

# CA'S

## Advanced Transportation Industry Clusters of Opportunity

Driving Market Expansion, Technology  
Innovation and Job Growth

AB 118 Status Report on the Alternative and  
Renewable Fuels and Vehicles Industry in California

September 2013

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## EXECUTIVE SUMMARY

California is a leader in the advanced transportation market. The state is at the forefront of the transition to alternative and renewable fuels and vehicle (ARFV) technologies with its increase in technology innovation and growth in industry jobs, as well as policies that encourage market growth in the advanced transportation industry.

Advanced transportation has emerged as a cluster of opportunity in California primarily through a combination of market forces, innovative state policies, strategic regional and local collaboration, and industry leadership. A cluster of opportunity is a combination of related sectors that are growing in terms of jobs, companies, investment, and/or innovation. California's advanced transportation cluster of opportunity is creating jobs and economic growth throughout the state as well as fostering technologies to help improve environmental quality. Employment in the ARFV industry in California has been steadily rising, increasing jobs by 39 percent and nearly doubling the number of establishments through the recession (from 2006 to 2011). Robust research and development activities, as well as increasing adoption of alternative vehicle and fuel technologies, have helped create a local market for the industry to grow. While currently a relatively small share of California's overall economy, the industry has the potential to rapidly expand both in terms of alternative vehicle and fuel sectors.

California's ARFV industry has developed as a result of strategic actions that stimulate market growth, drive innovation, and capture economic benefits to create jobs throughout California. Policies developed over the last 40 years, including standards for low emission vehicles and low carbon fuels, have stimulated consumer demand and helped generate supply of alternative fuels and vehicles, accelerating growth in the industry. Strategic collaboration among public and private sector leaders has helped ensure that California communities capture the economic benefits of industry growth, with a growing number of jobs and thriving businesses operating at all parts of the value chain.

Investments in research, development and deployment projects as well as collaborative research networks have helped to increase innovation in the state. California has registered an increasing number of ARFV patents in recent years and nearly doubled its share of total patents in the U.S.,

reaching the second highest amount of ARFV patents for 2010 and 2011. Private sector investment in California ARFV companies has also increased, reaching about \$1.5 billion in 2012.

California is also a leader in adopting new advanced transportation technologies. The number of transportation biofuel production projects has reached 47 as of July 2013, a 75 percent increase from 2007, with an increasing share in next generation advanced biofuel technologies. The number of alternative vehicles on California roads has almost doubled since 2006, and regions have installed a range of fueling infrastructure to support those vehicles. California is currently ranked first in the country for the number of public access electric charging stations in the state.

The ARFV industry has grown to a total of about 8,200 jobs in roughly 500 core business establishments directly related to the industry, though this employment level underestimates the broader impact of the industry, which includes jobs in related areas such as auto repair shops and large automobile manufacturers, as well as the environmental and social benefits of increased efficiency in ARFV technologies. Core industry jobs were dispersed across regions and segments of the value chain, with the highest proportion related to alternative motor vehicles and equipment companies. This growing industry includes workers in a variety of occupations that require a range of skill levels, with more than half of relevant occupations requiring less than a Bachelor's degree. These occupations have career potential, with three-fourths of the occupations earning an average annual wage of more than \$40,000 and about half with employment growth projected to be higher than the California average. While there are some specialized training programs focused on the ARFV industry, California has an opportunity to increase the number of opportunities for workers to specialize in skills that will prepare them to work in the growing industry.

Leveraging policies and programs at the state level, regions have been working collaboratively to accelerate growth in the ARFV industry. Cross-sector partnerships that foster robust research and development activity, align workforce training with the needs of high-growth sectors, and invest in ARFV infrastructure all help drive cluster growth at the regional level.

The following recommendations can help advance California's state and regional ARFV emerging clusters of opportunity:

**1. Focus on growing the ARFV industry as an economic development opportunity based on local strengths, not just social or environmental opportunities, to engage a broad coalition of partners.**

Economic prosperity and improving society and the environment are not mutually exclusive goals. California businesses have demonstrated the potential to grow while creating products that help the state attain its climate goals and increase local job opportunities. California is a diverse state and regions can leverage local strengths to grow the ARFV industry locally.

**2. Continue to lead in both stimulating market growth and driving innovation to support ARFV businesses and market readiness.**

California is at the forefront of the transition to ARFV, due in part to its supportive policies and programs that encourage market growth. However, other states are also targeting ARFV segments and creating competition for attracting businesses. California should maintain its leadership role in stimulating the market to provide a consistent market signal to the industry that the state is supportive of ARFV technologies and businesses.

An ongoing commitment to fostering a positive climate for innovation is also critical to the long-term growth of the industry. This includes financing research, development, and deployment projects through grants, loans, or underwriting to help businesses overcome funding hurdles in getting new technologies to commercial scale. AB 118, for example, should be renewed to help develop new ARFV technologies.

Policy makers should also ensure that ARFV and related policies do not have conflicting requirements or information. Policies and programs should also set firm goals, but strive to be technology agnostic, allowing businesses to innovate and find new solutions for achieving goals.

**3. Strengthen regional efforts to grow and capture the benefits of the ARFV industry for people and communities, leveraging state efforts to stimulate market growth and drive innovation.**

California regions have emerging prospects to advance the competitive position of the industry and increase economic prosperity. Stakeholders at the state level can support regional coalitions that mobilize employers and regional partners such as economic and workforce development to grow the local cluster. For example, the AB 118 grant for the Regional Industry Clusters of Opportunity (RICO) initiative is helping advance cluster growth and workforce preparation in the five grantee regions across the state.

Regions should also work with state and business partners to streamline and/or standardize the regulatory process for ARFV facilities and technologies to help companies grow. Regional ARFV partnerships can also help meet the industry's infrastructure needs by identifying priorities and building support for investments.

**4. Prepare the state's workforce on the regional level for careers in the local ARFV industry to support business expansion in the region.**

State and regional workforce organizations and academic institutions should prepare new and incumbent workers for local ARFV industry job opportunities. Initiatives such as RICO that bring workforce and economic development stakeholders together can help regional clusters grow and identify career pathways for local workers.

The ARFV industry presents new opportunities for workers across the spectrum, but these workers will need help identifying these career options and using their existing skills to transition to ARFV jobs. Workers that are in declining occupations should be tapped for potential transition into ARFV jobs. In addition, ARFV occupations that are projected to grow should have an outreach and training strategy to build the local workforce. Regional workforce needs will depend on local opportunities, and workforce organizations should work directly with industry partners to develop recognized credentials and/or skill requirements for ARFV jobs.

## INTRODUCTION

Transportation is a vital part of the California economy, connecting businesses and communities across the state with highways, railways, shipping, and aviation routes. This vast transportation network also takes a tremendous amount of energy to run, most of which comes from petroleum. In 2011, over 390 million barrels of crude oil were used to produce gasoline and diesel fuel consumed in California.<sup>1</sup> Burning this fuel creates air pollution such as particulates, air toxins and smog, contributing to air quality problems in many California regions. Transportation fuels are also the leading source of greenhouse emissions in California. Figure 1 shows that the transportation sector accounts for 38 percent total greenhouse gas emissions in California.

Given the impact of the transportation sector on California's economy and environment, California policymakers have implemented a number of laws and programs for more efficient, renewable, and innovative transportation fuels and vehicles. The California Alternative and Renewable Fuel, Vehicle Technology, Clean Air, and Carbon Reduction Act of 2007 (Assembly Bill (AB) 118) is an important part of California's transportation strategy. AB 118 created the Alternative and Renewable Fuel and Vehicle Technology Program in the California Energy Commission (The Commission) to fund projects to develop and deploy innovative technologies that transform the state's fuel and vehicle types to help attain the California's climate goals.

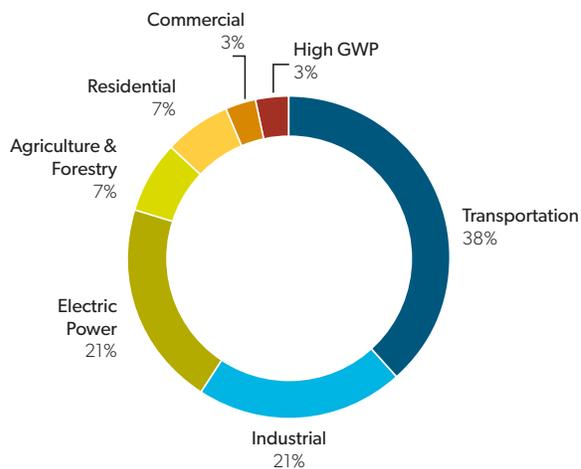
The alternative and renewable fuel and vehicle (ARFV) industry presents a "cluster of opportunity" for California. A cluster of opportunity is a combination of related sectors that are growing in terms of jobs, companies, investment, and/or innovation. Typically, a cluster of opportunity is comprised of sectors that are export-oriented, population driven, and offer occupations with career potential, creating workforce opportunities for regions in the state. The following four kinds of information can help identify advanced transportation clusters of opportunity for California and its regions:

1. **Growth in employment** (e.g. jobs by segment and occupation opportunities)
2. **Growth in companies** (e.g. new establishment formation or existing business growth)
3. **Growth in technology adoption** (e.g. biofuel production projects, alternative vehicles, clean vehicle rebates, and fueling infrastructure)
4. **Growth in innovation** (e.g. investments and patents)

This report tracks policy, innovation, technology adoption and deployment, and workforce dynamics in the advanced transportation industry in California and its regions. It is funded by The Commission through the California Workforce Investment Board. The report is being developed in conjunction with a Regional Industry Clusters of Opportunity (RICO) grant program that supports five California regions in advancing the ARFV industry and preparing the workforce for jobs in the growing market. The goal is to develop and implement alternative fuel and vehicle regional clusters of opportunity strategies, and mobilize employers and regional partners to advance the competitive position of targeted clusters. This RICO initiative is a structured process that supports regional economic and workforce development networks. These networks consist of economic and workforce development practitioners and industry, forming industry sector partnerships that are developing action plans to support and advance targeted ARFV industry clusters.

Figure 1

### Greenhouse Gas Emissions by Source California, 2010



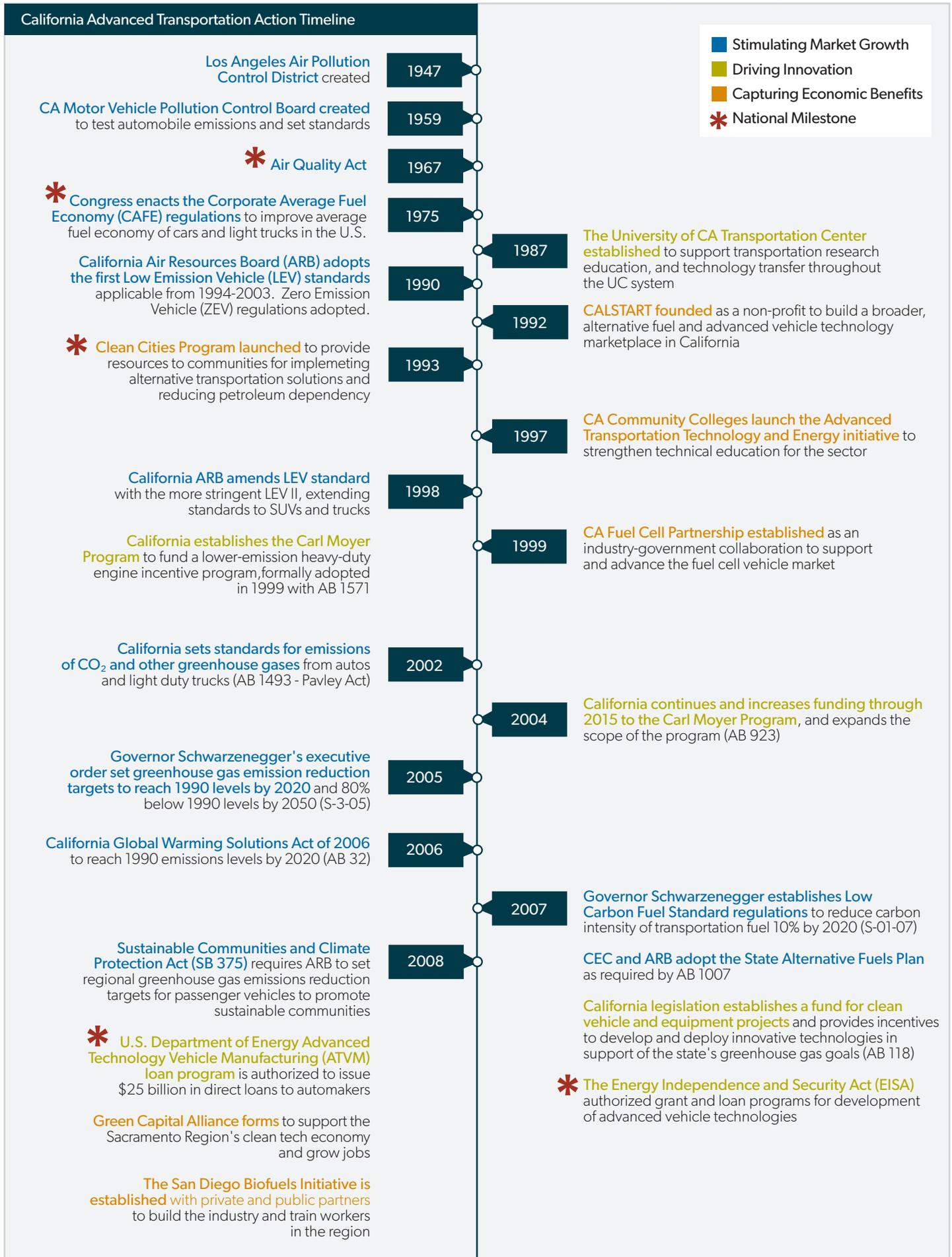
Data Source: California Air Resource Board, California Greenhouse Gas Inventory by Source and Activity  
Analysis: Collaborative Economics

## STRATEGIC ACTIONS TO ACCELERATE ADVANCED TRANSPORTATION IN CALIFORNIA

California has long been at the forefront of innovative alternative fuel and vehicle technologies. The programs and policies implemented in California have been replicated in other states, used as a model in federal initiatives, and California-based innovations have been adopted around the world. The California Advanced Transportation Action Timeline exhibits a sample of actions that have helped stimulate market growth, drive innovation, and capture economic benefits in California. These actions have involved a diverse set of stakeholders, ranging from local and state government agencies to private companies and academic institutions. Strategic collaboration across sectors and stakeholder groups has helped accelerate growth in the ARFV industry, positioning California as an industry leader.

### Strategic Actions to Accelerate California's Alternative and Renewable Fuel and Vehicle Industry

Stimulating Market Growth	<b>Increasing affordability, removing barriers, and setting standards</b> all help to increase company supply and consumer demand for alternative fuels and vehicles, stimulating market growth.
Driving Innovation	<b>Investing in research and development, funding new startup companies and technologies, and creating supportive networks</b> help to increase innovation in the industry.
Capturing Economic Benefits	<b>Supporting business growth and aligning workforce development efforts</b> helps ensure that industry growth benefits California communities and economies.



