse gas emissions and meet federal air quality standards in 2023 and 2032. Nitrogen oxide (NOx) emissions will need to be reduced by about 80 percent in the San Joaquin and South Coast air basins from today's levels to meet federal ozone requirements in 2023, while GHG emissions will need to be reduced by about 85 percent from today's levels by 2050. A staff draft of the project was released in June 2012 for public review and comment.[15] This draft looks at a mix of known fuels and vehicle technologies and explores whether and how this mix can simultaneously achieve both the air quality goals of the two air districts, as well as the state's climate change goal. The initial public draft of the vision represents a first step in a deeper analysis into the state's long-term goals.

Numerous concepts outlined in the vision have significant applicability to the ARFVT Program. The first of seven key concepts identified in the vision is "Technology Transformation," which outlines a shift in automakers' mass market vehicles toward advanced technology, such as zero-emission cars and trucks, over the next four decades. This is reflected in several of the ARFVT Program's continued funding allocations, including electric vehicle charging infrastructure, hydrogen fueling infrastructure, and the demonstration of advanced technology medium- and heavy-duty vehicles. Another key concept of the vision is to incorporate multiple strategies in meeting the state's goals. This is also reflected in the ARFVT Program's portfolio approach toward alternative fuels, which additionally incorporates low-carbon biofuels, natural gas, and propane as additional means of simultaneously supporting the state's climate and air quality goals.

## Zero Emission Vehicle Action Plan

On March 23, 2012, Governor Brown issued Executive Order B-16-12, which set a target of 1 million PEVs on the road by 2020, as well as 1.5 million PEVs on the road by 2025. The Executive Order tasked state government with identifying the strategies and actions that will be needed to support these aggressive vehicle deployment targets. In response, the Governor's Office of Planning and Research is coordinating the development of the *ZEV Action Plan,* which compiles these strategies and actions into a cohesive planning document for the state.

An initial draft of the *2012 ZEV Action Plan* was released in September 2012 and was the subject of a Governor's Office of Planning and Research stakeholder summit in Sacramento on September 28, 2012. The *2013 ZEV Action* Plan, issued in February 2013, builds on the previous draft and contains updated activities and strategies.[16] Many of the *ZEV Action Plan* strategies and actions apply directly to the funding categories supported by the ARFVT Program. In particular, the *ZEV Action Plan* calls on state agencies to support the development

---

[15] California Air Resources Board, South Coast Air Quality Management District, San Joaquin Valley Unified Air Pollution Control District, *Vision for Clean Air: A Framework for Air Quality and Climate Planning – Public Review Draft,* June 27, 2012. Available online. http://www.arb.ca.gov/planning/vision/docs/vision_for_clean_air_public_review_draft.pdf.

[16] Governor's Interagency Working Group on Zero-emission Vehicles, *2013 ZEV Action Plan: A Roadmap Toward 1.5 Million Zero-emission Vehicles on California Roadways by 2025*, February 2013. Available online. http://opr.ca.gov/docs/Governors_Office_ZEV_Action_Plan_(02-13).pdf

of infrastructure networks and community readiness for PEVs and FCVs, both of which have been significantly funded by the ARFVT Program. The *ZEV Action Plan* also highlights the importance of economic development as a result of growth in the ZEV sector. The plan highlights ongoing needs for public investment into workforce training and in-state manufacturing as a means of ensuring this tie between ZEV deployment and economic development. Both of these investments have been the target of ongoing ARFVT Program funding.

# CHAPTER 3: Alternative Fuels and Advanced Vehicle Technology Opportunities

The California 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. 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 an "update," *2013-2014 Investment Plan Update* does not provide a comprehensive walkthrough of the supply chain for each alternative fuel type. Instead, the *2013-2014 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 program'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 Energy Commission in September 2011.[17] The *2012-2013 Investment Plan Update* also provides a narrative bridge between this document and the *2011-2012 Investment Plan.*[18]

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 fiscal year 2013-2014.

## 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.[19] Due to their compatibility with

---

[17] 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 online. https://ww2.energy.ca.gov/2011publications/CEC-600-2011-006/CEC-600-2011-006-CMF.pdf

[18] Smith, Charles, Jim McKinney. 2012. *2012-2013 Investment Plan Update for the Alternative and Renewable Fuel and Vehicle Technology Program Commission Report.* California Energy Commission, Fuels and Transportation Division. Publication Number: CEC-600-2012-001-CMF. Available online. https://ww2.energy.ca.gov/2012publications/CEC-600-2012-001/CEC-600-2012-001-LCF.pdf

[19] 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

California's existing fleet of light-, medium-, and heavy-duty vehicles, these low-carbon substitute fuels have the potential for immediate, high-volume effects on California's fuel markets, which included roughly 14.8 billion gallons of gasoline and 3.3 billion gallons of diesel in 2010.

The Energy Commission's strategic goal for its ARFVT Program biofuels investments is to continue building the capacity of California firms to produce second and third generation advanced technology, low-carbon biofuels using waste-based and renewable feedstocks that can compete economically in California fuel markets. To meet LCFS and RFS2 goals for low-carbon biofuels, in-state producers will need to shift away from first generation biofuels based on corn, soy, and other foodstuffs. Several of these producers are already implementing such measures. The endgame is to find the right technologies and feedstocks that culminate in fully fungible liquid and gaseous biofuels that do not require special vehicles or parallel infrastructure.

Ethanol is the largest volume biofuel in California 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). In 2011, the U.S. Environmental Protection Agency (U.S. EPA) granted waivers to allow up to 15 percent ethanol in reformulated gasoline for use in model year 2001 and newer vehicles in response to the RFS2 goal. 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) that can use up to 85 percent ethanol (also known as E85) in their fuel.[20] 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. As of 2011, California ethanol refiners were producing 170 million gallons each year out of a capacity of 241 million gallons.[20] The remainder is imported into California primarily from ethanol production facilities in the Midwest. Most ethanol currently produced and used within California is derived from corn, and recent increases in the cost of corn (due to both drought and higher demand for corn-derived products, including ethanol) are negatively affecting in-state producers.

California's in-state ethanol producers have identified and are beginning to implement the necessary steps to produce lower-carbon advanced biofuels through more efficient production

---

differ from similar terms used by ARB under the LCFS, which are broader and include fuels such as electricity, natural gas, and hydrogen.

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

processes, new conversion technologies, and/or inclusion of alternative feedstocks. There may also be opportunities to partner new technology providers with existing ethanol producers to leverage the existing investments into the production of even lower-carbon biofuels.

California has an in-state biodiesel production capacity of roughly 46 million gallons per year, from which an estimated 26 million gallons will be produced in 2012.[21] 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). 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. However, establishing production and demand for diesel substitutes will be critical to meeting the state's lower carbon targets, as the state currently uses more than 3 billion gallons of diesel fuel per year.

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 nonroad vehicles. Within California, there is significant volume potential for renewable aviation fuel, roughly 3 billion gallons of conventional jet fuel annually.[22] The majority of this fuel is distributed through a small number of large airports, which makes it easier to integrate large volumes of renewable fuels. Similar opportunities may exist for ships seeking to use renewable fuels in the marine sector. For these reasons, the ARFVT Program will consider allowing these nonroad fuels to be eligible for funding under this section.

The Energy Commission has invested a significant portion of the ARFVT Program's funding toward expanding California's in-state production of low-carbon alternative fuels. The first two ARFVT Program investment plans funded about $45 million for 17 projects that will develop, demonstrate, and deploy next-generation technologies for biofuel production within California. Commercial-scale biomethane production from waste-based resources comprised the majority of the project funds. Most of these projects provide a carbon emission reduction of 70 to 90

---

[21] Joe Gershen, "California Biodiesel Alliance – Funding Request for AB 118 ARFVTP." Presented at the ARFVT Program Advisory Committee meeting on September 19, 2012. Available online. https://www.rand.org/content/dam/rand/pubs/research_reports/RR1900/RR1948/RAND_RR1948.pdf

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

percent compared to conventional gasoline or diesel.[23] Table 4 summarizes these initial awards, which were based on two solicitations.[24]

**Table 4: Summary of Initial Biofuel Production Awards**

| Fuel Type | Proposals Submitted | Funds Requested | Awards Made | Funds Awarded |
|---|---|---|---|---|
| Diesel Substitutes | 72 | $257,007,363 | 5 | $4,267,673 |
| Gasoline Substitutes | | | 3 | $5,363,538 |
| Biomethane | | | 9 | $35,318,080 |
| Total | 72 | $257,007,363 | 17 | $44,949,291 |

Source: California Energy Commission

Both of the above solicitations emphasized projects that used low-carbon, waste-based feedstocks. The approximate GHG emission reductions associated with these fuel pathways, as well as the comparative GHG emissions of their displaced fuels, are listed in Table 5.