2009

**CA Public Utilities Commission (PUC)** is directed to develop and implement policies to expand fueling infrastructure for plug-in hybrid and electric vehicles (SB 626)

**California ARB formally adopts Low Carbon Fuel Standard regulations** to reduce carbon intensity of transportation fuel 10% by 2020

**California establishes the Clean Vehicle Rebate Project and Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project** to provide rebates for zero emission or plug-in hybrid electric vehicle

\* **The American Recovery and Reinvestment Act makes available tax credits** up to \$7,500 for PEV purchases and up to \$4,000 for PEV conversion kits

\* **U.S. Environmental Protection Agency (EPA)** adopts more stringent tailpipe rules modeled after those of California

**CEC approves the first Investment Plan** to allocate \$176 million from AB 118 for 2008-09 and 2009-10 to encourage development and use of alternative vehicles and fuels

2011

**California ARB and CEC propose to reduce petroleum fuel consumption to 15% below 2003 levels by 2020** and to increase alternative fuels to 26% by 2022 (AB 638)

**California ARB approves increased funding** for the Clean Vehicle Rebate Project

**CEC approves nearly \$5 million in block grants to medium and heavy duty vehicle producers** to lower the cost of natural gas-powered buses and trucks for buyers

\* **Clean Cities Program awards \$5 million** to deploy EV infrastructure and charging stations

**CEC approves the Investment Plan** update to allocate \$100 million from AB 118 for 2011-12 to encourage development and use of alternative vehicles and fuels

**Elected and business leaders launch the Bay Area EV Strategic Council** to align policies, programs, and resources to accelerate the regional EV market

**Governor Brown releases the Zero Emissions Vehicle Action Plan** that identifies specific strategies and actions that state agencies will take to meet milestones of B-16-12

**The California ARB Annual Research Plan allocates \$1 million for 2013-14** for Advanced Clean Cars and Low Carbon Fuel Standard projects

**CEC approves the Investment Plan update to allocate \$100 million from AB 118 for 2013-14** to encourage development and use of alternative vehicles and fuels

2010

**California ARB finalizes regulation of Pavley Act** to reduce greenhouse gas emissions from passenger vehicles

**Clean technology manufacturing equipment** is exempt from sales tax (SB 71)

**California expands the Property Assessed Clean Energy program** to include residential electric charging stations (SB 1340)

**California extends HOV-lane access to PEVs** regardless of the number of occupants (SB 535)

\* **U.S. EPA finalizes Renewable Fuel Standard regulations**, requiring the U.S. to produce 36 billion gallons of biofuels by 2022

\* **U.S. EPA and U.S. Department of Transportation** require automakers to meet a 35.5 miles per gallon CAFE standard by 2016

**CEC approves the Investment Plan** update to allocate \$108 million from AB 118 for 2010-11 to encourage development and use of alternative vehicles and fuels

2012

**California ARB passes the Advanced Clean Car Rules for model years 2017-2025**, including a mandate for manufacturers to produce 1.4 million zero-emissions vehicles

**Governor Brown reinforces ARB's rules with an executive order** for 1.5 million zero-emission vehicles and supporting infrastructure to be operating in California by 2025 (B-16-12)

**California ARB issues final regulations** on the Low Carbon Fuel Standard

**California ARB approves \$27 million to provide incentives** for the purchase of advanced-technology passenger cars and heavy-duty trucks

\* **U.S. EPA and U.S. Department of Transportation issued a final rule** that raises the CAFE standard for cars and light-duty trucks to 54.5 miles per gallon by 2025

**CEC approves the Investment Plan** update to allocate \$100 million from AB 118 for 2012-13 to encourage development and use of alternative vehicles and fuels

**The Los Angeles County Economic Development Corporation establishes an E-Mobility Task Force** to foster and develop the region's EV industry

2013

## Stimulating Market Growth

Over the past 40 years, policies and programs that increase consumer demand and the availability of alternative fuels and vehicles have helped to stimulate market growth in California. Policymakers have acted to set standards for low emission vehicle technologies, remove regulatory barriers to expand access to technology deployment, and create financial incentives to increase affordability for consumers. These actions send a market signal to alternative fuel and vehicle companies that there will be a local demand for products, and many companies opt to ramp up production of goods and services in response.

Poor air quality in California in the 1950s motivated the state to act earlier than the rest of the nation to reduce air pollution from vehicles and fuels. For example, in 1959 California created the Motor Vehicle Pollution Control Board to test automobile emissions and set standards for air quality. When the Federal Air Quality Act of 1967 passed nearly a decade later, California was permitted to enforce its more stringent emissions standards. The state adopted the first Low Emission Vehicle (LEV) standards in 1990 to reduce air pollution from automobiles and other mobile sources, stimulating demand for more efficient vehicle technologies. In 2002, California specifically set limits on greenhouse gas emissions from vehicles, designating those emissions as a form of air pollution. California continues to push for efficiency improvements, and recently adopted the Advanced Clean Car rules in 2012 that set fuel efficiency standards for modeled years 2017-2025. The rules also included a mandate for automobile companies to make 1.4 million zero-emission vehicles available for sale in the state by 2025. Governor Brown reinforced this mandate with an executive order, setting a goal of 1.5 million zero-emission vehicles in California and infrastructure to support them by 2025.

California policymakers have also acted to stimulate the market for low carbon fuel. The state has created an Alternative Fuels Plan and updates its Bioenergy Action Plan annually since 2006, outlining actions to increase in-state bio-based fuel ("biofuel") production. In 2007, Governor Schwarzenegger signed an executive order to reduce carbon intensity of transportation fuel by 10 percent by 2020. The California Air Resources Board adopted this Low Carbon Fuel Standard in 2009, and the state is working with companies to implement these regulations.

In addition to stimulating supply, California policymakers have also acted to help make these new technologies more affordable to consumers. For example, the California Air Resources Board sponsored the Clean Vehicle Rebate Project to promote the purchase of zero-emission or plug-in hybrid passenger vehicles by providing a \$2,500 rebate to consumers. In addition, the Board has also sponsored the Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project to help public and private fleets convert to new

technologies by providing up to a \$60,000 rebate per vehicle. Both of these projects are also partly funded by AB 118. These actions on both the supply and demand side have helped California's alternative fuel and vehicle market growth.

## Driving Innovation

California has accelerated innovation in alternative fuel and vehicle technologies in the state by funding research, development, and deployment projects, investing in companies with new technologies, and establishing collaborative research networks. The University of California (UC) system established a Transportation Center in 1987 to support transportation research, education, and technology transfer throughout the multi-campus system. Individual universities have established internationally recognized programs as well. The UC Davis Institute of Transportation Studies, for example, is known for its multidisciplinary approach to transportation studies, and its Plug-In Hybrid & Electric Vehicle Research Center is the hub of collaboration and research on plug-in hybrid and electric vehicles for the state.

California policymakers have passed a number of laws to fund innovation in the sector. In 1998, California established the Carl Moyer Program to fund incentives for lower-emission heavy-duty vehicle engines. In addition, in 2007, California passed the California Alternative and Renewable Fuel, Vehicle Technology, Clean Air, and Carbon Reduction Act (AB 118), which establishes a \$200 million per year fund for clean vehicle and equipment projects through 2015. The Commission allocates \$100 million per year of this fund in its annual Investment Plan to develop and deploy innovative technologies in support of the state's greenhouse gas goals. The 2013-2014 Investment Plan, for example, supports projects to develop and improve alternative and renewable low-carbon fuels; expand fuel infrastructure, fueling stations, the manufacturing of alternative vehicles and equipment; establish workforce training programs; and conduct public education and promotion initiatives.

By leveraging strong local research and development assets, California is cultivating an atmosphere that fosters innovative technologies and new alternative fuel and vehicle companies.

## Capturing Economic Benefits

Economic benefits of the growing the ARFV industry—increased job growth and thriving businesses operating in all parts of the value chain—result from strategic collaboration among public and private sector stakeholders to capitalize on innovation in the industry as well as policies that stimulate market growth. Aligning workforce training with private sector demand is a critical strategy to ensure that there are both job opportunities and trained workers for the ARFV

industry in a regional economy. In addition, supporting and recruiting companies to locate and grow in the state, and encouraging the deployment of advanced transportation products are important actions to capture economic benefits of the growing industry.

California has numerous organizations dedicated to supporting the ARFV industry, ranging from economic development organizations to associations focused on increasing alternative fuel and vehicle education and awareness. These organizations help create an economic environment in which companies want to locate and grow. CALSTART, for example, is a non-profit member organization founded in 1992 to expand and support the ARFV industry in California by connecting players in the market and advocating for favorable policies. Other organizations are also working to create a skilled workforce for the sector in the state. The California Community Colleges' Advanced Transportation Technology and Energy initiative, for example, has been working since 1997 to train workers and strengthen technical education for the industry.

California's regions have been leveraging statewide actions to capture economic benefits locally. The San Diego Regional Biofuels Initiative, for example, is jointly managed by CleanTECH San Diego, BIOCUM and the San Diego Regional Economic Development Corporation, and brings together regional assets focused around the goal of commercialization and application of advanced biofuels. The Biofuels Initiative helps the region advance research, connect markets, and provide a forum for its public and private sector participants to share information and discuss the challenges and opportunities of the sector. Similar initiatives have been launched in other regions, such as the Green Capital Alliance in the Sacramento region and the Los Angeles County Economic Development Corporation's E-Mobility Task Force.

State officials can effectively develop and implement policies to encourage market growth and fund innovative technologies at the broad statewide level. However, without accompanying initiatives such as these to support businesses and workers, regional economies may struggle to successfully tap into the employment and economic benefits of the ARFV industry's expansion.

## CALIFORNIA'S GROWING ADVANCED TRANSPORTATION MARKET

### Advanced Transportation Market Potential

The market for ARFV has the potential to expand rapidly in the near future. ARFV companies include those that are involved in a variety of value chain activities, including research and development, manufacturing, installation, and/or services. These companies are working in sectors such as electric vehicles and charging infrastructure, natural gas vehicles and fueling infrastructure, alternative transportation energy storage (e.g. vehicle batteries), first and next generation alternative fuels, more efficient vehicle components or engines, and logistics products to improve fleet management and operations.

First generation alternative fuels (biofuels) already have an established role in the U.S. market. These biofuels include starch-based ethanol and biodiesel from feedstocks such as corn, sugar cane, and soybeans. In the U.S., one billion gallons of biodiesel and 14 billion gallons of ethanol were produced in 2011.<sup>2</sup> Next generation advanced biofuels, such as cellulosic ethanol, non-virgin oil based biodiesel and bio-synthetic gas, are also improving and increasing production. Advanced biofuels production capacity expanded to 685 million gallons in 2012 and is projected to grow to at least 1.6 billion gallons by 2015.<sup>3</sup> National investment in biofuels is expected to reach \$69 billion between 2013 and 2023 as revenues hit \$7.6 billion by 2023. Research shows that the market will remain

dominated by conventional ethanol in 2023, but have expanding research and investment in advanced biofuels.<sup>4</sup> U.S. policies such as the Renewable Fuel Standard and California's Low Carbon Fuel Standard are expected to continue to drive growth in the advanced biofuels market.

Alternative vehicles are also gaining vehicle market share. While alternative vehicles such as zero emission electric or hydrogen fuel cell vehicles, and low-emission compressed natural gas vehicles are still a small portion of the total market, California mandates and incentives for zero emission vehicles are helping to stimulate an increase in consumer demand. Electric vehicle sales in the U.S. doubled in the first half of 2013, with more than 40,000 vehicles sold, compared to first half of 2012.<sup>5</sup> In 2012, California had 32 percent of total electric vehicle sales in the country, making it the top state for electric vehicle sales.<sup>6</sup>

California is making strides to capitalize on this growing advanced transportation market. The strategic actions described in the timeline above have contributed to new innovative technologies and companies in the ARFV industry. The data in this section show that California is leading the way in innovation, deploying new technologies, and creating new jobs and occupation opportunities for Californians across the state in the ARFV industry.

## Innovation in Alternative and Renewable Fuel and Vehicle Technologies

Transportation technologies have evolved dramatically in the last 100 years, but new innovations are still necessary for California to achieve its greenhouse gas reduction goals. California businesses and inventors are striving to make the shift from a carbon-based to a cleaner and more efficient economy. Financial investments in alternative fuel and vehicle technology companies help to commercialize and scale new products and services. Similarly, patent registrations reflect private and public research and development investments and industry growth potential. Looking at changes in investments and patents together can illustrate California's role in leading the advanced transportation shift.

### Investment in ARFV Companies

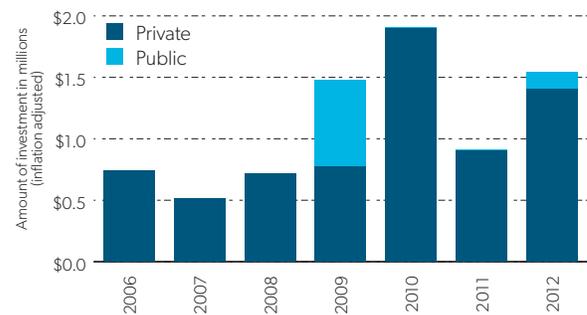
Investments in ARFV companies fuel the creation of new, innovative products and services. The public and private sector both play important roles in the investment landscape. The public sector, including state and federal government agencies, can provide seed money in the form of grants to test new ideas or loan guarantees to help companies scale up. The private sector, including venture capital firms, corporations, and banks, often provides a wider range of funding to early stage and established companies such as venture capital, project financing, and loans.

Total investment in ARFV companies in California reached about \$1.5 billion in 2012, more than twice as much as total investment five years prior in 2008 (Figure 2). Private sector investors are the major players in ARFV financing, providing 91 percent of the total investment in 2012. Public investments temporarily jumped in 2009 as a result of loan guarantees and grants from the American Recovery and Reinvestment Act.

Figure 2

### Public and Private ARFV Investments\*

California, 2006-2012

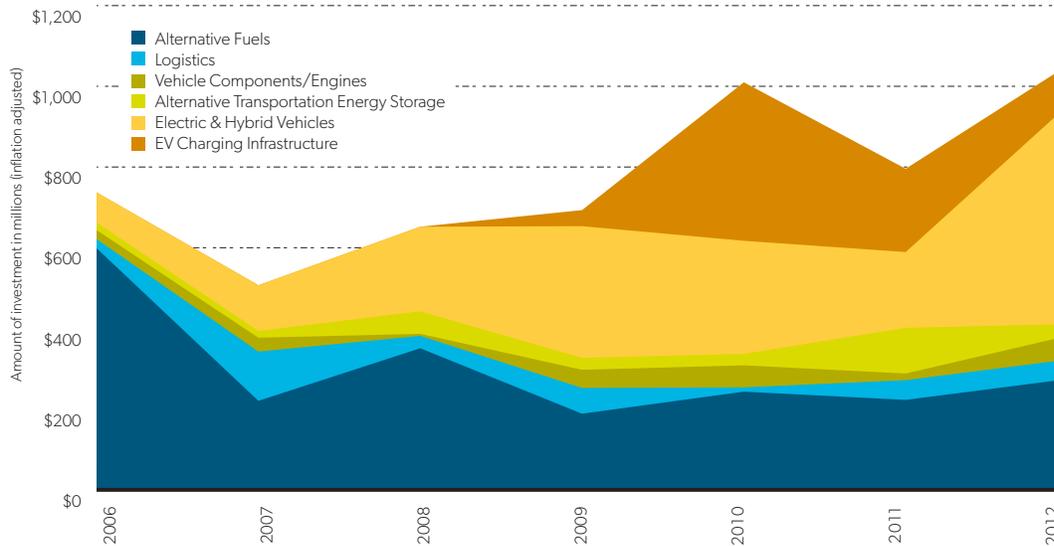


\* Private investor types include entities such as venture capitalists, banks and corporations. Public investor types include state or federal government entities.

Figure 3

### Venture Capital Investments

California, 2006-2012



### Total Number of Deals

2006	21
2007	30
2008	31
2009	36
2010	37
2011	33
2012	31

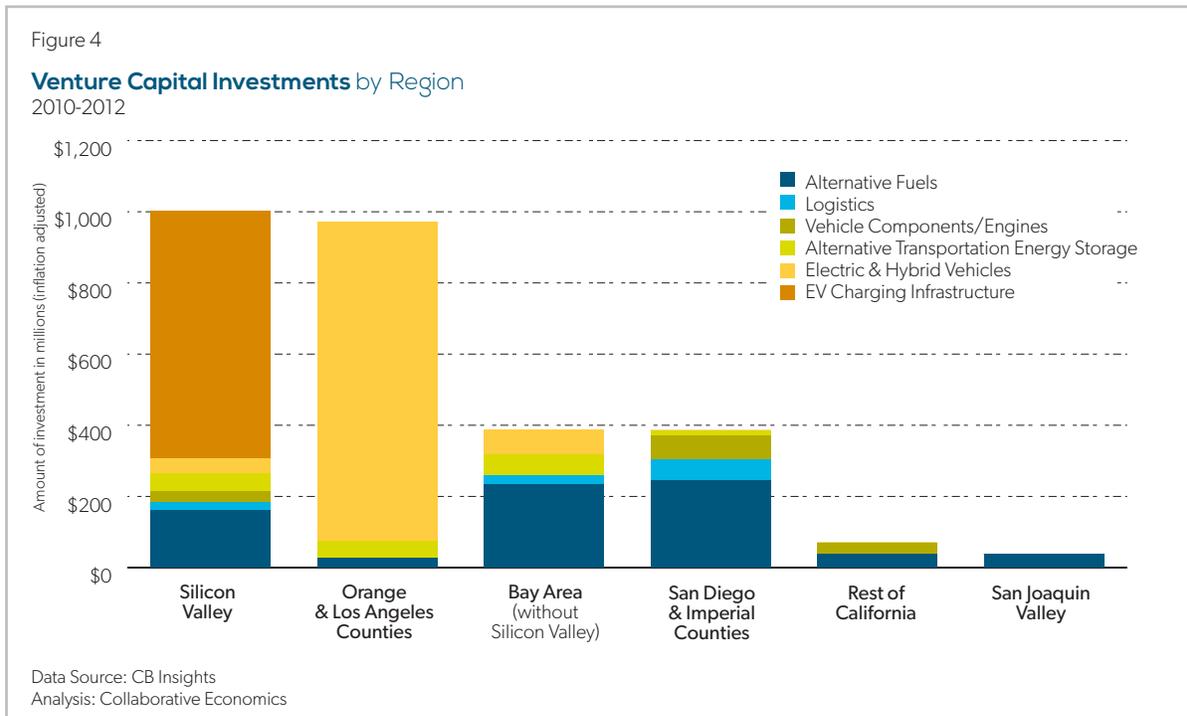
Data Source: CB Insights  
Analysis: Collaborative Economics

Venture capital investment is a subset of private sector investment and provided about two-thirds of the total investment in 2012. Tracking venture capital specifically is important because it is a leading indicator of investment in innovation and source of funding for new, innovative startup companies. While overall clean technology venture capital investment decreased in 2012, funding for ARFV companies reached a high of about \$1 billion, a 32 percent increase from 2011 (Figure 3). The ARFV industry has had an average of more than 30 venture capital deals each year since 2007, and about 40 unique companies were funded in 2011 and 2012 alone. The Electric & Hybrid Vehicles segment received the most investment in 2012 with about \$590 million. The second largest segment was Alternative Fuels, which was up 23 percent from 2011 to \$274 million, nearly half of which was provided to Sapphire Energy for their algae-based green crude oil production. Electric Vehicle (EV) Charging Infrastructure was the third largest segment in 2012 with \$99 million in investment, half of which went to ChargePoint for charging systems and services.

While the ARFV startup industry has had a few high profile companies struggle, they are a relatively small number compared to the total receiving investment, and were small employers in 2011 with each accounting for 40 employees

or less identified in the National Establishments Time Series Database (NETS). Fisker Automotive, for example, is now struggling, though it received most of the 2012 investment in the Electric & Hybrid Vehicles segment. Similarly, Better Place is a now bankrupt battery swapping company, but received half of the EV Infrastructure investment in 2012. Such ups and downs are common in early stage companies, and despite these industry losses the ARFV sector has also had successful company growth and exits into the public market. Notably, Tesla Motors, producer of all electric vehicles, went public in 2010 and has dramatically increased its stock price in 2013.

Silicon Valley and Orange & Los Angeles Counties led the state in ARFV venture capital investment over the past three years (Figure 4). Silicon Valley leads in EV Charging Infrastructure investment, while Orange & Los Angeles Counties lead in Electric & Hybrid Vehicles investments. Investments in Alternative Fuels, Vehicle Components/Engines, and Logistics are dispersed across the state, with San Diego & Imperial Counties receiving most of the investment in each category in the 2010-2012 time period. Alternative Transportation Energy Storage investments were also spread across the state, with most investments in the Bay Area and Silicon Valley.



### Patents in ARFV Technologies

Patents are one measure of innovation, demonstrating opportunities for ARFV companies to commercialize innovative products and improve cost effectiveness. Although not all patents have immediate commercial applications in the region in which they are developed, California's active investment community, network of innovative ARFV companies (many conducting in-house research and development) and supportive public policies increase the likelihood that local businesses are able to capitalize on the economic opportunity locally.

Alternative and renewable fuel and vehicle patents registered by California inventors with the U.S. Patent and Trade Office (USPTO) not only increased rapidly in recent years<sup>7</sup>, but California's share of total U.S. patent registrations in this sector nearly doubled, jumping from 4.9 percent in 2006 to 9.4 percent in 2011 (Figure 5). Alternative motor vehicle and energy storage/drive train technologies (Electric Vehicle, EV/Hybrid Battery, Hybrid Systems and mobile Fuel Cells) dominated patenting activity in the ARFV sector for California

in the 2010-2011 period. These patents accounted for roughly 80 percent of new patent registrations and increased more than 200 percent from 2005-2006.

In 2010-2011, California had the second highest amount of ARFV patents registered in the 2010-2011 period compared to other U.S. states, with more ARFV patents than the following five states combined (Table 1). California's increasing share of alternative fuel and vehicle patents is significant because it represents gaining ground on traditional leaders in the automotive industry, including both domestic and international inventors. California patents are growing at a faster rate than other leaders; while Japanese inventors registered 1.8 times as many patents with the USPTO in 2010-2011 compared to 2005-2006 and Michigan's ARFV patents doubled, California's patents more than tripled.

Tesla Motors (14 patents) and ChargePoint (8 patents) in Silicon Valley, and General Motors (6 patents) and Toyota Motor Engineering (5 patents) in Orange & Los Angeles

Figure 5  
**Patents Registered**  
California, 2000-2011

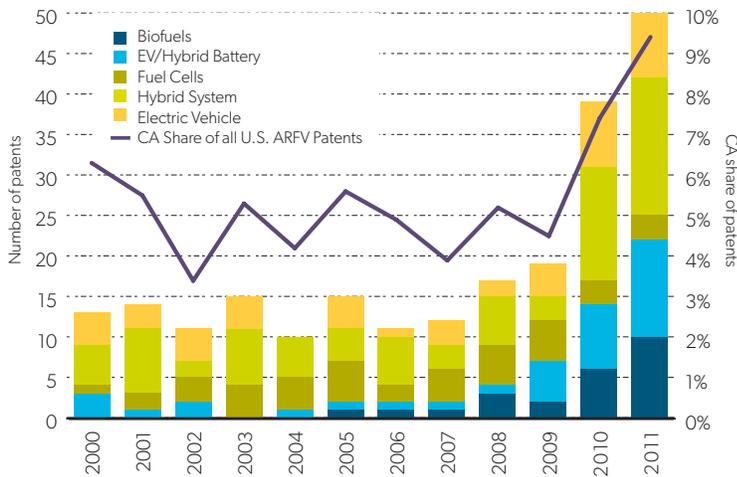


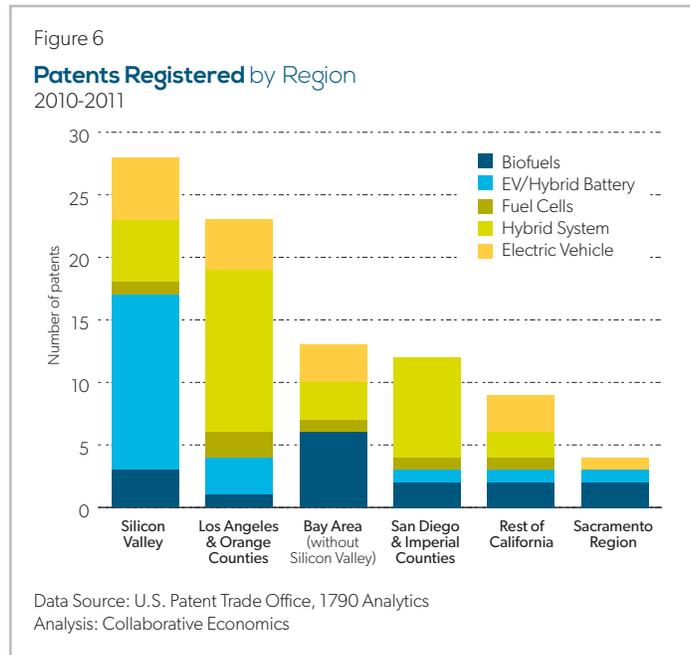
Table 1  
**Top Ranking States in ARFV Patents Registered**

	Ranking	Number of Patents	
	2010-11	2005-06	2010-11
Michigan	1	101	213
California	2	37	119
New York	3	11	35
Pennsylvania	4	8	25
Illinois	5	7	21
Indiana	6	15	19
Massachusetts	7	9	17
Florida	8	3	16
Ohio	8	15	16
Maryland	10	4	12

Data Source: 1790 Analytics  
Analysis: Collaborative Economics

Counties led patent registrations in vehicle-related technology segments in 2010-2011 (Figure 6). Although Silicon Valley registered the most vehicle-related technology patents of any region in the state in the 2010-2011 period, activity was led by a few major companies. In contrast, Orange and Los Angeles Counties had twice as many companies and individuals registering patents in this segment.

Biofuels registrations more than tripled between 2008-2009 and 2010-2011, led largely by strong growth in the greater Bay Area (including Silicon Valley), but with rising activity in the San Diego and Sacramento regions as well. ZeaChem Inc. registered the most biofuels patents of any company in the state in 2010-2011 through its research and development laboratory in Silicon Valley. Companies such as Solazyme, Genomatica and Novozymes in the San Diego region and Sacramento region also successfully registered patents during the same period.



## ARFV Technology Implementation and Growth

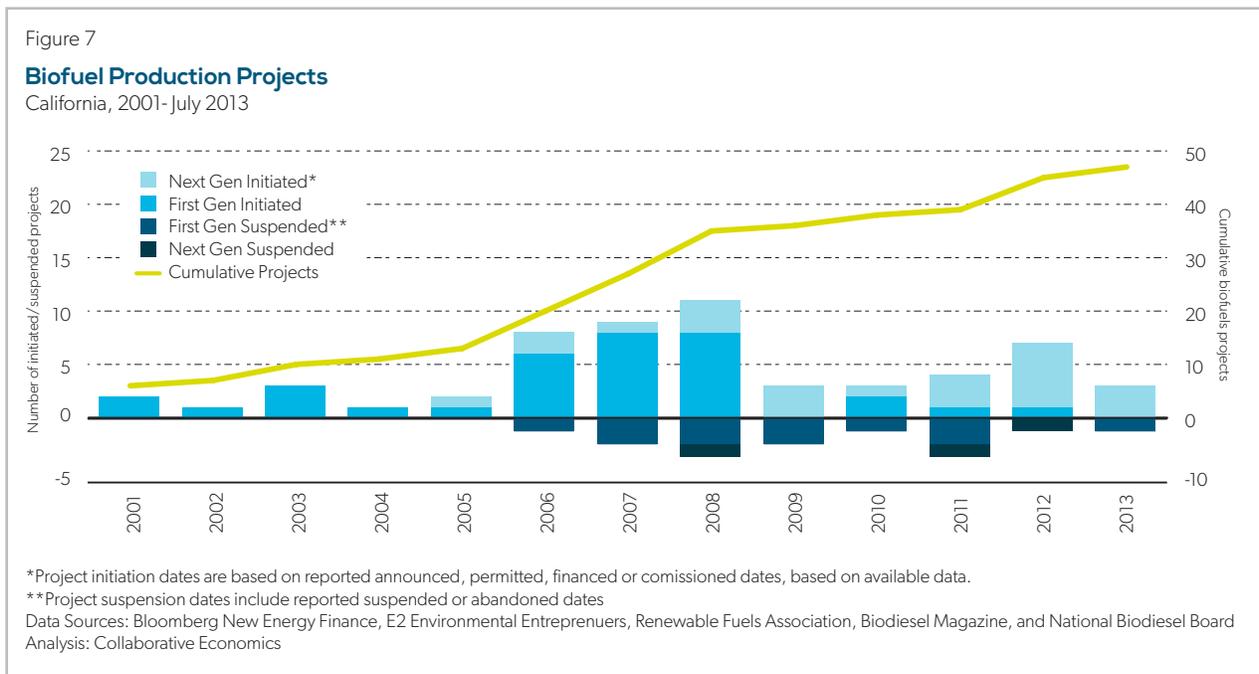
In addition to leading innovation in the ARFV industry, California has also been increasing demonstration, implementation and adoption of new technologies.

### Biofuel Production Projects

Commercialization and production of biofuels has increased rapidly in California since the early 2000s, capitalizing on growing research and investment and leveraging policies such as California's Low Carbon Fuel Standard and the federal Energy Policy Act of 2005. Biofuels include first generation biofuels such as ethanol and biodiesel, as well as a growing number of next generation advanced biofuels,

such as cellulosic ethanol or algae-based biodiesel. This section focuses on biofuel for transportation and excludes biomass or waste-to-energy processes that exclusively generate electricity or are used for pipeline gas.

In 2007, 27 transportation biofuel projects had been initiated in California. By July 2013, the number had increased by 75 percent, to 47 projects. Much of the expansion over this period occurred in next generation biofuels, which now account for more than a third of biofuel projects underway or commissioned in the state (Figure 7).