**Table 5: Estimates of GHG Emissions for Initial Biofuel Production Grants**

| Fuel | Description of GHG Emission Estimates | GHG Emission Estimates ($gCO_2e/MJ$)[25] |
|---|---|---|
| CARBOB | (Displaced by ethanol projects) | 99.18 |
| Diesel | (Displaced by biomethane and diesel substitute projects) | 98.03 |
| 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[26] |

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

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 displace 124 million to 632 million gallons of petroleum-based fuels annually by 2020 and reduce annual GHG emissions by 1.3

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

[24] PON-09-003 and PON-09-604.

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

[26] 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.

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. In addition to these awards, the Energy Commission has provided $6 million to support in-state ethanol producers to continue production and transition to a lower-carbon product. As of July 1, 2013, Assembly Bill 523 (Valadao, Chapter 183, Statutes of 2012) will prohibit ARFVT Program funding for ethanol production that is derived from the edible plant portions of corn.

With remaining funds from the *2010-2011 Investment Plan* and *2011-2012 Investment Plan*, the Energy Commission provided $37.7 million in a solicitation for projects that will support biofuel production (PON-11-601). Due to the extensive list of quality proposals, the Energy Commission opted to use $8.7 million in applicable funds from the *2012-2013 Investment Plan Update* to supplement this funding, for a total of $46.4 million. Table 6 shows the number and type of biofuel production projects proposed for award under this solicitation.

Several stakeholders have expressed support for greater focus on diesel substitutes, given the more limited advanced vehicle technologies currently available in the medium- and heavy-duty sector. As shown in Table 6, there were a significant number of proposals and amount of funding requested for diesel substitutes projects, while the proposed awards ended up being distributed more evenly among diesel substitutes, gasoline substitutes and biomethane. This is due, in large part, to the use of funding from the *2011-2012 Investment Plan*, which established separate categories of funding for each fuel type. Diesel substitutes projects scored well in this solicitation and can be reasonably assumed to be very competitive in future solicitations as well.

**Table 6: Summary of Recent Biofuel Production Awards**

| Fuel Type | Proposals Submitted | Funds Requested | Projects Proposed for Award | Funds Proposed for Award |
|---|---|---|---|---|
| Diesel Substitutes | 31[27] | $86,159,343 | 6 | $16,772,187 |
| Gasoline Substitutes | 17 | $33,857,659 | 4 | $15,061,083 |
| Biomethane | 13 | $27,540,320 | 4 | $14,589,993 |
| Total | 61 | $147,557,322 | 14 | $46,423,263 |

Source: California Energy Commission

To be eligible for this funding, gasoline substitute and diesel substitute production projects were required to show 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 were required to use prelandfill waste-based biomass sources. Projects were scored based on several criteria, including sustainability criteria such as GHG reduction, natural resource impact, feedstock sourcing, and sustainability certification. Projects scored higher based on their usage of waste-based feedstocks, reduced

[27] Includes one aviation fuel project.

impacts on natural resources, and use of marginal or abandoned land. Together, the sustainability criteria comprised roughly one-quarter of the possible scoring points.

Assembly Bill 341 (Chesbro, Statutes of 2011, Chapter 476) set a state goal of reducing, recycling, or composting 75 percent of solid waste by 2020 and requires the California Department of Resources Recycling and Recovery to report to the Legislature on progress toward meeting this goal. This goal should support prelandfill biomethane production by increasing the availability of organic waste feedstocks. The Energy Commission supports this target and will consider prioritizing prelandfill biomethane production in future solicitations over landfill gas projects, while still allowing landfill gas projects to compete.

The Public Interest Energy Research (PIER) Program is also preparing awards from a solicitation focused on biomethane production. These proposed awards provide approximately $2.4 million for projects that can demonstrate the value added of cobenefits and coproducts that are a result of biomethane production. The identification and demonstration of these value-added components will help show how biomethane can maintain economic viability in a market where conventional natural gas is relatively cheap. The ARFVT Program's funding for biomethane projects will be carefully coordinated with projects funded by the PIER Program, both to avoid duplication and to take advantage of new findings and opportunities.

There remains about $9.3 million for biofuels production from 2012-2013, which has been allocated for a commercial-scale advanced biofuels solicitation in spring 2013. The focus of this solicitation will be to support the increased production capacity and/or GHG emission reduction of in-state biofuel production at a commercial scale. As part of the scoring criteria, "Sustainability" will represent roughly one-third of proposals' total score.

Given the ongoing oversubscription of quality projects in this category, the Energy Commission intends to allocate $23 million in this *2013-2014 Investment Plan Update* for production of gasoline substitutes, diesel substitutes, biomethane, and other biofuels (Table 7). This allocation reflects the Energy Commission's goal of maintaining a portfolio of potential fuels and technologies, and a long-term goal of seeing multiple types of in-state biofuel production succeed. This allocation will continue to emphasize fuels that can be produced from lower carbon, sustainable feedstocks, as well as drop-in fuels that can use existing infrastructure. The evaluation criteria used for funding new projects, including sustainability criteria, may be similar to those used in previous biofuel production solicitations.

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

**Table 7: Alternative Fuel Production and Supply Funding Allocation**

| | |
|---|---|
| Biofuel Production and Supply | $23 Million |

Source: California Energy Commission

# Alternative Fuel Infrastructure

## Charging Infrastructure

Ensuring adequate charging infrastructure is critical in encouraging the deployment of PEVs. The Energy Commission's strategic goal for its investments in charging infrastructure is to accelerate market growth and acceptance for light-duty electric cars in California by ensuring that all early market purchasers of electric vehicles have access to convenient and low-cost charging infrastructure.

Residential chargers for single-family and multiunit 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, especially PHEV 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 BEVs as they can replenish 12 to 15 miles of vehicle range per hour charged.[28] However, the cost of the added equipment and installation for this level of charging can range from several hundred to several thousand dollars. [29]

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.[29] 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 multiunit 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 his or her employer's building, several hours ahead of the day's typical peak electricity demand. In a survey of early CVRP recipients, just under one-third of vehicle owners reported having access to workplace charging.[30] Fleet-owned PEVs typically charge at night, and many have regular, predictable driving routes.

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

---

[28] Electrification Coalition, *Electrification Roadmap, Revolutionizing Transportation and Achieving Energy Security*, November 2009.

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

[30] California Center for Sustainable Energy, California Plug-in Electric Vehicle Owner Survey. Available online. https://energycenter.org/thought-leadership/news/california-plug-electric-vehicle-owner-survey

more comfortable relying on the electric range of their vehicles. In the previously mentioned survey, 83 percent of respondents expressed varying levels of dissatisfaction with public charging infrastructure.[30] 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 business case for the installers of public charging stations. In some cases, it can be challenging to find a willing private or workplace site host for PEV charging equipment, and public support or incentives may be helpful. Public support for charging infrastructure at destinations (such as state and national parks and other popular attractions) may also be warranted since these locations are often distant from the PEV owners' most frequented charging points.

Nonresidential, daytime 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, such as increased reliance on peaker plants and distribution-level reliability issues.[31] 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 (or 0.6 percent of the systemwide total).

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 locating fast chargers in urban regions, followed by connecting corridors.

Currently, there is no single universal standard for fast chargers. One standard, known as CHAdeMO, is being used by early market Japanese BEVs such as the Nissan Leaf and the Mitsubishi i-MiEV. Another standard, recently adopted by SAE International, is commonly known as the Combo standard. Several major automakers (including BMW, Chrysler, Ford, and General Motors) support this standard. Tesla Motors is additionally deploying its own fleet of fast chargers based on a proprietary standard unique to Tesla. The Energy Commission supports charging infrastructure that can support either (and preferably both) of the CHAdeMO or SAE Combo standards.

On March 23, 2012, Governor Brown announced a settlement by the California Public Utilities Commission (CPUC) with NRG Energy, Inc., that will support the further construction of at least 200 fast chargers and a minimum of 10,000 stubs for chargers in at least 1,000 locations around the state within four years of the settlement date. [32] This will vastly expand the availability of fast chargers, residential chargers, and workplace chargers within the service territories of investor-owned utilities. Details regarding the implementation of this new

---

[31] The term "smart grid" refers to an electricity transmission and distribution system that is integrated with modern telecommunications.

[32] Office of Governor Edmund G. Brown Jr., "Governor Brown Announces $120 Million Settlement to Fund Electric Car Charging Stations Across California," https://www.ca.gov/archive/gov39/2012/03/23/news17463/index.html. This settlement was approved by the Federal Energy Regulatory Commission on November 5, 2012.

initiative are still under development, and the Energy Commission will coordinate with the CPUC and NRG Energy, Inc., on the deployment of this charging infrastructure. As the details of this deployment emerge, the Energy Commission may selectively target its funding of charging infrastructure to avoid duplicating the work being done under the settlement. This may include targeting specific regions and/or types of charging infrastructure.

To date, the ARFVT Program has awarded nearly $25 million in funding for large-scale deployments of charging points. 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. This infrastructure, in turn, has helped California develop the largest fleet of PEVs in the nation, accounting for more than 40 percent of all nationwide PEV purchases over the past two years. The number of charging points funded by the ARFVT Program is summarized in Table 8. In the most recent solicitation (PON-11-602), the amount of funding requested for charging infrastructure projects exceeded available funding by about $11 million. This oversubscription was most notable in the areas of residential charging and fast charging. All workplace charging and fleet charging proposals that received passing scores were funded.