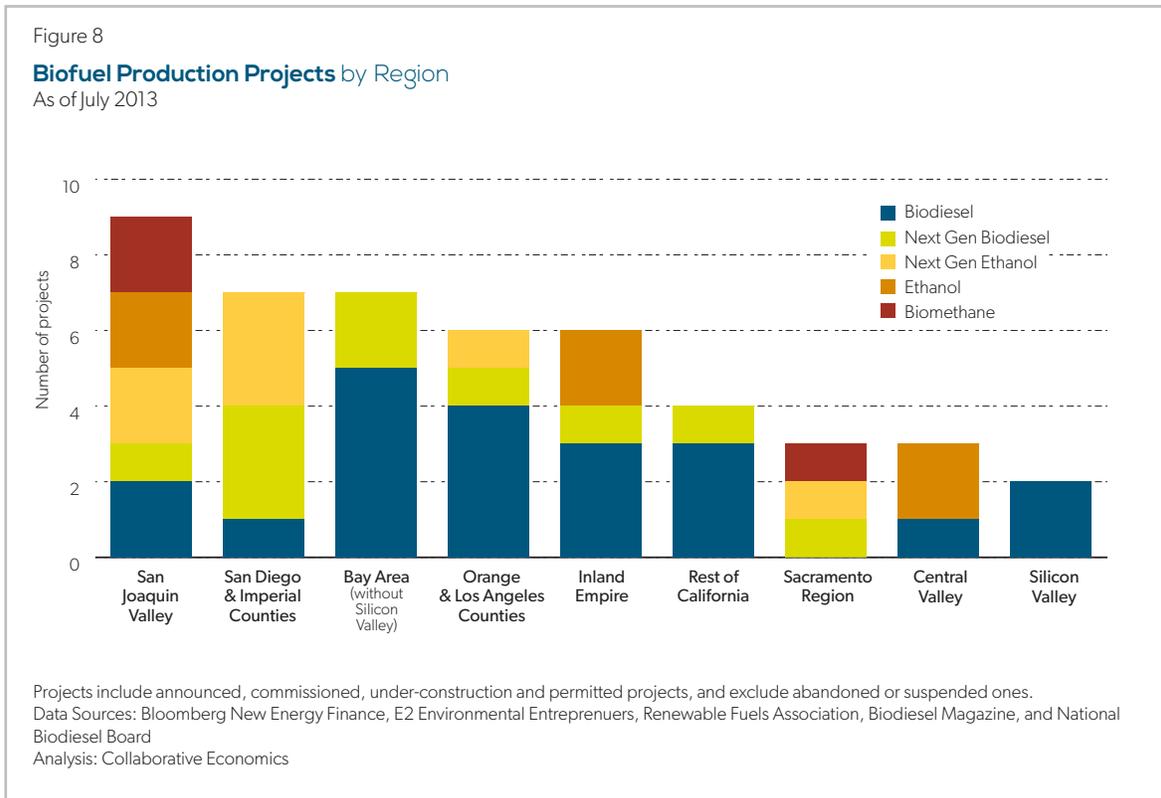
California regions have developed different strengths in transportation biofuels (Figure 8). The San Joaquin Valley is home to the highest number of biofuel projects in California (9 projects as of July 2013), but the total number of projects in the region has declined slightly since 2009 with operations suspended at three first generation ethanol and biodiesel plants. At present, more than half of San Joaquin Valley's active projects are next generation pilot and demonstration facilities, including the Mendota Next Generation Bioenergy Demonstration Plant which will convert sugar beets into ethanol<sup>8</sup> and Edeniq's cellulosic ethanol pilot facility, which successfully completed 1,000 hours of continuous operation in May 2013.<sup>9</sup>

San Diego & Imperial Counties and the Bay Area without Silicon Valley have the second highest number of biofuels projects in the state (each with 7 active projects). Both regions are heavily involved in next generation biofuel research and demonstration. In San Diego & Imperial

Counties, five out of the region's seven active projects kicked off in the last three years, all of them involving advanced biofuel feedstocks.

In the Sacramento Region, waste-to-energy production recently expanded into transportation fuels, suggesting an emerging strength. Dairy digesters and other biomass/biogas processes in the region have typically generated electricity or supplied a natural gas pipeline. In 2012, CleanWorld launched a project to produce renewable natural gas (biomethane) to fuel a local truck fleet and has since announced an expansion of its facility.

The Commission has helped fund a number of these active biofuel projects and pre-development activities for others with AB 118 grants. The Mendota Bioenergy Plant and CleanWorld biomethane plant, for example, both received AB 118 grants.



### Alternative Vehicle Registrations

California policies that support ARFV technologies have helped increase the adoption of alternative vehicles across the state. Alternative vehicles include zero emission vehicles such as electric and hydrogen fuel cell and low-emission vehicles using fuels such as natural gas, ethanol, and propane. Growth in alternative vehicles and fuels are supported by policies such as the Low Carbon Fuel Standard, the Advanced Clean Car Rules and Governor Brown's executive order for zero emission vehicles.

California residents have nearly doubled the number of alternative vehicles registered since 2006, reaching 2.3 percent of all vehicle registrations in the state in 2011 (Figure 9). This increase was largely driven by an increase in flex ethanol vehicles that can use higher proportions of renewable ethanol fuel than standard vehicles. California averaged about 23 alternative vehicles per thousand registrations in 2011 (Table 2). San Joaquin Valley had a higher adoption rate of 28 alternative vehicles per thousand registrations, most of which were flex ethanol.

Natural gas vehicle registrations increased 13 percent between 2006 and 2011. Nearly half of these vehicles are in Orange & Los Angeles Counties, with a mix of light duty and medium/heavy duty vehicles. The Commission has multiple AB 118 investment projects underway to expand the natural gas vehicle market by supporting new vehicle technologies and infrastructure. For example, the South Coast Air Quality Management District (SCAQMD), the Ports of Los Angeles and Long Beach received \$5 million, in addition to federal and project participant funds, to replace 180 existing diesel-fueled trucks with versions powered by cleaner-burning liquid natural gas (LNG). The South Coast Air Basin is highly impacted by poor air quality and replacing diesel trucks with LNG trucks is expected to help improve the environment and grow the natural gas vehicle sector. The SCAQMD is also a partner on other AB 118 projects in the region to design, develop and deploy medium- and heavy-duty plug-in hybrid and electric vehicles, which will also help reduce emissions from regional shipping ports and routes.

Figure 9

**Alternative Vehicle Registrations by Fuel Type**  
California, 2006-2011

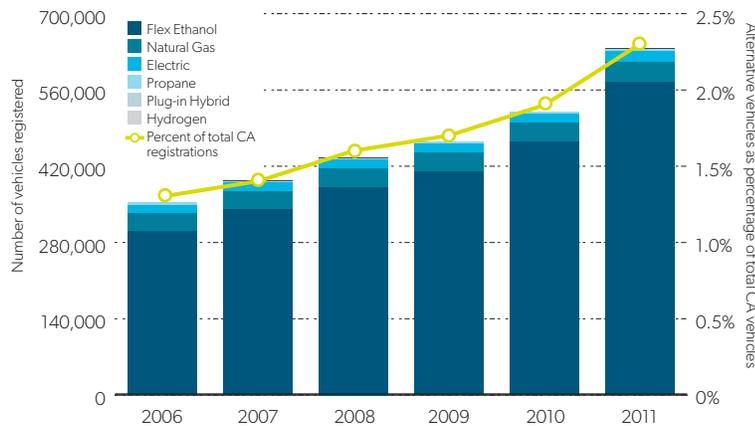


Table 2

**Alternative Vehicle Registrations Rates**  
By Region, 2011

Region	Alternative Vehicles* (per 1,000 registrations)
California	23.1
San Joaquin Valley	28.0
Rest of California	24.5
Sacramento Region	24.2
San Diego & Imperial Counties	21.7
Los Angeles & Orange Counties	21.5
Silicon Valley	17.0
Bay Area without Silicon Valley	16.0

\*Note: Alternative Vehicles include the following fuel types - Flex Ethanol, Natural Gas, Plug-in Hybrid, Propane, Electric and Hydrogen.

Data Source: California Energy Commission  
Analysis: Collaborative Economics

### Clean Vehicle Rebates

In addition to supporting alternative vehicles that use a range of lower emission fuel types, California has taken specific actions to stimulate demand for zero emission vehicles. In 2012, the California Air Resources Board approved the Advanced Clean Car Rules that set new greenhouse gas and pollution reduction requirements for model years 2017-2025, as well as specific requirements for automakers to sell an increasing share of zero emission vehicles by 2025. Governor Brown reinforced this rule with an executive order target to have 1.5 million zero emission vehicles on California roads by 2025.

In support of these policies, the state established the Clean Vehicle Rebate Project to promote the production and use of zero emission vehicles. Through this project, individuals and business owners receive a rebate of up to \$2,500 for the purchase of a light duty vehicle. This rebate helps reduce the

price differential between conventional vehicles, and cleaner alternative vehicles, incentivizing early adopters to buy zero emission vehicles.

The California Air Resources Board and The Commission have appropriated a total of \$63.7 million in fiscal years 2009-2013 to this program, which has helped subsidize over 26,000 plug-in hybrid electric and zero emission vehicles (fuel cell or all electric) across the state through the first half of 2013 (Figure 10). Rebates surged in 2012 to a total of about 11,000 and are set to exceed that level in 2013.

Orange & Los Angeles Counties have received the most rebates with 38 percent of the total, though the region also has the most vehicles in the state (Table 3). Silicon Valley has the second highest number of rebates with 20 percent of the total, which greatly exceeds its seven percent share of total vehicles in the state.

Figure 10

**Clean Vehicle Rebates by Region**  
Plug-In Hybrid and Zero Emission Vehicle Rebates  
2010-2013\*

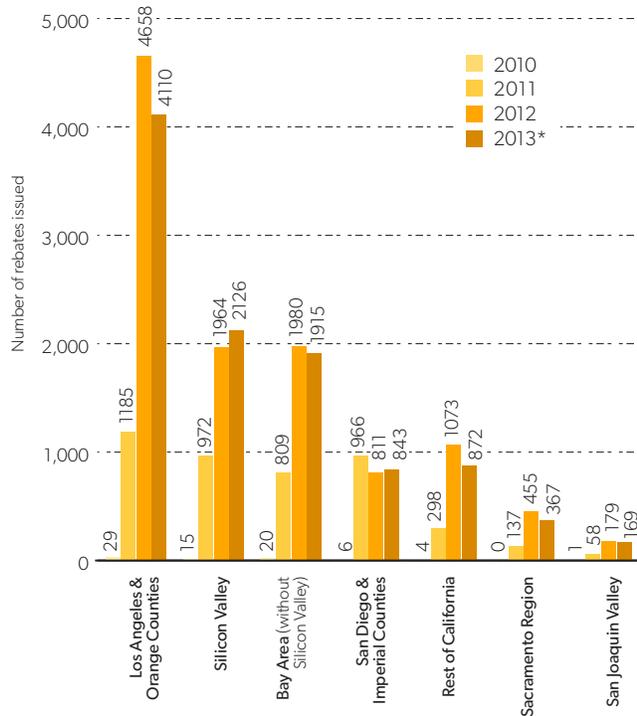


Table 3

**Clean Vehicle Rebates**  
California

	Total Regional Rebates (2010-2013*)	Regional Share of Total CA Rebates	Regional Share of Total CA Vehicle Registrations (2011)
Los Angeles & Orange Counties	9,982	38%	33%
Silicon Valley	5,077	20%	7%
Bay Area without Silicon Valley	4,724	18%	10%
San Diego & Imperial Counties	2,626	10%	9%
Rest of California	2,247	9%	11%
Sacramento Region	959	4%	6%
San Joaquin Valley	407	2%	10%

\*Note: 2013 data as of June 17, 2013  
Data Source: Center for Sustainable Energy California, Clean Vehicle Rebate Project, California Energy Commission  
Analysis: Collaborative Economics

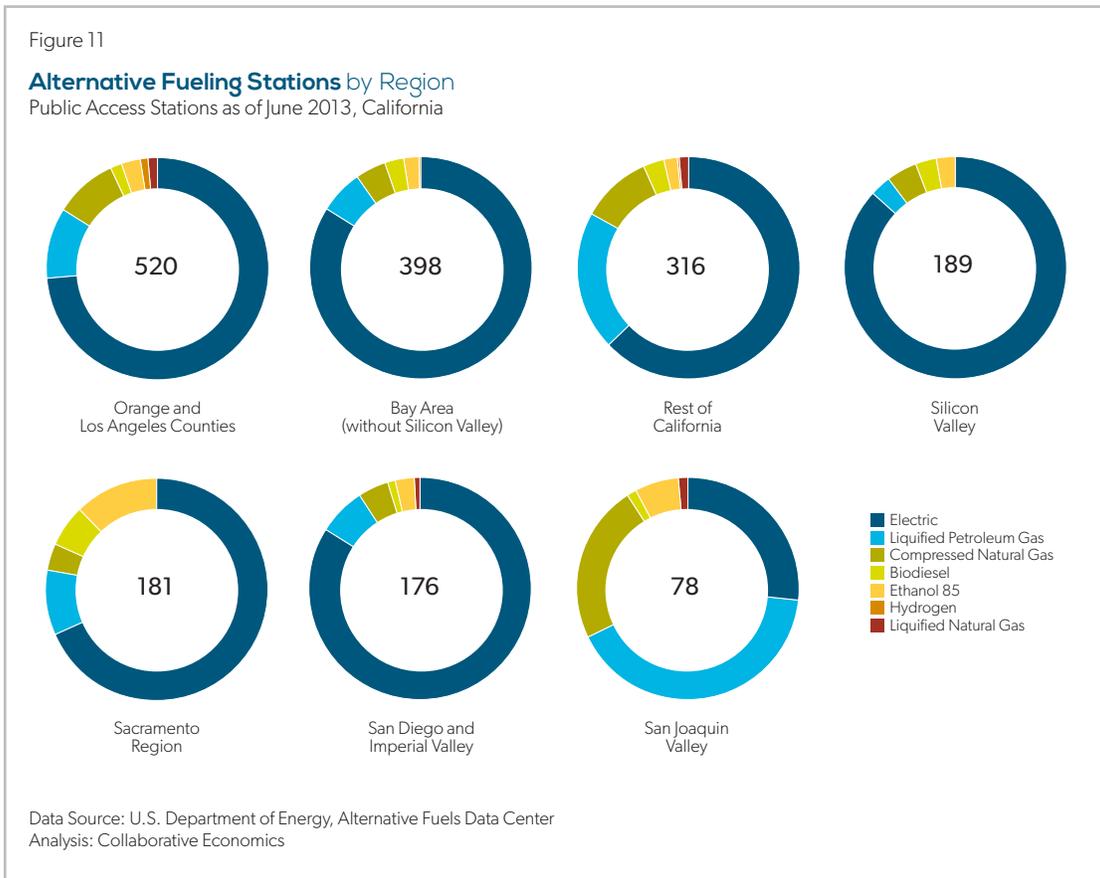
### Alternative Fuel Infrastructure

Widely-available alternative fueling infrastructure is a critical requirement of widespread adoption of new alternative vehicles. Range anxiety is a common concern among electric vehicle owners as the batteries are generally not able to provide enough charge for long distance trips. A survey of Clean Vehicle Rebate recipients found that they are highly satisfied with their choice to go electric and use of the vehicles, but still have concerns and dissatisfaction with the range of electric vehicles and availability of public charging infrastructure.<sup>10</sup> In 1997, Oak Ridge National Laboratory analyzed survey responses regarding the choice to adopt alternative fuel vehicles, and found that American consumers are more willing to opt for alternative fuel vehicles when public fueling infrastructure is more available, especially when there is also a price differential between the conventional and alternative fuel.<sup>11</sup> It follows that although private fueling stations are important to support individual businesses, fleets, or individual use, public access stations are essential for wider adoption of alternative vehicles.

California has increased the number of public access alternative fuel stations in recent years to support alternative vehicle adoption. Regions in California vary in their fuel type focus, though electric is the dominant type in most areas of the state (Figure 11). According to the U.S. Department of

Energy, 83 percent of the public electric charging stations in California opened in the last two and a half years. Public electric charging stations are located across the state, though they are most prevalent in areas with high numbers of Clean Vehicle Rebates received. These stations are particularly concentrated in the state's major metropolitan areas (Figure 12). Orange & Los Angeles counties have the most electric charging stations, followed by the Bay Area and Silicon Valley. Orange & Los Angeles counties also have a noticeable number of liquefied petroleum gas and compressed natural gas stations. San Joaquin Valley has the fewest number of public access stations, but the most diverse mix of fuel types in the state, while the Sacramento Region has the most public access Ethanol 85 stations.