**Table 8: Summary of Charging Infrastructure Awards**

| | **Executed Awards (PON-08-10, PON-09-006)** | | **Recent and Upcoming Awards (PON-11-602)** | |
|---|---|---|---|---|
| **Charger Type** | **Charge Points** | **Funding** | **Charge Points** | **Funding** |
| Residential | 2,233 | $16,050,915 | 1,633 | $4,207,359 |
| Nonresidential | 3,059 | | 152 | $756,402 |
| DC Fast Chargers | 38 | | 39 | $2,532,707 |
| Total | 5,192 | $17,422,000 | 1,822 | $7,496,468 |

Source: California Energy Commission

Many of these awards were made directly to the infrastructure providers. In addition to this model, the Energy Commission will also consider whether to prioritize agreements with site owners or other third-party entities in future solicitations.

In addition to the installation of charging infrastructure equipment, the Energy Commission recognizes other needs that must be met to ensure the smooth introduction of PEVs. Several of these needs are identified in the *2013 ZEV Action Plan*. For example, the Energy Commission has already provided $2 million to support regional planning and readiness for PEVs.[33] The *ZEV Action Plan* also identifies the need to support accessibility of charging stations for all PEV drivers, interoperability of charging infrastructure regardless of manufacturer, and transparency of information provided by PEV chargers. The *ZEV Action Plan* also calls for the California Independent System Operator to develop a roadmap for commercializing vehicle-to-grid technologies that can provide multiple services to the grid and

[33] The *ZEV Action Plan* references the need to "support local governments' efforts to prepare communities for increased PEV usage and the coming commercialization of FCEVs." The Energy Commission's action in this area is covered in more detail in the "Regional Alternative Fuel Readiness and Planning" section.

thereby create added value for PEV owners. There may be opportunities to research and demonstrate the value of such systems using funding from the ARFVT Program.[34] Similar opportunities may exist to demonstrate the "second life" value of used vehicle batteries for electricity storage. If successful, this concept may also provide added value for PEV owners. Finally, commercial electric truck charging infrastructure will be needed soon by early adopter companies such as UPS and FedEx as they begin to demonstrate all-electric delivery trucks in their large California fleets.

For 2013-2014, the Energy Commission will reserve $7 million to expand the state's network of charging stations and to support infrastructure activities that will support the growth in PEV deployment. This includes several of the priorities outlined in the *ZEV Action Plan* as well as any other identified infrastructure needs.

## Hydrogen Fueling Infrastructure

Light-duty fuel cell vehicles using hydrogen as fuel are expected to have a significant role in meeting the state's GHG emission reduction targets and related transportation policy goals. These vehicles have zero tailpipe emissions; are similar to conventional vehicles with regard to range, refueling time, and operation; and are two to three times as efficient as combustion engines. According to the *Vision for Clean Air* draft, zero-emission vehicles (including FCVs and BEVs) may need to account for all light-duty passenger vehicles by 2040 to meet the state's GHG emission reduction target for 2050. The precise mix between FCVs and BEVs will vary based on performance needs within this sector of vehicles. The scenarios illustrated in the *Vision for Clean Air* depict a 70-30 mix of FCVs and BEVs in new auto sales by 2040.[35]

A range of carbon intensities exist for FCVs, depending on their production and distribution pathway. A selection of such intensities based on LCFS values are shown in Table 9 in grams of carbon dioxide equivalent per megajoule ($gCO_2e/MJ$), along with the carbon intensity of gasoline for comparison.[36] The adjusted carbon intensity values reflect an average energy efficiency ratio of 2.5 for fuel cell vehicles and 1 for gasoline vehicles. Pathways that use a higher percentage of renewable feedstocks have even lower carbon intensity values. Among the most common pathways used for new hydrogen fueling infrastructure, HYGN001 with 33 percent renewable feedstock and HYGN003 with 33 percent renewable feedstock would reduce GHG emissions compared to gasoline by 56 percent and 68 percent, respectively.

---

[34] An initial project in this area has been funded by the ARFVT Program in coordination with the U.S. Air Force at the Los Angeles Air Force Base. This is detailed further in the "Emerging Opportunities" section.

[35] California Air Resources Board, Appendix to the June 27, 2012 Vision for Clean Air: A Framework for Air Quality and Climate Planning – Scenario Assumptions and Results. August 20, 2012. Available online. https://ww3.arb.ca.gov/planning/vision/docs/draft_scenario_assumptions_and_results_appendix.pdf

[36] This table was originally prepared in response to questions on the Energy Commission's current hydrogen infrastructure solicitation (PON-12-606). The original document is available online. https://ww2.energy.ca.gov/2013publications/CEC-600-2013-002/CEC-600-2013-002-AD2.pdf

These are roughly comparable to the GHG emission reductions offered by current BEVs (63-70 percent).[37]

**Table 9: Carbon Intensity of Hydrogen Pathways for Fuel Cell Vehicles**

| LCFS Pathway Identifier | Description | Carbon Intensity Value ($gCO_2e/MJ$) | Adjusted Carbon Intensity Value ($gCO_2e/MJ$) |
|---|---|---|---|
| CBOB001 (Gasoline, for comparison) | Based on the average crude oil delivered to California refineries and average California refinery efficiencies | 99.18 | 99.18 |
| HYGN001 | Compressed hydrogen from central reforming of natural gas (includes liquefaction and regasification steps) | 142.20 | 56.88 |
| | Above, with 33% renewable feedstock (Estimated) | 103.05 | 44.07 |
| HYGN002 | Liquid H2 from central reforming of NG | 133.00 | 53.20 |
| HYGN003 | Compressed hydrogen from central reforming of natural gas (no liquefaction and regasification steps) | 98.80 | 39.52 |
| | Above, with 33% renewable feedstock (Estimated) | 78.30 | 31.32 |
| HYGN004 | Compressed H2 from on-site reforming of natural gas | 98.30 | 39.32 |
| HYGN005 | Compressed H2 from on-site reforming with renewable feedstocks | 76.10 | 30.44 |

Source: California Energy Commission, California Air Resources Board

In June 2012, eight major automakers had fuel cell electric vehicles on California roads, and three transit agencies were operating fuel cell electric buses. Many of these automakers are also taking part in other FCV deployment rollouts in other countries, such as Germany and Japan. To prepare for the early commercial launch of fuel cell vehicles in California, the Energy Commission is committed to funding sufficient hydrogen fueling stations in key areas. Without a guarantee of sufficient infrastructure, automakers will be unable to commit significant resources to the production of FCVs.

[37] Based on LCFS pathways ELC001 (124.10 $gCO_2e/MJ$) and ELC002 (104.71 $gCO_2e/MJ$), with an energy efficiency ratio of 3.4.

Similarly, without automakers' commitment to the production of these vehicles, the state will not provide funding for hydrogen fueling stations. Based on automaker surveys and the California Fuel Cell Partnership's recently released *Road Map Report*, the number of FCVs in California is expected to significantly increase to 53,000 by 2017.[38] The CFO Regulation includes one upper-bound scenario that includes as many as 124,000 FCVs by 2020.[39] 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.[40] While modest in comparison to the state's annual consumption of gasoline, these initial levels are necessary steps in the state's long-term goal of bringing low-carbon vehicle technologies into the broader market. Adequate fueling infrastructure must be available for these vehicles to launch successfully into the market and contribute to the state's long-term GHG emission reduction targets. Overcoming this barrier is one of the central actions identified in the Governor's *2012 ZEV Action Plan*.

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 seven publicly available fueling stations within California, with three more under development. However, several of these existing stations are no longer state-of-the-art, provide very limited fueling capacity, and offer only low-pressure refueling. These include stations previously funded by several parties, including the U.S. Department of Energy (U.S. DOE) and ARB. With funds allocated from the *2008-2010 Investment Plan*, the Energy Commission has awarded $15.2 million in ARFVT Program funding for a total of 10 public fueling stations: 8 new and 2 upgrades. Once completed, this will bring the total number of public fueling stations in California to 17 by the end of 2013, of which 15 are expected to be in continued operation by 2015. Also using funds from the *2008-2010 Investment Plan*, the Energy Commission provided funding for 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.

Based on the automakers' survey, the California Fuel Cell Partnership identifies a need for 68 stations by the end of 2015 for the successful expansion of FCVs. This target consists of 46 stations within the key deployment clusters to allow for a roughly 6-minute travel time to

---

[38] California Fuel Cell Partnership, *A California Road Map: The Commercialization of Hydrogen Fuel Cell Vehicles*, June 2012. Available online. https://cafcp.org/sites/default/files/A%20California%20Road%20Map%20June%202012%20(CaFCP%20technical%20version).pdf

[39] 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 online. http://www.arb.ca.gov/regact/2012/cfo2012/cfoisor.pdf.