The Commission has helped fund a number of recent alternative fueling station projects with AB 118 grants. These projects have been for multiple fuel types, including hydrogen, natural gas, and electric. For example, the Association of Bay Area Governments received a grant to install up to 423 charging stations in the region as a part of its Bay Area Electric Vehicle Corridor Project. Also, the agricultural company Border Valley Trading received a grant to install a public access LNG station in Coachella Valley to support regional LNG fleets.



California also leads the country in public access alternative fueling stations. In electric charging, for example, the state has 22 percent of all public stations, nearly three times more total stations and twice as many stations per million people than Texas, the next leading state (Table 4). California also has the most biodiesel, compressed natural gas, hydrogen, and liquefied natural gas stations in the U.S.

Figure 12

**Electric Charging Stations in California**

Public Access Stations as of June 2013

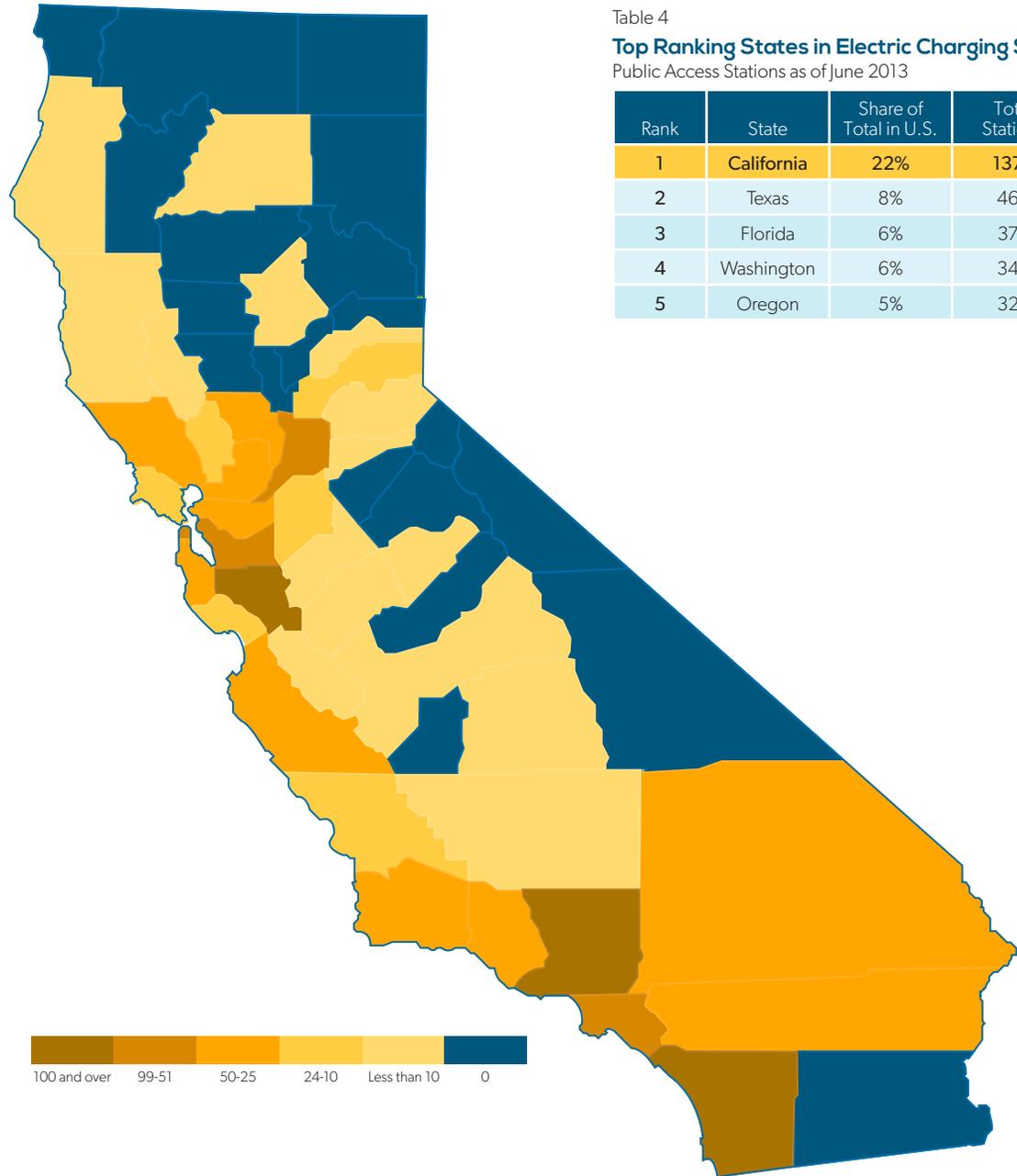


Table 4

**Top Ranking States in Electric Charging Stations**

Public Access Stations as of June 2013

Rank	State	Share of Total in U.S.	Total Stations	Stations per million ppl
1	California	22%	1373	36.1
2	Texas	8%	465	17.8
3	Florida	6%	379	19.6
4	Washington	6%	345	50.0
5	Oregon	5%	327	83.9

Data Source: U.S. Department of Energy, Alternative Fuels Data Center , U.S. Census Bureau  
 Analysis: Collaborative Economics

## ARFV Industry Workforce Expansion

The growing ARFV industry has created jobs across the state, many of which require new training programs to prepare the workforce.

### Core Employment in the ARFV Industry

Jobs in the ARFV industry are growing in California, and represent a promising opportunity for the California economy. By 2011, California's overall economy had recovered enough from the 2007-2008 recession to return to 2006 employment levels. In contrast, ARFV core employment grew 39 percent and the number of establishments nearly doubled between 2006 and 2011 (Table 5). Although the ARFV industry still accounts for a small proportion of the California's total economy, robust research and development activity, increasing adoption of alternative vehicle and biofuel technology, and strategic efforts to encourage development of regional industry clusters have poised the sector for strong growth in the future. The Commission surveyed companies and projected that workforce and technology development efforts through AB 118 alone would add nearly 5,400 new jobs in California, about 3,500 of which would be long term positions.<sup>12</sup>

This section examines a snapshot of California's ARFV industry in 2011 to profile the market's core employment and diversity of activities across regions. Employment data used in this analysis is built from the National Establishments Time Series database, which contains employment at the individual business location (establishment) level throughout the state of California. Using industry organization membership lists, private and public financing reports, local government programs and industry codes to identify specific companies active in the sector, companies were identified that are developing, producing, supplying and servicing products in the ARFV industry. Table 6 details the types of ARFV technologies included within each industry segment.

Table 5  
**Total Number of Core ARFV Establishments**  
California

Year	Number of Establishments
2001	142
2006	260
2011	504

Data Source: National Establishment Time Series Database  
Analysis: Collaborative Economics

Table 6

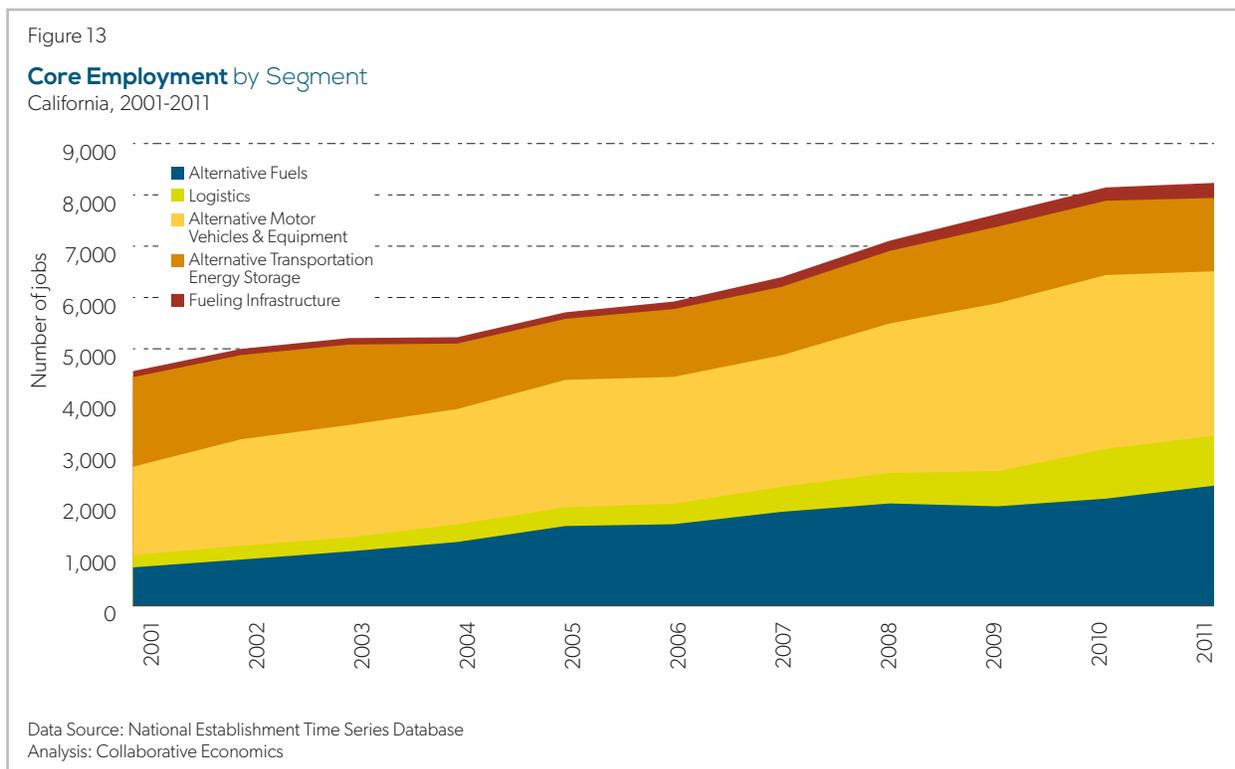
### Segments of the Alternative and Renewable Fuel and Vehicle Industry

Alternative Motor Vehicles & Equipment	<b>Motorized vehicle and equipment technology</b> including, electric, hybrid and natural gas vehicles, as well as diesel technology, and efficiency-enhancing vehicle/engine components.
Alternative Fuels	<b>Transportation fuels</b> including biodiesel, ethanol, hydrogen, and algae-based.
Fueling Infrastructure	<b>Technology enabling vehicle fueling and storage of alternative fuels</b> , including electric vehicle charging, and hydrogen, natural gas, ethanol and biodiesel fueling.
Alternative Transportation Energy Storage	<b>Power and energy storage technology for alternative motor vehicles</b> , including advanced batteries (advanced lead-acid, lithium-ion, nickel-metal hydride and ultracapacitors), proton exchange membrane (PEM) fuel cells, and hybrid hydrogen storage systems.
Logistics	<b>Products and services to enhance efficiency in transportation</b> including fleet tracking and traffic monitoring.

Analysis: Collaborative Economics

Employment levels represent core employment in companies directly related to alternative fuels and vehicles in California. This dataset includes companies that devote a majority of their business efforts to ARFV technologies and services, but does not include companies that have some activity but not an explicit focus on ARFV. For example, vehicle repair shops with employees that service alternative vehicles, but work primarily with conventional vehicles, are not included in this analysis. A 2009 survey of employers by the California's Employment Development Department identified roughly 19,000 vehicle technicians across the state servicing alternative vehicles in some capacity, but only 9,050 of them spent the majority of their time on alternative vehicles.<sup>13</sup> The current dataset excludes establishments without an explicit focus on ARFV, and therefore would not count the majority of these jobs. Similarly, a farmer or processing facility supplying a cellulosic ethanol pilot plant with leftover biomass and large automakers like General Motors and Honda are not included. Companies that are shifting into ARFV activities constitute the "adaptive" ARFV sector. These companies adapting into ARFV are important for overall market growth and increasing the social and environmental benefits of the ARFV technology improvements, but this section will focus on core companies that are primarily focused on ARFV and are leading change in the industry.<sup>14</sup>

In January 2011, California had roughly 8,200 jobs in the core ARFV industry (Figure 13), spread across more than 500 establishments and a variety of segments as described in Table 6. The industry has growing levels of entrepreneurship, with nearly twice as many establishments in 2011 as compared to 2006, and nearly 3.5 times as many compared to 2001. New firms generated an average of 42 percent of new ARFV jobs per year in California between 2005 and 2010, while firm expansions accounted for an average of 56 percent of industry employment growth over the same period. Firms moving into California contributed roughly two percent of ARFV jobs per year. Core employment in Fueling Infrastructure grew fastest between 2006 and 2011 at an average annual rate of 21 percent. Alternative Fuels and Logistics also had high growth rates over the same time period, increasing at average annual rates of 6.6 percent and 14 percent respectively. Alternative Motor Vehicles & Equipment continued to account for the largest share of ARFV jobs (39%, over 3,200 jobs), though employment declined from 2010 levels. Since 2011, several California ARFV companies have filed for bankruptcy protection and reduced their workforces, including Fisker Automotive, Coda Automotive, and Better Place, but these companies were relatively small employers in 2011 and each accounted for 40 employees or less.



Jobs in manufacturing and production companies, accounting for 31 percent of total ARFV employment in 2011, rose 58 percent from 2006 to 2011 (Figure 14). Research & Development jobs also had a large increase, rising 21 percent over the same period. Services accounted for the largest share of ARFV employment (34%), but dipped eight percent from 2010 to 2011 after five consecutive years of employment increase.

California's ARFV jobs are spread around the state (Figure 15), with Orange & Los Angeles Counties home to the most ARFV jobs with nearly 2,500 jobs. The Greater Bay Area including Silicon Valley had the next largest share of jobs with roughly 2,100 workers, and San Diego & Imperial Counties had about 1,720 jobs. Regional employment characteristics and segment strengths are discussed further in the Regional Spotlight section.

Silicon Valley grew fastest among California regions, more than doubling employment between 2006 and 2011, largely related to increased biofuels research and development activity (Figure 16). San Diego & Imperial Counties' employment increased 50 percent over the same period, with strong growth in an array of alternative fuel establishments and a few transportation logistics companies. San Joaquin Valley had the second highest concentration in the state of biofuel jobs in proportion to the region's total workforce in 2011. Although the Sacramento region had a relatively low number of jobs in biofuels in 2011 (roughly 150), biofuels employment increased by 50 percent from 2006 to 2011, and the number of ARFV establishments more than tripled. Jobs growth in the Inland Empire and Ventura County drove the much of the expansion seen in the Rest of California category.

Figure 14

**Core Employment By Value Chain Activity**  
California, 2011

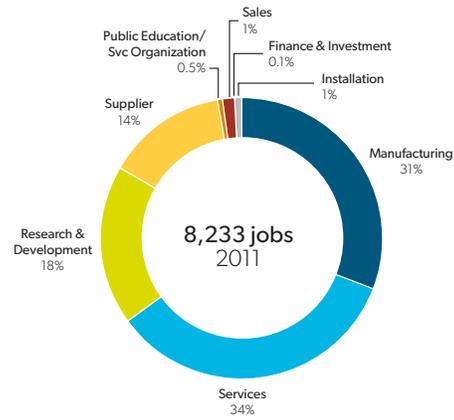


Figure 15

**Core Employment by Region**  
California, 2011

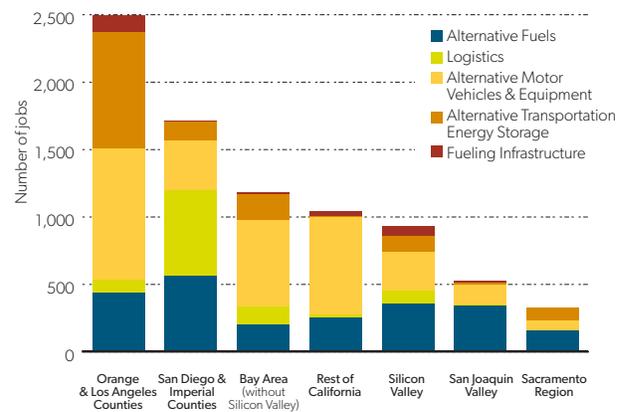
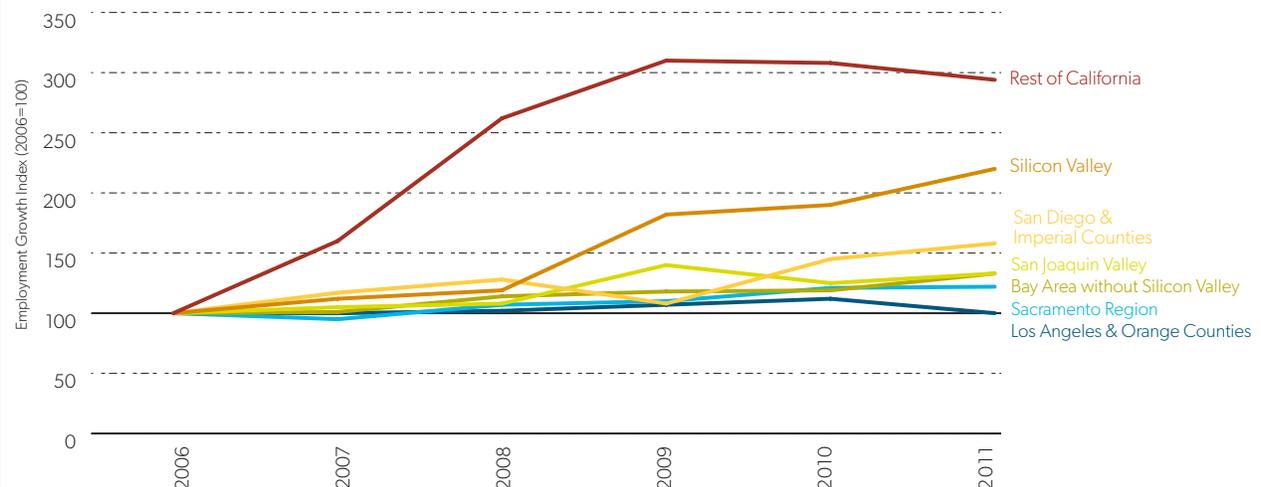


Figure 16

**Core Employment Growth by Region**  
California, 2006-2011



Data Source: National Establishment Time Series Database  
Analysis: Collaborative Economics

### Occupations in the ARFV Industry

The ARFV industry includes workers in a wide variety of occupations throughout the supply chain, ranging from research and development, to manufacturing and sales. The California Economic Development Department and other states have conducted surveys to define and measure green jobs, as well as other information such as training requirements and needs, for the overall green economy as well as for specific industries such as ARFV. The Bureau of Labor Statistics (BLS) used these results and interviews with industry experts to identify common occupations in the electric vehicle and biofuel industries. BLS identified a total of 42 occupations using the Standard Occupational Classification system, which allows for cross referencing with employment and wage data. While the list of occupations is not exhaustive for the ARFV industry, it does provide the most comprehensive list available of the most common occupations in ARFV businesses. Some occupational skills may transfer directly from a different industry into an ARFV business, though other occupations or skills may require additional training for an ARFV specific skill set. This list can be a starting point for regions to target certain occupations for training and emerging growth opportunities, as will be done in the AB 118 RICO process.

Common occupations for biofuel and electric vehicle industries are listed in the following tables. The number of employees, average annual wage, typical entry education levels, green outlook, and employment projections for each identified occupation are detailed below. Occupation titles

are standardized across industries, so the results below are for all industries and not ARFV specific, though this does provide a snapshot of the potential workforce pool for the ARFV industry. The Green Outlook (Table 7) is the result of research by the Occupational Information Network's (O\*NET) National Center for Development, which analyzed occupations in the green economy to identify how worker requirements and demand is expected to change.

The electric vehicles industry has 23 common occupations identified by BLS (Table 8) in areas such as scientific research, design and development, manufacturing, electric vehicle maintenance, infrastructure development, and sales and support. Nearly three-fourths of those occupations have an average annual wage of more than \$40,000. In addition, more than half of the occupations identified typically require less than a bachelor's degree, providing many opportunities for workers across skill levels. 'Green' activities, which include electric vehicles industry activities, are projected to create increased demand for half of these occupations according to the Green Outlook classification. In California specifically, 12 of these occupations have employment projections near or higher than the state average (Figure 17). These fast-growing occupations are also across all wage levels.

Table 7 Green Outlook Descriptions	
 Enhanced Skills Occupations	<p><b>Green economy activities and technologies are likely to cause significant change to the work and worker requirements.</b> New tasks, skills, knowledge, credentials may be needed. Employment demand remains the same, but there is potential for an increase.</p>
 New and Emerging Occupations	<p><b>The impact of green economy activities and technologies is sufficient to create the need for unique work and worker requirements,</b> which results in the generation of new occupations.</p>
 Increased Demand	<p><b>Green economy activities and technologies are likely to increase the employment demand,</b> but will not lead to significant changes in the work and worker requirements.</p>

Data Source: O\*Net

Table 8

**Common Occupations in the Electric Vehicles Industry**

California

Occupation Title	State Average Annual Wage (Q1 2013)	State Employment (May 2012)	General Education Category	Green Outlook
Electronics engineers, except computer	\$108,916	30,140	🎓🎓🎓	+
Electrical engineers	\$108,737	24,110	🎓🎓🎓	+
Software developers, applications	\$106,558	88,260	🎓🎓🎓	Not available
Industrial production managers	\$106,481	17,420	🎓🎓🎓	☀️
Chemical engineers	\$101,899	2,210	🎓🎓🎓	⬆️
Materials engineers	\$99,727	2,850	🎓🎓🎓	Not available
Industrial engineers	\$98,778	20,680	🎓🎓🎓	⬆️
Materials scientists	\$95,282	1,240	🎓🎓🎓	⬆️
Electrical power-line installers and repairers	\$89,083	7,260	🎓🎓	⬆️
Urban and regional planners	\$81,863	8,650	🎓🎓🎓	+
Chemists	\$80,991	11,640	🎓🎓🎓	⬆️
Commercial and industrial designers	\$65,837	3,370	🎓🎓🎓	⬆️
Electricians	\$64,430	41,900	🎓🎓	⬆️
Mechanical drafters	\$58,453	4,500	🎓🎓	Not available
Mechanical engineering technicians	\$57,607	5,040	🎓🎓	☀️
Automotive Service Technicians and Mechanics	\$44,316	54,700	🎓🎓	+
Machinists	\$42,290	32,040	🎓🎓	+
Customer service representatives	\$39,396	200,450	🎓	⬆️
Computer-controlled machine tool operators, metal and plastic	\$38,578	9,610	🎓🎓	⬆️
Engine and other machine assemblers	\$34,088	1,050	🎓	⬆️
Electromechanical equipment assemblers	\$32,332	6,260	🎓	Not available
Electrical and electronic equipment assemblers	\$31,893	25,390	🎓	⬆️
Team assemblers	\$28,255	78,930	🎓🎓	⬆️
Retail Salespersons	\$26,360	448,440	🎓	Not available

**Average Wage Levels**

- 🟩 \$80,000 and up
- 🟨 \$40,000 - \$79,999
- 🟦 Below \$39,999

**General Education Category**

- 🎓🎓🎓 Bachelor's Degree or Higher
- 🎓🎓 Post-High School Training to Associate's Degree
- 🎓 High School Diploma or Less

**Green Outlook**

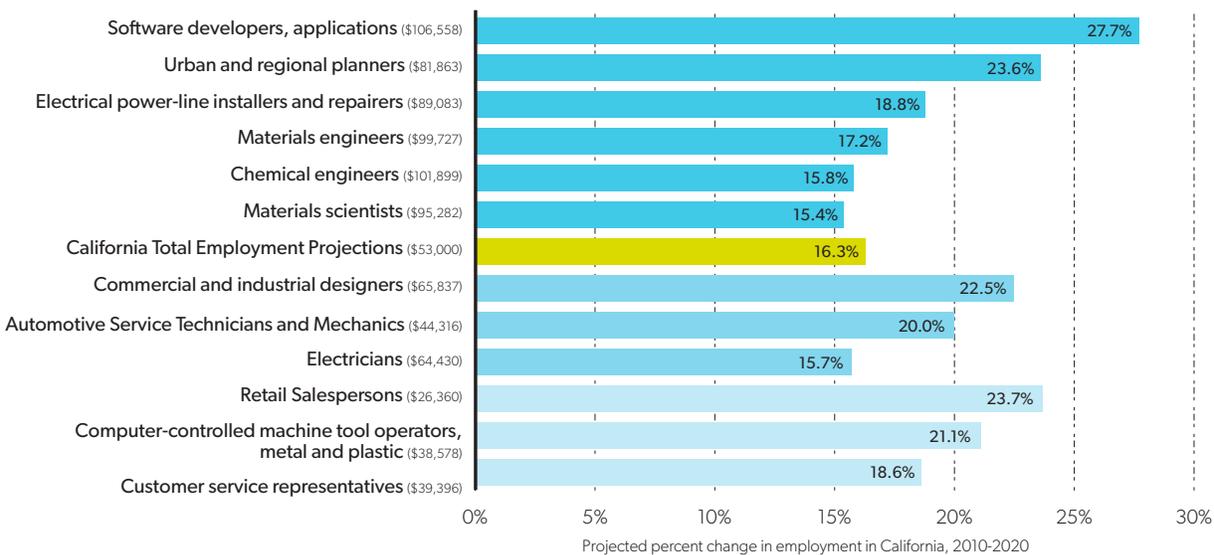
- ⬆️ Enhanced Skills Occupations
- ☀️ New and Emerging Opportunities
- ⬆️ Increased Demand

Data Source: California Employment Development Department, U.S. Bureau of Labor Statistics, and O\*NET Online  
 Analysis: Collaborative Economics

Figure 17

**Fast Growing Occupations in the Electric Vehicles Industry**

Employment Projections and Average Annual Wage  
California



Note: Average annual wage is from Q1 2013, employment projections are for 2010-2020.  
Data Source: California Employment Development Department, U.S. Bureau of Labor Statistics  
Analysis: Collaborative Economics

The biofuel industry has 23 occupations identified by BLS (Table 9) in areas such as scientific research, engineering, construction, agriculture, plant operations, and sales. All but two of these occupations have an average annual wage of more than \$40,000, and nearly half earn more than \$90,000 a year on average. Ten of the identified occupations typically require less than a bachelor’s degree education. In addition, five of these occupations have a Green Outlook of New and Emerging, showing the activities related to the biofuels industry has the potential to create the need for unique work and new occupations. In California specifically, 10 of these occupations have employment projections near or higher than the state average (Figure 18), all in occupations with average annual wages of more than \$40,000.

Table 9

**Common Occupations in the Biofuels Industry**

California

Occupation Title	State Average Annual Wage (Q1 2013)	State Employment (May 2012)	General Education Category	Green Outlook
Electrical engineers	\$108,737	24,110	🎓🎓🎓	+
Construction managers	\$106,782	22,100	🎓🎓	+
Industrial production managers	\$106,481	17,420	🎓🎓🎓	🌟
Chemical engineers	\$101,899	2,210	🎓🎓🎓	↑
Industrial engineers	\$98,778	20,680	🎓🎓🎓	↑
Civil engineers	\$97,058	34,900	🎓🎓🎓	🌟
Biochemists and biophysicists	\$96,078	5,980	🎓🎓🎓	Not available
Mechanical engineers	\$95,709	23,900	🎓🎓🎓	🌟
Environmental engineers	\$94,798	6,150	🎓🎓🎓	🌟
Wholesale and manufacturing sales representatives, technical and scientific products	\$92,085	48,000	🎓🎓🎓	🌟
Farmers, ranchers, and other agricultural managers	\$90,388	1,010	🎓	+
Microbiologists	\$86,594	3,580	🎓🎓🎓	Not available
Chemists	\$80,991	11,640	🎓🎓🎓	↑
Agricultural engineers	\$77,259	180	🎓🎓🎓	Not available
Soil and plant scientists	\$73,346	1,670	🎓🎓🎓	+
Buyers and purchasing agents, farm products	\$67,093	970	🎓🎓	↑
Operating engineers and other construction equipment operators	\$65,753	21,890	🎓🎓	↑
Industrial machinery mechanics	\$55,675	19,880	🎓🎓	↑
Chemical equipment operators and tenders	\$49,156	2,440	🎓🎓	↑
Chemical technicians	\$47,445	5,360	🎓🎓	↑
Construction laborers	\$43,198	85,000	🎓	+
Agricultural equipment operators	\$23,904	5,400	🎓	Not available
Farmworkers and laborers, crop, nursery, and greenhouse	\$19,259	164,310	🎓	Not available

**Average Wage Levels**

- 🟩 \$80,000 and up
- 🟨 \$40,000 - \$79,999
- 🟦 Below \$39,999

**General Education Category**

- 🎓🎓🎓 Bachelor's Degree or Higher
- 🎓🎓 Post-High School Training to Associate's Degree
- 🎓 High School Diploma or Less

**Green Outlook**

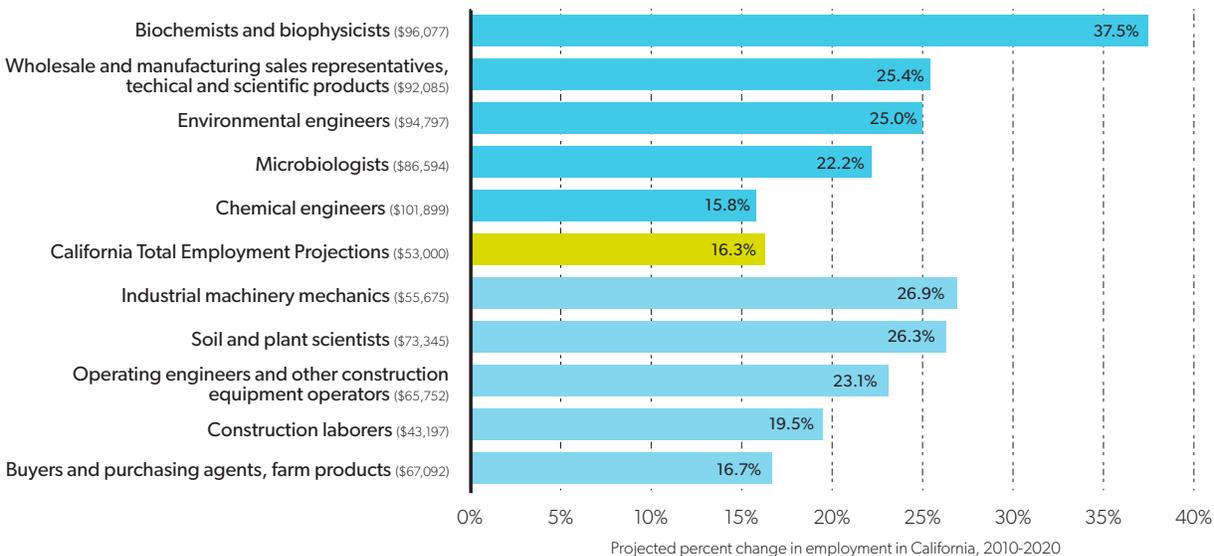
- ⊕ Enhanced Skills Occupations
- 🌟 New and Emerging Opportunities
- ↑ Increased Demand

Data Source: California Employment Development Department, U.S. Bureau of Labor Statistics, and O\*NET Online  
 Analysis: Collaborative Economics

Figure 18

**Fast Growing Occupations in the Biofuels Industry**

Employment Projections and Average Annual Wage  
California



Note: Average annual wage is from Q1 2013, employment projections are for 2010-2020.  
Data Source: California Employment Development Department, U.S. Bureau of Labor Statistics  
Analysis: Collaborative Economics

Many additional occupations have transferable skills that would be relevant in the biofuel and electric vehicle industries. O\*NET identifies more than 200 occupations that are related to the 42 occupations identified above. Of these related occupations, 28 occupations are projected to decline in employment in California between 2010 and 2020, and more than 100 are projected to grow at a slower rate than the statewide level of 16.3 percent. For example, Elevator Installers and Repairers (projected to have 0% growth 2010-2020) is a related occupation to Electricians and Electrical Power-Line Installers and Repairers, suggesting Elevator workers could move into these faster growing electric vehicle industry occupations with minimal training. California has the opportunity to retrain these workers in related occupations and shift them into growing occupations in the ARFV industry.