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

stations, plus 22 additional stations for connector locations, destination locations, and the development of new clusters.[41]

Subsequent to the *2008-2010 Investment Plan,* the Energy Commission has allocated $28.7 million toward hydrogen fueling infrastructure across three investment plans. Based on previous solicitations, each additional hydrogen fueling station might have a total capital cost ranging from $2 million to $3 million. Assuming ARFVT Program funding share of $1.5 million per station, this amount of funding could support up to 19 additional stations. With no additional funding, this would bring the total number of public retail hydrogen stations in California to roughly 36 by 2014.

Although the initial deployment of hydrogen fueling stations is costly on a per-vehicle basis, the cost per vehicle may decline from $5,000 to $10,000 per vehicle to $1,400 to $2,000 per vehicle as the FCV market matures.[42] In the coming years, sustained capital will be required for expanding new hydrogen stations and the continued operation of existing hydrogen stations. 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 10,000 within a single air basin and 20,000 statewide. Simultaneously, there are ongoing efforts 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.[43]

For this reason, the Energy Commission will provide $20 million for expanding light-duty FCV access to hydrogen fueling stations in 2013-2014. Based on the previous estimate of $1.5 million per station, this translates into roughly 13 additional stations, raising the potential number of on-line stations to roughly 49 by the end of 2015.

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

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

---

[41] 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.

[42] UC Davis Institute of Transportation Studies, *Sustainable Transportation Energy Pathways: A Research Summary for Decision Makers*, 2011. Available online. See Chapter 5: "Comparing Infrastructure Requirements." http://steps.ucdavis.edu/STEPS.Book

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

clusters, these clusters may require new stations with larger capacities and accelerated dispensing rates.

A critical issue for hydrogen station developers and operators is how to cover operating expenses for new stations in the early years of operation prior to the wide-scale commercial sales of FCVs in 2015. Accordingly, 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.

## 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. 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, lower consumer familiarity, 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 fewer 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, exacerbated by the fact that most conventional gasoline fueling stations are no longer owned by oil companies. From PON-09-006, the Energy Commission has two active projects to support E85 fueling station installations. When completed, these projects 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. DOE will contribute an additional $6.9 million. While still continuing, the build-out of these stations is proceeding slowly. Using funds from the three subsequent investment plans, the Energy Commission made an additional $11.4 million available for E85 fueling stations in PON-11-602. This funding is expected to provide for more than 120 additional E85 fueling stations once the agreements are completed.

In addition to being available, 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 allow it to compete sufficiently with gasoline for use in FFVs. E85 possesses roughly 75 percent of the energy density of gasoline (E10). To have a comparable cost per mile, E85 must be priced at roughly 25 percent less than comparable gasoline prices. On average, however, recent E85 prices have typically ranged from 10 to 15 percent lower than gasoline.

Given the Energy Commission's existing agreements and allocations for E85 fueling stations, the potential for new E85 stations to undercut the market viability of previously funded

stations, and the current challenge of E85 to compete with gasoline prices, the Energy Commission intends to pause funding and reevaluate the extent to which additional ARFVT Program support for E85 fueling installations may be appropriate in future investment plans. This will also allow time for existing ARFVT Program awardees to catch up to their existing commitments for installing E85 fueling stations.

## Upstream Infrastructure for Diesel Substitutes

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 to 20 percent. This blending wall is typically the result of warranties by the vehicle manufacturer. ASTM International, which develops specifications for conventional diesel fuel, has approved blends of up to 5 percent biodiesel to be fungible with conventional diesel. If all of California's diesel fuel were blended with biodiesel at this 5 percent level, the result would be nearly 200 million gallons per year of potentially low-carbon biofuel. However, pure biodiesel is not fungible 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 terminal racks and several plants, most of which require modifications to dispense biodiesel. The lapse of the Biodiesel Mixture Excise Tax Credit in December 2011, which provided a tax incentive of $1 per gallon of pure biodiesel, may hamper the expansion of this infrastructure. However, the LCFS regulation has encouraged the regulated fuel distributors to integrate larger shares of biodiesel into their upstream infrastructure. Several major oil terminals throughout the state have begun converting existing infrastructure to accommodate biodiesel blending.

Based on earlier projects proposed to the ARFVT Program, infrastructure modification costs are estimated to be $500,000 to $3 million per site. Using funds from the initial *2008-2010 Investment Plan,* the Energy Commission provided $3.9 million in funding to support such infrastructure modifications. Expansion of actual diesel substitutes production, as well as any necessary on-site storage, has also been incorporated into the ARFVT Program's funding for biofuel production. More recently, the Energy Commission released PON-11-602 in February 2012, which included up to $3.1 million for biodiesel and renewable diesel infrastructure. This included projects at the wholesale, bulk, or terminal distribution level rather than the retail level. This funding was undersubscribed with only three applicants requesting (and receiving) a combined $1.1 million. Given an upcoming deadline for encumbering ARFVT Program funds, the remaining funds for this category were transferred to oversubscribed categories.

Given the private investment beginning to support large-scale biodiesel blending as well as the undersubscription of proposals in the most recent infrastructure solicitation, the Energy Commission is not proposing additional funding for diesel substitutes infrastructure in the *2013-2014 Investment Plan Update*.

## Natural Gas Fueling Infrastructure

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

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. In a subsequent solicitation (PON-11-602), 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.* Of this funding, roughly $6.9 million was proposed for 23 projects that will install new or upgraded CNG and LNG fueling stations. Several of these fueling stations incorporate renewable natural gas; others provide needed fueling infrastructure for school districts.

Using the remaining $2.7 million from the *2011-2012 Investment Plan*, in addition to $1.4 million added by the *2012-2013 Investment Plan Update*, the Energy Commission issued PON-12-605. This solicitation offered up to $300,000 for school fleet stations or CNG stations, and up to $600,000 for LNG stations. Based on the proposals received, the Energy Commission anticipates making awards for six new CNG stations, five upgraded CNG stations, and two new LNG/CNG stations. School districts, municipalities, and municipal solid waste agencies constituted the majority of awardees. Fourteen additional proposals requesting a combined $4.2 million received passing scores but were not awarded due to insufficient funds.

To help ensure the continued viability of these and future fueling stations, several organizations have emphasized a need for further focusing on natural gas vehicle deployments, rather than expanded infrastructure.[44] For 2013-2014, the Energy Commission will maintain its previous allocation of $1.5 million to continue support for natural gas fueling infrastructure (Table 10). The Energy Commission is exploring prioritizing this funding for school districts and other public transit but remains open to consideration of other specific needs. Alternatively, if the Energy Commission revises the structure of its natural gas vehicle deployment incentives, this funding for fueling stations may be incorporated into a larger solicitation along with vehicle deployment funding.

## 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,

[44] 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.

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, depending on the fleet meeting a minimum monthly throughput. 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.[45]

In the *2011-2012 Investment Plan*, the Energy Commission allocated $500,000 to expand propane fueling infrastructure. Included in PON-11-602, this allocation was open to all fueling stations, specifically targeted toward school districts and projects within rural regions that integrate vehicle deployment, infrastructure development, and workforce development. No applications were received for this allocation, and the funds were redirected to other oversubscribed categories. The Energy Commission does not plan to provide additional funding for propane infrastructure in 2013-2014 but will continue to assess this opportunity in future years.

**Table 10: Alternative Fuel Infrastructure Funding Allocation**

| | |
|---|---|
| Charging Infrastructure | $7 Million |
| Hydrogen Fueling Infrastructure | $20 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.[46] 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. Current retail prices for compressed natural gas are notably lower than diesel and gasoline, on both a diesel-gallon-equivalent basis and gasoline-gallon-equivalent basis.

Additionally, these vehicles have the potential to realize immediate and medium-term petroleum and GHG emission reductions. Converting from diesel fuel to CNG reduces a

46 Based on information contained in applications for U.S. DOE's Clean Cities program, combined with propane working group information.

[46] Schremp et al. 2011. *Transportation Energy Forecasts and Analyses for the 2011 Integrated Energy Policy Report. California Energy Commission*. CEC‐600‐2011‐007‐SD.

vehicle's lifecycle carbon emissions from medium- and heavy-duty vehicles by 15 to 25 percent. Similarly, if converting to LNG, lifecycle carbon emissions can be reduced by 10 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 (nearly 10 percent); however, the development and growth of renewable propane or renewable dimethyl ether (which can be used as a propane substitute) can further increase this reduction.[47]

Depending on the engine type and application, these vehicles can also offer potentially significant air pollution reduction benefits. The ARB has indicated that it may issue a voluntary set of NOx standards for heavy-duty vehicle engines that would be more stringent than the current standard of 0.20 grams per brake horsepower-hour. While still under development, these could include voluntary standards that are 50 percent, 75 percent, and 90 percent lower than the current standard[48]. While not specific to alternative fuel engines, this standard could expand the market potential of engines that can meet these aggressive goals. For example, the Energy Commission is pursuing two projects that can reduce NOx emissions in natural gas engines by more than 90 percent compared to the existing standard.

In response to federal cost-sharing opportunities arising from the 2009 American Recovery and Reinvestment Act, the ARFVT Program provided roughly $14.4 million to help deploy more than 320 natural gas trucks, with accompanying fueling infrastructure. More recently, the ARFVT Program provides buydown 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 reflect the incentive needed to induce the purchase of an alternative fuel vehicle, as well as the upfront capital cost in comparison to a desired "payback period."

The Energy Commission has completed one round of incentive funding and is in the midst of a second round. The number of vehicles deployed as a result of these incentives is shown in Table 11, broken down by fuel type and gross vehicle weight. In addition to these vehicles, reservations have been filed for hundreds more natural gas and propane vehicles. While no funding remains for additional natural gas vehicle reservations, there is still funding available for propane vehicle reservations. These funds do not yet include the allocations from the *2012-2013 Investment Plan Update,* which provides $10.8 million for natural gas vehicles and $1.8 million for propane vehicles.

---

[47] U.S. DOE, "Alternative Fuels Data Center: Propane Vehicle Emissions," http://www.afdc.energy.gov/vehicles/propane_emissions.html.

[48] Air Resources Board, "Proposed Optional Low NOx Standards for Heavy Duty Engines, Extended Engine Warranties, and Heavy Duty Zero Emission Vehicles Certification," March 11, 2013. Available online. http://www.arb.ca.gov/msprog/onroad/optionnox/presentations/lownox_ws_031113.pdf.

**Table 11: Summary of Natural Gas and Propane Vehicle Incentives**

| | First Incentive Round (PON-10-604) | | Second Incentive Round (To Date) (PON-11-603) | |
|---|---|---|---|---|
| **Fuel Type** | **Vehicles Claimed** | **Funds Claimed** | **Vehicles Claimed** | **Funds Claimed** |
| Natural Gas ≤8,500 lbs. | 119 | $357,000 | 63 | $189,000 |
| Natural Gas 8,501-14,000 lbs. | 95 | $760,000 | 41 | $328,000 |
| Natural Gas 14,001-26,000 lbs. | 87 | 1,740,000 | 93 | $1,860,000 |
| Natural Gas ≥26,001 lbs. | 133 | $4,256,000 | 156 | $4,056,000 |
| Propane ≤8,501-14,000 lbs. | 55 | $330,000 | 98 | $588,000 |
| Propane 14,001-26,000 lbs. | 0 | $0 | 24 | $240,000 |
| Propane School Bus ≥14,001 lbs. | 34 | $680,000 | 26 | $520,000 |
| Total | 523 | $8,123,000 | 1,024 | $7,781,000 |

These numbers do not account for pending reservations and are subject to change

Source: California Energy Commission, as of March 20, 2013

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 original funding level from the *2012-2013 Investment Plan Update* of $12 million for natural gas vehicle incentives in 2013-2014. Once deployed, these vehicles will also provide the opportunity for further integration of low-carbon biomethane into the transportation market. Based on lessons learned from previous years administering these vehicle deployment incentives, the Energy Commission may consider alternative methods of implementing its incentives. This includes revisiting vehicle type eligibilities, per-vehicle incentive levels, and using a proposal-based solicitation (rather than a reservation-based incentive) for natural gas vehicle incentives.

The Energy Commission has provided 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. To date, however, there has been comparatively slow demand for propane vehicle incentives under the Energy Commission's buydown incentive program, and some stakeholders have raised concerns that the propane incentive process has even inhibited the vehicles' deployment. Given this, and the comparatively minor GHG emission reductions offered by propane vehicles, the Energy Commission will be reconsidering the role of ARFVT Program funding in this area.

## 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 Tesla Model S) 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. The Governor's Executive Order B-16-12, for instance, set a target of 1 million ZEVs on the road by 2020 and 1.5 million ZEVs on the road by 2025. The executive order also set a goal of increasing the number of zero-emission vehicles to at least 10 percent of the state government's light-duty fleet by 2015 and 25 percent by 2020. The Department of General Services has already prepared an implementation plan in response to this directive, which outlines several necessary steps toward implementation.[49]

The primary barriers to expanding light-duty PEVs' entrance in the market are incremental upfront costs, battery capacity, and charging infrastructure. Investments into battery development are occurring at multiple levels. To help address the first barrier, ARB provides incentive funding for light-duty PEVs through the Clean Vehicle Rebate Project (CVRP). The Energy Commission has invested more than $13 million in ARFVT Program funding toward four projects that are conducting advanced technology battery research and development; however, the federal government has taken the most aggressive steps in this area. The American Recovery and Reinvestment Act provided roughly $1.5 billion toward battery manufacturing facilities, and the U.S. Department 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. Finally, the Energy Commission, with the support of other state and local agencies, is also funding projects through the ARFVT Program to reduce the barriers associated with charging infrastructure (as discussed in a previous section).

As of March 2013, the CVRP has issued more than $44 million in incentives for more than 10,000 zero-emission vehicles (predominantly BEVs) and more than 9,000 PHEVs. By the end of 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.[50] For 2011-2012, in response to increasing demand, ARB reduced the per-vehicle incentive level for future applications. For example, the rebate amount for a full-function BEV was lowered to $2,500, and the rebate amount for a PHEV was lowered to $1,500. The Energy Commission provided $2 million in 2011 to augment the CVRP when the original ARB funds were depleted. More recently, the CVRP has seen a spike in rebates for PHEVs as the Chevrolet Volt and Toyota Prius Plug-In have entered the market. The Energy Commission provided $2 million in 2011 to augment the CVRP to ensure sufficient state-level incentive funding for this important class of electric vehicles. An additional $4.5 million for CVRP was allocated in the *2012-2013 Investment Plan Update* to augment the CVRP in response to growing consumer demand.

---

[49] Department of General Services, Office of Fleet and Asset Management, *Executive Order B-16-12 Implementation Plan*, revised September 12, 2012. Available online. https://www.ca.gov/archive/gov39/2012/03/23/news17472/index.html

[50] California Center for Sustainable Energy, *Clean Vehicle Rebate Project: Fiscal Year 2009-2011 Final Report*, October 18, 2011. Available online. https://energycenter.org/program/clean-vehicle-rebate-project

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, the availability of reduced electricity rates, and incentives for installation of home charging units.

Based on historical CVRP data, anticipated original equipment manufacturer (OEM) production volumes, and the continuing addition of new PEV models, the demand for CVRP rebates is likely to outstrip previously committed funds in 2013-2014. Depending on the growth of PEVs, ARB's ongoing funding for CVRP should be sufficient to provide for anticipated incentives in 2013-2014. The Energy Commission will continue to work closely with ARB to ensure sufficient incentive funding for light-duty electric vehicles and will reserve $5 million in ARFVT Program funding to supplement CVRP funding as needed. In the long term, as PEV deployments accelerate but AQIP funding remains flat, the state may consider new strategies for ensuring the sustainability of incentives as necessary to support the successful rollout of early PEVs in California.

## 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, ranging from hybrid electric drive in diesel vehicles to electric drive vehicles with natural gas range extenders to fuel cell buses to all-electric drive shuttles and trucks. In each case, however, the qualities of the technology must be matched to the customer's vehicle needs. 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 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. 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 precommercial demonstration projects in August 2011. 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. This solicitation initially 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 match the strong interest in this category, the Energy Commission subsequently added funding from other undersubscribed funding categories, bringing the total funding for the solicitation up to $22.3 million. Of the 7 applications (including 30 individual projects), the Energy Commission proposed to provide the maximum $16.9 million toward 4 applications (with 14 individual projects). The funded projects provide significant support to the incorporation of hybrid, plug-in hybrid, and all-electric drive technologies into medium- and heavy-duty vehicles, as well as the demonstration of new natural gas engines.[51]

The value of these technologies is further highlighted in both the *Vision for Clean Air* and the *ZEV Action Plan*. While not a forecast of actual market penetrations, the draft *Vision for Clean Air* outlines a scenario where meeting the state's GHG reduction and air quality improvement goals entails the rapid transition of medium- and heavy-duty vehicles to advanced technologies including plug-in hybrids, all-electrics, and fuel cell vehicles.[52] To support in-state economic development, the *ZEV Action Plan* calls on the state to continue supporting the demonstration and commercialization of ZEV-related technologies.

In combination with the state's support for low-carbon biomethane, the demonstration of advanced, low (or near-zero) NOx natural gas engines also provide the opportunity to support the state's climate and air quality goals. The PIER Program has had a significant role in commercializing large displacement engine sizes, based on a priority identified in the *Natural Gas Vehicle Research Roadmap*.[53] Several engine OEMs have subsequently announced plans to introduce 12-, 13-, and 15-liter engine offerings in 2013 and 2014 that will further support the expansion of natural gas into the medium- and heavy-duty sector. The PIER Program is also investigating potential demonstration of low-pressure, on-board natural fuel tanks as well as the possible expansion of natural gas engines ranging from 6 to 8 liters.