**Training the ARFV Workforce**

Many California workers will need to be trained for skills specific to the ARFV industry as the market grows. For example, an automotive service technician may need specialized training to work on the electrical systems in electric vehicles, and electricians may need specific

knowledge to install an electric charging station. California has already developed a number of training programs to start retraining workers. For example, Long Beach City College in Los Angeles County has developed an Advanced Transportation Technology Center to teach students about alternative fuels and automotive technology. The California Institute of Nanotechnology in San Jose has a program to become a Certified Electric Vehicles Technician. Through the Educating and Developing Workers for the Green Economy (EDGE) Initiative, UC San Diego Extension offers specialized Biofuels Certificates to train workers ranging from research and development scientists and engineers to field technicians and business development professionals.

While training programs such as these show progress throughout the state, there is still additional opportunity to train workers in specialized ARFV skills in this growing industry. The AB 118 RICO process will help close this training gap by working directly with regional ARFV industry employers to identify training needs and develop training programs.

## SPOTLIGHT: CALIFORNIA REGIONS DRIVING STATEWIDE GROWTH

California is a large and diverse state, with varying regional strengths, priorities, and assets. Therefore, regional as well as state-level actions are necessary to increase the ARFV market and contribute to economic growth statewide. The following profiles highlight ARFV industry activity occurring in the five regions participating in the AB 118 RICO grant (during 2013-2014) with the California Workforce Investment Board.

### Orange and Los Angeles Counties

Orange & Los Angeles Counties have the highest regional core employment in ARFV in California with about 2,500 jobs as of January 2011 (Figure 19). The region has the highest concentration of jobs in the Energy Storage and Alternative Motor Vehicles & Equipment segments in California, with about 870 and 970 jobs respectively (see Figure 15). Overall employment is down slightly in recent years however, and is now on par with 2007 levels of core employment.

#### Emerging Strength in Alternative Vehicles

The region has a growing strength in the Alternative Motor Vehicles & Equipment segment. Most of the companies in that segment are currently involved in vehicle component and engine technologies. The largest regional employers in this segment include IMPCO Technologies, which develops and manufactures products such as cleaner internal combustion engines, and Quantum Technologies, which develops and manufactures products such as natural gas vehicle systems.

The region is also increasing innovation activity in alternative vehicles, as shown by venture capital investment (see Figure 4) and patents registered in the region. Alternative fuel and vehicle patents more than doubled in 2011 compared to 2010 (Figure 20). Patents in Hybrid Systems and Electric Vehicles have accounted for most of the total patents in the region in recent years. Large automobile companies, including General Motors, Toyota, and Honda, have been the most active in patent registrations in the region.

#### Regional Support for Alternative Vehicles

The region has a number of supportive policies and organizations to accelerate alternative vehicle company growth and deployment of technologies. The SCAQMD, which includes both Los Angeles and Orange counties in its jurisdiction, has a number of programs and policies to promote alternative vehicles to help clean the region's air. Its Clean Fuels Program funds research, development, and deployment projects on low emission transportation technologies. They also have a requirement for government fleets and private contractors under contract with public entities to purchase non-diesel lower emission and alternative fuel vehicles.<sup>15</sup>

Regional government and business leaders, including local economic development groups, are also involved in supporting the regional ARFV industry. Both counties also have clean technology focused organizations that support innovative ARFV-related startups, including CleanTech OC in Orange County and Cleantech LA in Los Angeles. These organizations provide a range of services, including connecting companies to local research experts, educating stakeholders, advocating for favorable public policy, and fostering collaboration to increase regional economic growth and job creation in the industry.

Figure 19  
Core Employment by Segment  
Orange and Los Angeles Counties, 2001-2011

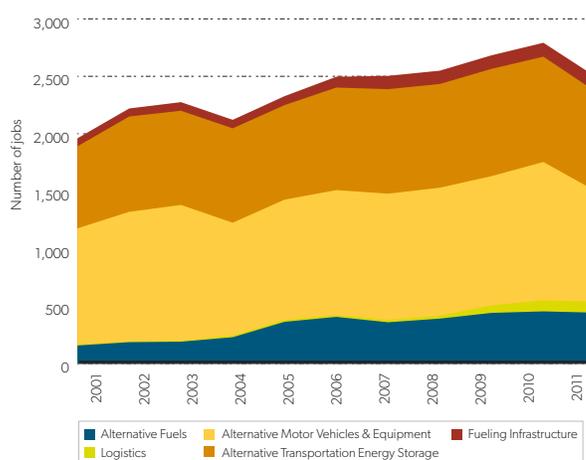
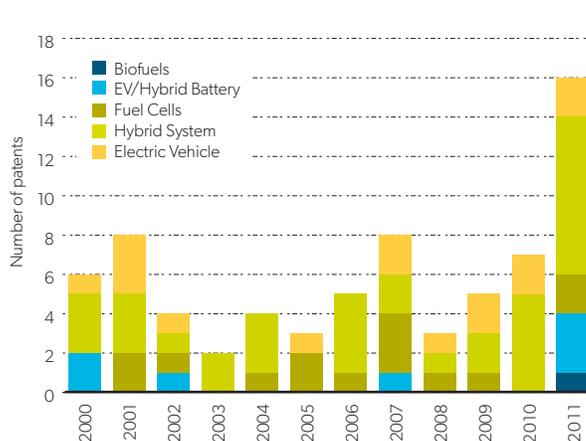


Figure 20  
Patents Registered  
Orange and Los Angeles Counties, 2000-2011



Data Source: National Establishment Time Series Database, Green Establishments Database, U.S. Patent Trade Office, 1790 Analytics  
Analysis: Collaborative Economics

## Silicon Valley

Silicon Valley's ARFV industry employed over 930 people as of January 2011, more than doubling the number of jobs since 2006 (Figure 21). The greatest share of employment was in the Alternative Fuels segment, with about 360 jobs in 2011. This segment is led by Codexis Inc., a biobased chemical company that employed over 200 people in 2011, while other companies in the segment are focused on developing next generation biofuels.

Alternative Motor Vehicles & Equipment, a segment that includes electric and hybrid vehicles, was the second-largest segment, employing nearly 300 people in 2011. The rest of the nine-county Bay Area includes an additional 650 jobs in this segment, suggesting regional specialization (see Figure 15). Fueling Infrastructure in Silicon Valley accounted for about 70 jobs, roughly half of which are electric vehicle charging companies in Silicon Valley.

### Emerging Leadership in Electric Vehicles

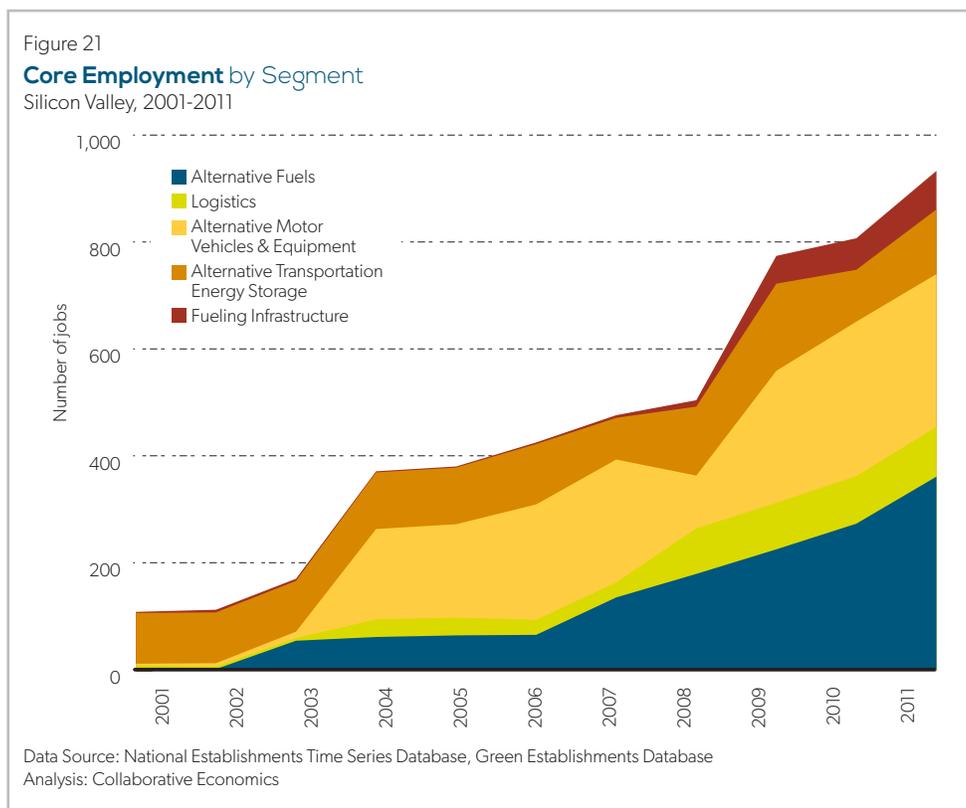
The concentration of electric vehicle jobs in the Bay Area including Silicon Valley, as well as local and state policies and programs to support electric vehicle growth, show an emerging cluster in the region. Silicon Valley is home to Tesla, a growing market leader in electric vehicles and a sector anchor for the region. In addition, the Bay Area has a high concentration of electric vehicles, with 38 percent of all clean vehicle rebates in the state issued in the region (see Table 3).

Silicon Valley has particularly high adoption rates, with 20 percent of all California rebates issued in the region despite having only seven percent of the state's vehicles.

Venture capital investments and patents in electric vehicle technology signal future growth in the segment. Since 2010, there has been \$740 million of venture investment into EV Charging Infrastructure and in Electric and Hybrid Vehicles (Figure 22). Silicon Valley also leads the state in the number of patents filed in the segment, having filed 14 EV/Hybrid Battery patents and five Electric Vehicle patents in 2010-2011 (see Figure 6).

### Regional Incentives for Electric Vehicles

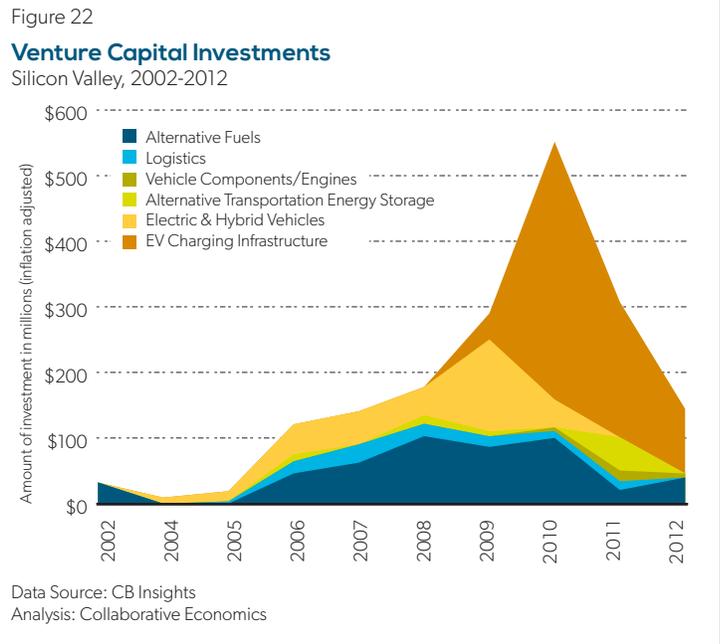
Policies at the regional level augment state incentives for electric vehicle adoption, encouraging regional residents and businesses to buy the vehicles and install charging infrastructure. For example, the City of San Jose runs a Clean Air Vehicle Program, offering residents with plug-in electric vehicles purchased from San Jose dealerships to park for free in selected city parking garages.<sup>16</sup> The City also implemented a streamlined residential permitting process to encourage the installation of home charging systems. The Bay Area Air Quality Management District (BAAQMD) also provides financial incentives throughout the region to promote the installation of home chargers. BAAQMD is also working to fund a network of Direct Charge fast charges in the Bay Area.



### Cross-Sector Collaboration to Promote Electric Vehicles

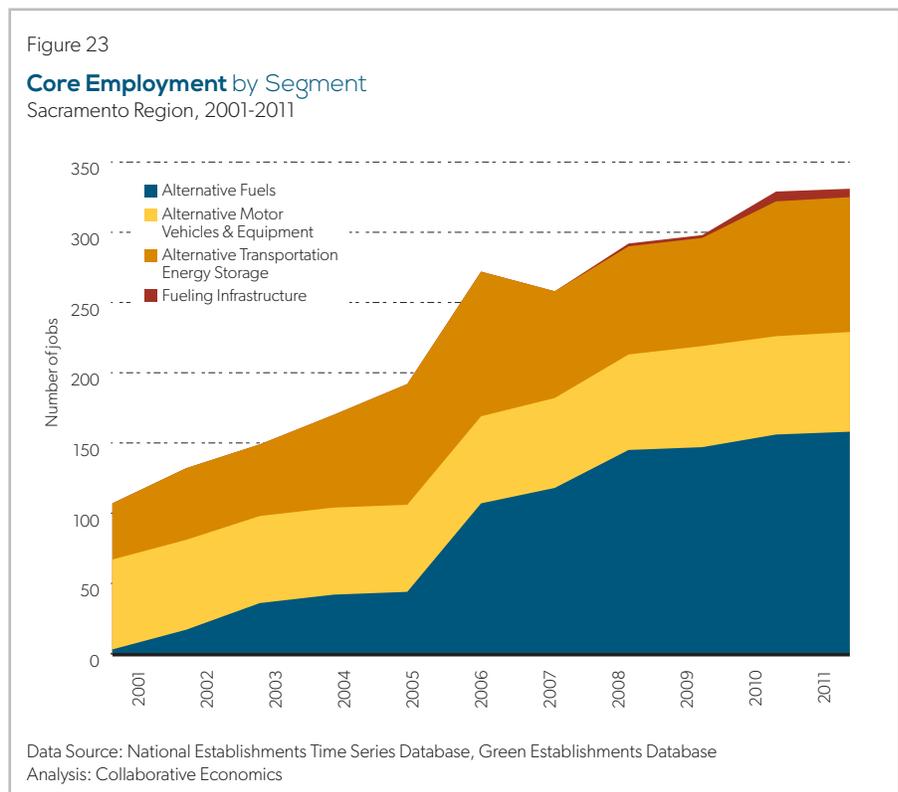
Leaders in Silicon Valley and the wider San Francisco Bay Area have worked together on a number of regional initiatives to prepare the region to support growth in electric vehicles. Working across sectors, these efforts have helped remove barriers to electric vehicle adoption while encouraging innovation in the segment. The Bay Area Electric Vehicle Strategic Council, for example, is an association of public and private sector leaders throughout the Bay Area, committed to making the Bay Area the "Electric Vehicle Capital of the U.S." Facilitated by the Bay Area Climate Collaborative, the Council has secured more than \$5 million in new funding to develop necessary regional infrastructure for new electric vehicles.