For 2013-2014, the Energy Commission is allocating $15 million to expand the demonstration of medium- and heavy-duty vehicles (Table 12). This represents a significant increase over the *2012-2013 Investment Plan Update* allocation of $6 million, which had to be supplemented with transferred funds from other undersubscribed categories. This increase is based on the needs and opportunities identified in both the *Vision for Clean Air* project, the *2013 ZEV Action Plan,* and the volume of qualified proposals received to date. Unlike the light-duty vehicle sector, there is no regulation akin to the ZEV regulation that will shift medium- and heavy-duty

---

[51] 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.

[52] ARB, *Appendix to the June 27, 2012 Draft Vision for Clean Air: A Framework for Air Quality and Climate Planning – Scenario Assumptions and Results*, August 20, 2012. Available online. www.arb.ca.gov/planning/vision/vision.htm. See pages 22-28.

[53] Bevilacqua-Knight, Inc. 2009 *Natural Gas Vehicle Research Roadmap*. California Energy Commission, PIER Transportation Program. (CEC-500-2008-044-F). Available online. http://www.energy.ca.gov/2008publications/CEC-500-2008-044/CEC-500-2008-044-F.PDF.

vehicles toward advanced technologies. Additionally, given the variety of unique applications of medium- and heavy-duty vehicles, there is a greater need for the demonstration of advanced technologies in a variety of vehicle applications. Even within a given application and technology area, multiple projects may need to be funded to drive competition and improvement, as well as to demonstrate the technology's maturity.

**Commercial-Scale Projects**

Building on the successes of previous demonstration projects, California has seen more interest in commercializing 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, ARB is providing up to $45,000 in incentives for advanced technology vehicles under the HVIP.

ARB has directed $54 million to HVIP in the first three years. Using these funds, the program has provided incentives for nearly 1,300 vehicles, including 348 electric trucks.[54] Of this $54 million, the Energy Commission provided $4 million to fund incentive vouchers for 150 electric drive Class 6 package delivery trucks.

The maximum voucher of $30,000 for hybrid trucks, 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, ARB recently revised HVIP incentive levels to allow up to $45,000 for zero-emission trucks. While demand for hybrid trucks had begun to slow, the new higher incentive for zero-emission trucks may increase demand for HVIP funding.

**Table 12: Alternative Fuel and Advanced Technology Vehicles Funding Allocation**

| | |
|---|---|
| Natural Gas Vehicle Incentives | $12 Million |
| Light-Duty Plug-In Electric Vehicle Incentives | $5 Million |
| Medium- and Heavy-Duty Advanced Technology Vehicle Demonstrations | $15 Million |

Source: California Energy Commission

## Emerging Opportunities

The previous sections of the *2013-2014 Investment Plan Update* 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.

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

[54] ARB, *Assembly Bill 118 Air Quality Improvement Program Funding Plan for Fiscal Year 2012-2013, Appendix A: Status Update on Assembly Bill 118 AQIP Projects*, June 28, 2012. Available online. https://ww2.arb.ca.gov/resources/documents/aqip-formal-regulatory-documents

competitive solicitation. While the Energy Commission is continuing to evaluate methods for developing such a solicitation, there have been several immediate opportunities to leverage federal funding programs that can expand the development and deployment of alternative fuels and technologies within the state.

With funds combined from the *2010-2011 Investment Plan* and the *2011-2012 Investment Plan*, the Energy Commission has reserved a combined $9 million for innovative technologies and federal cost-sharing projects. These projects are summarized in Table 13. The *2012-2013 Investment Plan Update* included an additional $4.5 million for additional activities and outlined examples of the types of opportunities that may exist.

**Table 13: Executed and Planned Agreements**

| Primary Partners | Description | ARFVT Program Funding | Outside Funding |
|---|---|---|---|
| California Institute of Technology; U.S. DOE | Develop methods to generate fuels directly from sunlight. (Part of U.S. DOE's Energy Innovation Hub program.) | $5 Million | Up to $122 Million |
| Lawrence Berkeley National Laboratory; U.S. Department of Defense | Demonstrate the viability of an all-electric, non-tactical vehicle fleet. Explore the possibility of the vehicles participating in the California Independent System Operator's ancillary services markets. | $1 Million | $2.75 Million |
| South Coast Air Quality Management District | Demonstrate the use of hybrid electric trucks with the ability to use an overhead electric line for charging and as a range extender. | $3 Million | TBD |

Source: California Energy Commission

In May 2012, the Energy Commission approved $5 million in cost-share funding for the Joint Center for Artificial Photosynthesis, an energy innovation hub sponsored by the U.S. DOE. The Joint Center for Artificial Photosynthesis will 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.

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 a first step by the U.S. Air Force Base in implementing a larger Department of Defense plan to establish strategies for large-scale integration of PEVs. In May 2012, the Energy Commission approved a $1 million agreement with Lawrence Berkeley National Laboratory to demonstrate an all-electric fleet of vehicles at the Los Angeles Air Force Base. These vehicles will also serve to evaluate the potential for similar vehicles to generate revenue by participating in the California Independent System Operator's ancillary services markets. Depending on future decisions by the U.S. Air Force and Department of Defense, partnership and cofunding from the ARFVT Program could help

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

The Energy Commission will reserve $4 million in ARFVT Program funding for 2013-2014 to support these and other emerging opportunities (Table 14). In identifying and selecting projects for this allocation, the Energy Commission may prioritize projects that offer significant federal cost-sharing opportunities. These funds may be combined with the previously reserved funding for this category from previous investment plans, or with other funding allocations from this investment plan as appropriate.

**Table 14: Emerging Opportunities Funding Allocation**

| | |
|---|---|
| Emerging Opportunities | $4 Million |

Source: California Energy Commission

## Manufacturing

California's advanced technology manufacturing companies have had tremendous success in raising capital for precommercial and early commercialization activities. In particular, California has held a significant advantage in raising venture capital and private equity for electric drive technologies. In 2010, California accounted for 80 percent of total U.S. venture capital in PEV-related sectors and ranked first nationwide in PEV technology patents. To translate this investment into job growth, the Energy Commission has offered ARFVT Program support to manufacturing projects in the alternative fuel and vehicle technology sectors.

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. More information on these awards is provided in the *2011-2012 Investment Plan* and *2012-2013 Investment Plan Update*.

The Energy Commission allocated $10 million for manufacturing projects in the *2011-2012 Investment Plan* and $18 million in the *2012-2013 Investment Plan Update*. These funds were used in a second solicitation for manufacturing projects in February 2012, and the Energy Commission issued a revised notice of proposed awards in September 2012. Out of $53.2 million requested, the Energy Commission has reserved funding for $28 million among the seven highest scoring proposals. These new projects include funding for the manufacturing of new vehicles, drive systems, and battery modules. Each of these projects will require a minimum of 50 percent in nonstate match share funding.

Numerous companies have spoken with Energy Commission staff about their interest in expanding or relocating manufacturing facilities within California. However, the persistently slow economy and its effect on capital markets continue to be a challenge for emerging vehicle and component manufacturers. In its investments, the Energy Commission will continue to prioritize projects that support economic development and fulfill the market needs of low-carbon alternative fuels and technologies.

To continue to support in-state economic development, the Energy Commission will allocate $5 million for projects that can support the in-state manufacture of advanced transportation technologies and alternative fuel components in 2013-2014 (Table 15). This includes funding

for facilities, equipment, and working capital, as needed. This allocation is lower than previous years in light of the significant investments made in recent investment plans. This slower pace of funding will allow time for new potential projects to emerge before the Energy Commission releases the next solicitation in this area, while still maintaining the Energy Commission's long-term interest.

**Table 15: Manufacturing Funding Allocation**

| | |
|---|---|
| Manufacturing Projects | $5 Million |

Source: California Energy Commission

## Workforce Training and Development

Workforce training and development are critical in 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 advise ongoing innovation and refinement to increase market acceptance. The Governor's *ZEV Action Plan* recognizes this need and calls for state agencies to continue providing workforce training funds for employer-driven needs as well as job training programs through community colleges and local workforce investment boards.

The Energy Commission has used previous workforce training funds to establish interagency agreements with California's workforce training agencies, including the Employment Development Department (EDD) at $7.25 million, the California Community Colleges Chancellor's Office (CCCCO) at $4.5 million, and the Employment Training Panel (ETP) at $6.75 million. The interagency agreements have been structured to fund alternative fuel and low-emission vehicle-specific training 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. The latter includes surveying industry training needs, assessing existing training programs and resources, developing curriculum and training materials, training, and providing regional industry cluster support planning grants.

To date, these agreements have provided $9.2 million in training funding for 5,746 individuals and more than 130 businesses and municipalities, as shown in Table 16.

**Table 16: Workforce Training Funding**

| Partner Agency | Funded Training (in Millions) | Match Contributions (in Millions) | Trainees | Businesses Assisted | Municipalities Assisted |
|---|---|---|---|---|---|
| ETP | $5.4 | $6.2 | 4,747 | 81+ | 13+ |
| EDD | $3.8 | $7.5 | 999 | 36+ | |
| Total | $9.2 | $13.7 | 5,746 | 117+ | 13+ |

Source: California Energy Commission

Examples of recent funding recipients include:

- The California Manufacturers and Technology Association ($558,000) is upgrading the skills of more than 300 workers at alternative and renewable fuel companies. In particular, these jobs focused on workers involved in ethanol production, electric vehicles production, battery development, and other clean technology products.
- The California Labor Federation ($999,460) is developing a training program for three regional public transit agencies, which will train nearly 1,300 workers in green vehicles and equipment.
- Tesla Motors ($756,000) is training 350 employees in a curriculum that spans the spectrum of PEV production. The amount of training per worker ranges from a minimum of 24 hours to a maximum of 200 hours.

The Energy Commission is also interested in expanding workforce training programs related to alternative fuels and advanced vehicle technologies. In particular, the Energy Commission is seeking information on available avenues for providing applicable workforce training to military veterans as well as career pathways for high school students. The Energy Commission will also investigate opportunities that may exist to partner with undergraduate and graduate programs in science, engineering, and business.

The passage of Proposition 39 in November 2012 may reconfigure the state's overall approach to providing workforce training in the clean energy industry and related sectors. This potential funding might displace the need for some Energy Commission investments and may require some partner agencies to rebalance their priorities. However, the Energy Commission will continue to work with such entities to determine how ARFVT Program funding can be implemented to the maximum effect. Additional opportunities may also arise with individual community colleges that are particularly interested in developing their own workforce training programs. The Energy Commission will reserve $1.5 million for workforce training and development projects for 2013-2014. An additional $500,000 will be reserved for other projects that will further support related workforce training and development activities, such as industry workforce analysis, apprenticeship training programs, and career pathways development (Table 17).

**Table 17: Workforce Training and Development Funding Allocation**

| | |
|---|---|
| Workforce Training and Development | $2 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 and 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 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.[55] 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 for sustainability studies and research from the *2011-2012 Investment Plan* will provide additional support to ensure California's switch to low-carbon fuels uses sustainable resources.

As new feedstocks and technologies enter California's transportation fuels market, the Energy Commission remains interested in ensuring the environmental sustainability of the state's transition to lower-carbon alternative fuels. For example, in addition to ongoing support for sustainability studies for biofuels, the Energy Commission will also consider the need for sustainability investments related to electric vehicles. This can include, among other strategies, second-life strategies for batteries and battery recycling. Both of these are identified as important actions in the *ZEV Action Plan.* To the extent needed, the Energy Commission may provide ARFVT Program funding to support sustainability studies from the related funding allocations within this investment plan.

## 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 10 regions to assist in developing strategic plans for charging infrastructure; establishing "best practices" for PEV-ready building and public work guidelines; and streamlining the processes of charging infrastructure permitting, installation, and inspection. The Energy Commission may provide additional funding to support the implementation of these plans at the local level or provide incentives to encourage ZEV

[55] 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.

readiness. This regional readiness planning will also help fulfill one of the actions identified in the *ZEV Action Plan.*

For the *2013-2014 Investment Plan Update*, the Energy Commission is interested in building on these existing PEV regional readiness grants. Several recipient regions have expressed a need for further funding to transition from readiness planning to implementation.[56] Among other tasks, additional funding in this area may be needed to support the following goals:

- Streamlining the permitting process for charging infrastructure installations, which will need to involve dozens of permitting offices within each region
- Coordination of siting for new charging infrastructure
- Development of a statewide PEV infrastructure plan and coordination between regions
- Education on PEV issues for local agencies, workplaces, multiunit dwelling owners, and fleet managers
- Development of informational resources such as city or local agency websites
- Signage to inform drivers of charging infrastructure locations
- Consumer education efforts that can be tailored to the needs of individual regions
- Addition of new PEV regional planning groups

Given these needs, the Energy Commission will reserve an additional $3.5 million in this investment plan toward furthering regional readiness and interest in PEVs.

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.[57] 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.[58] These needs are expected to be considered in a solicitation released in 2013 using funds from the *2012-2013 Investment Plan Update*, which included $2.7 million in funding for this category.

## 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 in expanding both the supply of and demand for

[56] Several of these findings are derived from a workshop held at the Energy Commission on January 30, 2013. Participants included representatives from local governments, charging infrastructure providers, automakers, nongovernmental organizations, the Governor's Office of Planning and Research, and other state agencies.

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

[58] 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.

alternative fuels and advanced technology vehicles. Centers provide suppliers with opportunities to develop and demonstrate advanced technology vehicles, a neutral site for individual companies to collaborate on technology demonstrations, and 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). On the demand side, centers can help centralize the attention of fleet managers that are interested in alternative fuels and advanced vehicles, provide on-site training of potential customers, and integrate vehicle technology development with workforce training efforts.

The Energy Commission provided $2.7 million to support the development and/or expansion of such centers in the *2012-2013 Investment Plan Update*. These funds are intended to provide upfront costs for developing such centers and not to create an ongoing funding obligation for the ARFVT Program. Several potential projects have been proposed under this category, and the Energy Commission is weighing options on how to solicit and select proposals. For the *2013-2014 Investment Plan Update*, the Energy Commission is allocating $2 million to supplement the previous year's funding (Table 18). This is based on the identification of a growing number of potentially valuable projects, several of which also offer opportunities to leverage federal funding. This combined amount of funding might be sufficient to fund two to four projects, depending on the individual proposals received.

## 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 Energy 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 lifecycle-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, and Energy Use in Transportation (GREET) 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 2013-2014, the Energy Commission anticipates funding 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 *2013-2014 Investment Plan Update.*

## Measurement, Verification, and Evaluation

The Energy Commission is also responsible for program measurement, verification, and evaluation efforts. State law requires the Energy Commission to evaluate the program's efforts in the biennial *Integrated Energy Policy Report*. The goals of measurement, verification, and evaluation 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 previous allocation for measurement, verification, and evaluation from the *2010-2011 Investment Plan*.

Following a request for proposals, the Energy Commission has awarded up to $4.5 million to administer this work. This analysis will provide insight on program performance and contributions toward meeting state goals and will advise future ARFVT Program and other program work. As with funding for technical assistance and analysis projects, the Energy Commission expects to provide any needed 2013-2014 funding for this category using funds that are separate from the *2013-2014 Investment Plan Update.*

**Table 18: Market and Program Development Funding Allocation**

| | |
|---|---|
| Regional Alternative Fuel Readiness and Planning | $3.5 Million |
| Centers for Alternative Fuels and Advanced Vehicle Technology | $2 Million |

Source: California Energy Commission

# CHAPTER 4: Funding Allocations

Table 19 shows the total funding allocations for 2013-2014.

**Table 19: Summary of Proposed Funding Allocations for 2013-2014**

| | Project/Activity | Proposed Funding Allocation for 2013-2014 |
|---|---|---|
| **Alternative Fuel Production** | Biofuel Production and Supply | $23 Million |
| **Alternative Fuel Infrastructure** | Electric Charging Infrastructure | $7 Million |
| | Hydrogen Fueling Infrastructure | $20 Million |
| | Natural Gas Fueling Infrastructure | $1.5 Million |
| **Alternative Fuel and Advanced Technology Vehicles** | Natural Gas Vehicle Incentives | $12 Million |
| | Light-Duty Plug-In Electric Vehicles | $5 Million |
| | Medium- and Heavy-Duty Advanced Vehicle Technology Demonstration | $15 Million |
| **Emerging Opportunities** | Emerging Opportunities | $4 Million |
| **Manufacturing** | Manufacturing Facilities, Equipment and Working Capital | $5 Million |
| **Workforce Training and Development** | Workforce Training and Development | $2 Million |
| **Market and Program Development** | Regional Alternative Fuel Readiness and Planning | $3.5 Million |
| | Centers for Alternative Fuels and Advanced Fuel | $2 Million |
| | **Total Available** | **$100 Million** |

Source: California Energy Commission

# GLOSSARY

AIR QUALITY IMPROVEMENT PROGRAM (AQIP)—Program that provides mobile source incentives to reduce greenhouse gas, criteria pollutant, and toxic air contaminant emissions through the deployment of advanced technology and clean transportation in the light-duty and heavy-duty sectors.[59]

ALTERNATIVE AND RENEWABLE FUELS AND VEHICLE TECHNOLOGY PROGRAM (ARFVTP)—Now known as the Clean Transportation Program, created by Assembly Bill 118 (Nunez, Chapter 750, Statutes of 2007), with an annual budget of about $100 million. Supports projects that develop and improve alternative and renewable low-carbon fuels, improve alternative and renewable fuels for existing and developing engine technologies, and expand transit and transportation infrastructures. Also establishes workforce training programs, conducts public education and promotion, and creates technology centers, among other tasks.

BATTERY ELECTRIC VEHICLE (BEV)—Also known as an "All-electric" vehicle (AEV), BEVs utilize energy that is stored in rechargeable battery packs. BEVs sustain their power through the batteries and therefore must be plugged into an external electricity source in order to recharge.

CALIFORNIA AIR RESOURCES BOARD (ARB)—The "clean air agency" in the government of California whose main goals include attaining and maintaining healthy air quality, protecting the public from exposure to toxic air contaminants, and providing innovative approaches for complying with air pollution rules and regulations.

CALIFORNIA COMMUNITY COLLEGES CHANCELLOR'S OFFICE (CCCCO) committed to students getting the high-quality curriculum, support and instructional services that they deserve. The office and various subdivisions are responsible for providing leadership, oversight and assistance for California's community college system.

CALIFORNIA ENERGY COMMISSION (CEC)—The state agency established by the Warren-Alquist State Energy Resources Conservation and Development Act in 1974 (Public Resources Code, Sections 25000 et seq.) responsible for energy policy. The CEC's five major areas of responsibilities are:

1. Forecasting future statewide energy needs.
2. Licensing power plants sufficient to meet those needs.
3. Promoting energy conservation and efficiency measures.
4. Developing renewable and alternative energy resources, including providing assistance to develop clean transportation fuels.
5. Planning for and directing state response to energy emergencies.

---

59 CARB Low Carbon Transportation Investments and Air Quality Improvement Program https://ww2.arb.ca.gov/our-work/programs/low-carbon-transportation-investments-and-air-quality-improvement-program/about

Funding for the CEC's activities comes from the Energy Resources Program Account, Federal Petroleum Violation Escrow Account, and other sources.

CALIFORNIA PUBLIC UTILITIES COMMISSION (CPUC)—A state agency created by constitutional amendment in 1911 to regulate the rates and services of more than 1,500 privately owned utilities and 20,000 transportation companies. The CPUC is an administrative agency that exercises both legislative and judicial powers; its decisions and orders may be appealed only to the California Supreme Court. The major duties of the CPUC are to regulate privately owned utilities, securing adequate service to the public at rates that are just and reasonable both to customers and shareholders of the utilities; including rates, electricity transmission lines and natural gas pipelines. The CPUC also provides electricity and natural gas forecasting, and analysis and planning of energy supply and resources. Its main headquarters are in San Francisco.

CLEAN FUELS OUTLET REGULATION (CFO)— intended to provide fueling infrastructure to meet the needs of those driving clean, alternative fuel vehicles.[60]

CLEAN VEHICLE REBATE PROGRAM (CVRP)— promotes clean vehicle adoption in California by offering rebates of up to $7,000 for the purchase or lease of new, eligible zero-emission vehicles, including electric, plug-in hybrid electric and fuel cell vehicles.[61]

COMPRESSED NATURAL GAS (CNG)—Natural gas that has been compressed under high pressure, typically between 2,000 and 3,600 pounds per square inch, held in a container. The gas expands when released for use as a fuel.

CORPORATE AVERAGE FUEL ECONOMY (CAFE)—A sales-weighted average fuel mileage calculation, in terms of miles per gallon, based on city and highway fuel economy measurements performed as part of the federal emissions test procedures. CAFE requirements were instituted by the Energy Policy and Conservation Act of 1975 (89 Statute. 902) and modified by the Automobile Fuel Efficiency Act of 1980 (94 Statute. 1821). For major manufacturers, CAFE levels in 1996 are 27.5 miles per gallon for light-duty automobiles. CAFE standards also apply to some light trucks. The Alternative Motor Fuels Act of 1988 allows for an adjusted calculation of the fuel economy of vehicles that can use alternative fuels, including fuel-flexible and dual-fuel vehicles.

ELECTRIC DRAYAGE DEMONSTRATION (EDD)—References a project funded by the CEC, SCAQMD, and ports of Los Angeles and Long Beach (via a "Technology Advancement Program" grant) to deploy advanced, zero-emission Class 8 drayage trucks at the two ports.

EMPLOYMENT TRAINING PANEL (ETP)—Provides funding to employers to assist in upgrading the skills of their workers through training that leads to good paying, long-term jobs. The ETP was created in 1982 by the California State Legislature and is funded by California employers through a special payroll tax.

---

[60] CARB Clean Fuels Outlet Website https://ww3.arb.ca.gov/fuels/altfuels/cf-outlets/cf-outlets_approval.htm

[61] CARB Clean Vehicle Rebate Program Website https://cleanvehiclerebate.org/eng/about-cvrp

FLEX-FUEL VEHICLE (FFV)—FFVs are designed to run on gasoline or gasoline-ethanol blends of up to 85 percent ethanol (E85). Except for a few engine and fuel system modifications, they are identical to gasoline-only models. FFVs experience no loss in performance when operating on E85, and some generate more torque and horsepower than when operating on gasoline. However, since ethanol contains less energy per volume than gasoline, FFVs typically get about 15—27 percent fewer miles per gallon when fueled with E85.[44]

GREENHOUSE GAS (GHG)—Any gas that absorbs infrared radiation in the atmosphere. Greenhouse gases include water vapor, carbon dioxide (CO2), methane (CH4), nitrous oxide (NOx), halogenated fluorocarbons (HCFCs), ozone (O3), perfluorinated carbons (PFCs), and hydrofluorocarbons (HFCs).

GREENHOUSE GASES, REGULATED EMISSIONS, AND ENERGY USE IN TRANSPORTATION (GREET®)—A full lifecycle model sponsored by the Argonne National Laboratory (U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy). GREET® fully evaluates energy and emission impacts of advanced and new transportation fuels, the fuel cycle from well to wheel, and the vehicle cycle through material recovery and vehicle disposal. It allows researchers and analysts to evaluate various vehicle and fuel combinations on a full fuel-cycle/vehicle-cycle basis.

HYBRID AND ZERO-EMISSION TRUCK AND BUS VOUCHER INCENTIVE PROJECT (HVIP)—A project launched in 2009 by the ARB in partnership with CALSTART to accelerate the purchase of cleaner, more efficient trucks and buses in California.

LIQUEFIED NATURAL GAS (LNG)—Natural gas that has been condensed to a liquid, typically by cryogenically cooling the gas to minus 260 degrees Fahrenheit (below zero).

LOW CARBON FUEL STANDARD (LCFS)—A set of standards designed to encourage the use of cleaner low-carbon fuels in California, encourage the production of those fuels, and therefore reduce greenhouse gas emissions. The LCFS standards are expressed in terms of the carbon intensity of gasoline and diesel fuel and their respective substitutes. The LCFS is a key part of a comprehensive set of programs in California that aim cut greenhouse gas emissions and other smog-forming and toxic air pollutants by improving vehicle technology, reducing fuel consumption, and increasing transportation mobility options.

MEGAJOULE (MJ)—A joule is a unit of work or energy equal to the amount of work done when the point of application of force of one newton is displaced one meter in the direction of the force. It takes 1,055 joules to equal a British thermal unit. It takes about one million joules to make a pot of coffee. A megajoule itself totals one million joules.

NITROGEN OXIDES (OXIDES OF NITROGEN, NOx)—A general term pertaining to compounds of nitric oxide (NO), nitrogen dioxide (NO2), and other oxides of nitrogen. Nitrogen oxides are typically created during combustion processes and are major contributors to smog formation and acid deposition. NO2 is a criteria air pollutant and may result in numerous adverse health effects.

ORIGINAL EQUIPMENT MANUFACTURER (OEM)—Makes equipment or components that are then marketed by its client, another manufacturer, or a reseller, usually under that reseller’s own name.

PLUG-IN HYBRID ELECTRIC VEHICLE (PHEV)—PHEVs are powered by an internal combustion engine and an electric motor that uses energy stored in a battery. The vehicle can be plugged in to an electric power source to charge the battery. Some can travel nearly 100 miles on electricity alone, and all can operate solely on gasoline (similar to a conventional hybrid).

PLUG-IN ELECTRIC VEHICLE (PEV)—A general term for any car that runs at least partially on battery power and is recharged from the electricity grid. There are two different types of PEVs to choose from—pure battery electric and plug-in hybrid vehicles.

RENEWABLE FUEL STANDARD (RFS)– National policy that requires a certain volume of renewable fuel to replace or reduce the quantity of petroleum-based transportation fuel, heating oil or jet fuel

UNITED STATES DEPARTMENT OF ENERGY (U.S. DOE)—The federal department established by the Department of Energy Organization Act to consolidate the major federal energy functions into one cabinet-level department that would formulate a comprehensive, balanced national energy policy. DOE's main headquarters are in Washington, D.C.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY (U.S. EPA)—A federal agency created in 1970 to permit coordinated governmental action for protection of the environment by systematic abatement and control of pollution through integration or research, monitoring, standards setting, and enforcement activities.

UNIVERSITY OF CALIFORNIA, DAVIS (UC Davis)—A public research university located in Davis, California. It is one of the 10 campuses in the University of California (UC) system.

ZERO EMISSION VEHICLE (ZEV)—Vehicles that produce no emissions from the on-board source of power (e.g., an electric vehicle).