The Silicon Valley Leadership group, the region's leading public policy business trade organization and a member of the Bay Area Electric Vehicle Strategic Council, has also championed the acceleration of electric vehicle adoption in the region. A 2013 conference hosted by the Leadership Group convened regional leaders to discuss electric vehicle-related innovations being developed in Silicon Valley that can help accelerate the region's transition to sustainable transportation.



### Sacramento Region

The six county Sacramento Region's ARFV industry has been growing steadily over the past ten years, with a majority of people employed in the Alternative Fuels segment as of January 2011 (Figure 23). The Alternative Fuels segment includes biodiesel, ethanol, and other next generation biofuel companies performing a range of functions along the value chain. The segment has grown by 48 percent since 2006 in Sacramento, both in terms of research and development and production.



### Innovation in Biofuels

The UC Davis Institute of Transportation Studies serves as a strong research asset in the region, leading the state in research and policy analysis. This research capability, as well as a growing concentration of biofuel companies in the region, is helping to advance the Alternative Fuels segment in Sacramento.

As of 2011, a majority of Alternative Fuel and Vehicle jobs in Sacramento were in biofuel research and development. Davis-based Novozymes, the research and development arm of the Danish biotech company, is the largest employer in the segment, employing 65 people in 2011. The company has been responsible for two ethanol patents since 2008, both with applications in transportation. Novozymes maintains a close partnership with UC Davis as a source of talent and as a collaborative scientific partner.

CleanWorld, based in Gold River, uses anaerobic digestion technology developed in partnership with UC Davis to produce biogas from organic waste at Sacramento's South Area Transfer Station. In partnership with Atlas Disposal, a Sacramento-based waste hauler, the biodigester at Sacramento's South Area Transfer station will be used to power the company's fleet, replacing one million gallons of diesel per year. The facility is currently being expanded and when completed, will be the country's largest system of its kind. Research for CleanWorld's anaerobic digestion technology was patented by UC Davis Professor Ruihong Zhang after ten years of research and development.

Sacramento's Renewable Energy Testing Center, a 60,000-square-foot facility to support the development of biomass technology for electricity and transportation, is helping to accelerate the commercialization of biofuel technology in the Sacramento region. The Center is operated by Technikon LLC in coordination with the Renewable Energy Institute International. By providing space, as well as project management and finance expertise to Sacramento-based biomass companies, the Center is working to accelerate biomass technologies and companies in the region. The Center is currently home to four biomass companies, including Sierra Energy which uses waste gasification to create renewable transportation fuels.

### Biofuel Production & Applications to Transportation

Including CleanWorld's waste-to-energy digester, the Sacramento region has three biofuel production projects that generate transportation fuels including biodiesel and ethanol (Table 10)

While projects that use biogas to produce transportation fuel are relatively rare, the Sacramento region has multiple facilities that use biogas to produce electricity. These projects produce biogas from organic waste including agricultural waste or wastewater, and then combust that gas to generate electricity. The biogas could also be processed into renewable natural gas which can be used as a transportation fuel.

Table 10

**Biofuel Production Projects**  
Sacramento Region

	Location	Fuel Type	Project Initiated
West Biofuels Next Generation Bioethanol Pilot Plant	Yolo	Next Gen Ethanol	2008
Sierra Energy Renewable Energy Testing Center	Sacramento	Next Gen Biodiesel	2012
Clean World Partners Waste-to-Energy Digester	Sacramento	Biomethane (RNG)	2012

Data Sources: Bloomberg New Energy Finance, E2 Environmental Entrepreneurs, Renewable Fuels Association, Biodiesel Magazine, and National Biodiesel Board  
Analysis: Collaborative Economics

## San Joaquin Valley

The eight county San Joaquin Valley encompasses hundreds of square miles and a range of ARFV activities, from production of biofuels to installation of alternative vehicle infrastructure. Although San Joaquin Valley's ARFV sector has a relatively low concentration of workers, ARFV employment nearly tripled between 2001 and 2011, and was comparatively more specialized in Alternative Fuels than the state overall (Figure 24). Pacific Ethanol, Calgren Renewable Fuels, Edeniq and Cilion are among the larger biofuel employers in the region. Alternative Motor Vehicles & Equipment accounted for the second highest share of jobs in the ARFV sector, though involved only a few firms, largely related to medium- and heavy-duty vehicles.

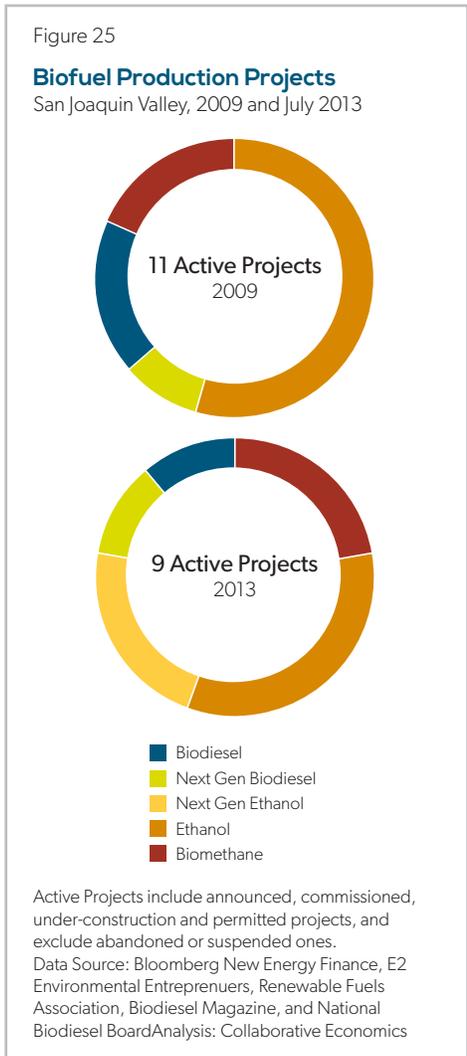
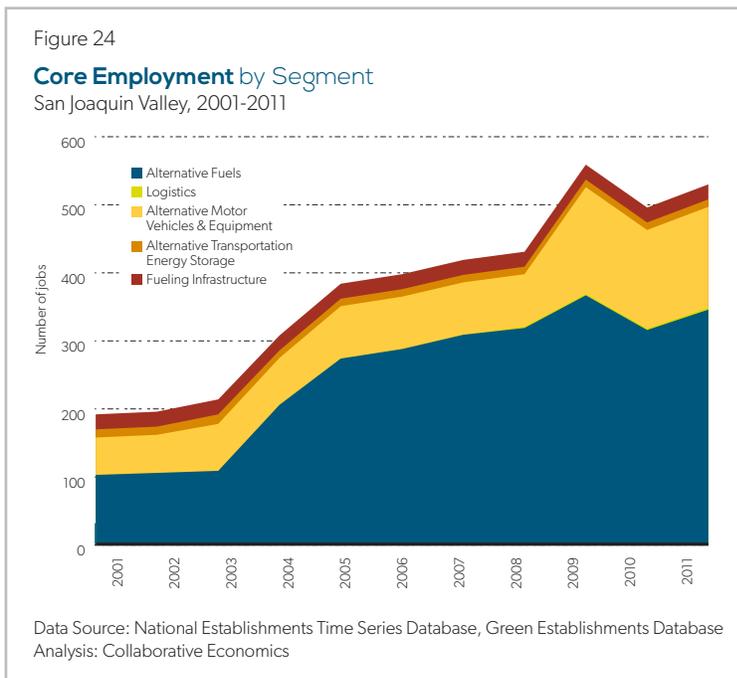
### Connecting ARFV with Sustainable Agriculture

Transportation biofuel production activity in the San Joaquin Valley has shifted over the past few years. The region had a total of 11 active projects in 2009 and decreased to nine active projects in 2013 (Figure 25). Production facilities that use first generation corn and soy feedstocks have been decommissioned and biofuel production has been further integrated into the regions' sustainable agriculture efforts. Several initiatives to explore next generation feedstocks and derive ancillary benefits from biofuels are currently underway in the region. For example, a research partnership between Fresno State University and the U.S. Department of Agriculture that launched in 2008 explored the viability of growing canola to manage agricultural waste products in the water supply, and then processing the oil into biodiesel.<sup>17</sup> The Mendota Bioenergy Five Points demonstration facility using beets to produce ethanol is another example; in addition to yielding ethanol, waste products can be used to produce biomethane and the facility recycles water for irrigation.

Although not directly related to transportation biofuels, considerable effort has been made to promote anaerobic digesters on dairy farms in the Central Valley, which can be used to produce electricity or supply the natural gas pipeline.<sup>18</sup> Some facilities, such as Hillarides Dairy, have already taken biogas a step further and compressed it into renewable natural gas to fuel vehicles. Although this represents an opportunity for the region, biomethane for transportation fueling has not yet been widely adopted.

### Promoting Adoption of Alternative Vehicles

The region has also incentivized adoption of alternative vehicle technologies through various local policies. Since 2012, the region has encouraged consumers to purchase alternative fuel light duty vehicles (include plug-in electric and natural gas vehicles) with a \$3,000 rebate. Targeting businesses, San Joaquin Valley Air Pollution Control District offers incentives to retrofit or replace medium- and heavy-duty diesel vehicles. It also encourages local governments to install alternative fueling infrastructure with rebates. To equip the workforce to service these vehicles, Air Pollution Control District also promotes alternative fuel vehicle mechanic training.



## San Diego and Imperial Counties

ARFV employment in San Diego & Imperial Counties is the most concentrated in the state of California. Core employment in the industry has increased by half since 2006 (increasing 58%), and in 2011 the share of ARFV jobs in the regional workforce overall was twice the rate in California overall.

Alternative Fuels is one of the region's most prominent segments, accounting for more than 550 jobs in the region in 2011 (Figure 26). Biodiesel-related jobs specifically have increased by more than 50 percent between 2006 and 2011. Although transportation logistics provided the highest number of ARFV sector jobs in the region in 2011, a handful of larger companies provided the most jobs; in contrast, the Alternative Fuels segment includes more than 35 establishments with roughly a third focused on biofuels research. Synthetic Genomics, Sapphire Energy and Verdezyne were among the largest employers in the Alternative Fuels segment in the region in 2011.

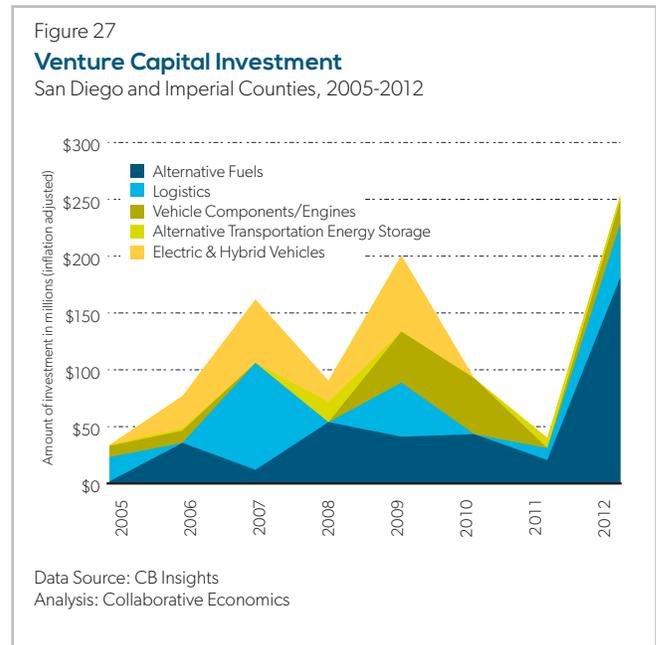
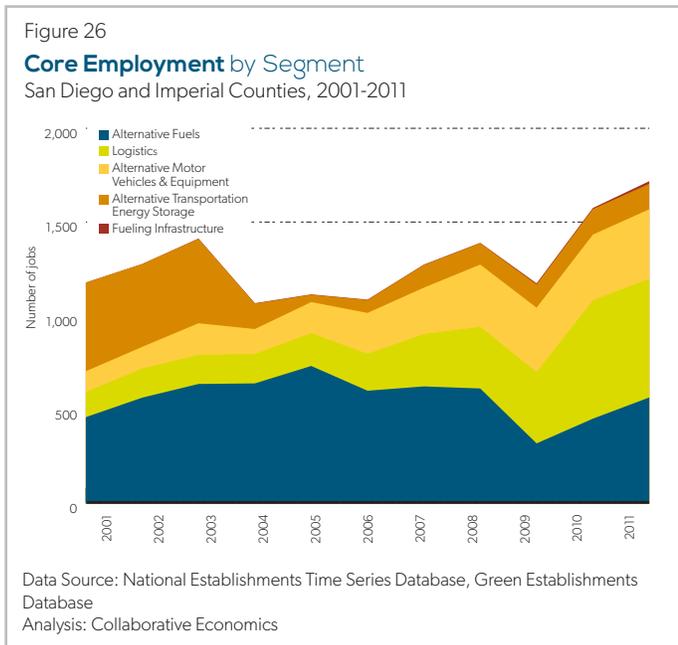
### Commercializing Next Generation Biofuels

The San Diego metro area has long been a hub of biotechnology research and development, and provides this central activity for the biofuels sector in the region. In addition to research at private companies, the region is home to multiple research centers, including the San Diego Center for Algae Biotechnology, which was founded by the University of California San Diego; the Scripps Institution of Oceanography; the Salk Institute; and San Diego State University. British Petroleum operates its Biofuels Global Technology Center in the region as well. Next generation

biofuels such as biodiesel produced from algae or jatropha, and cellulosic ethanol are prominent directions of research in the region.

Progress towards commercializing next generation biofuels and launching production facilities has been promising in San Diego & Imperial Counties. Six next generation biofuels projects (many of them demonstration scale) have been initiated since 2010, more than doubling the number of biofuel facilities in the region in just three years. In addition, the biofuels sector received more than \$181 million in investment in 2012 (Figure 27), and was second only to the San Francisco Bay Area (including the Silicon Valley) within California in biofuels investment levels. A widely touted \$144 million investment in Sapphire Energy drove much of the investment jump in 2012, though eight biofuels companies received capital over the period.

To strengthen its position as a leader in next generation biofuels, San Diego has already built up institutional infrastructure to upskill its biofuels workforce and foster cross-business collaboration. A group of economic development and education organizations launched the Educating and Developing Workers for the Green Economy (EDGE) Initiative, which offers certifications and training for technician as well as advanced scientific research positions at local colleges. CleanTECH San Diego, an economic development organization focused on expanding the clean economy, is one of the EDGE partner organizations and has also identified to connected biofuels businesses through its Biofuels Initiative.



## CONCLUSION AND RECOMMENDATIONS

This report shows that California stakeholders have made tremendous progress in the ARFV industry in the past ten years. Policymakers have implemented a number of laws and regulations that are helping stimulate the market and incentivize innovation in ARFV technologies, companies are developing innovative products and processes, and regions are capturing the economic benefits of market growth.

While the progress to date is impressive, there are still additional opportunities for supportive actions to grow markets, spur innovation, and create jobs. The ARFV industry has distinct opportunities and requirements for growth that can be most effectively advanced through regional industry partnerships and working together to leverage supportive state policies and programs. The following recommendations can help advance California's state and regional ARFV emerging clusters of opportunity:

### 1. **Focus on growing the ARFV industry as an economic development opportunity based on local strengths, not just social or environmental opportunities, to engage a broad coalition of partners.**

Economic prosperity and improving society and the environment are not mutually exclusive goals. California businesses have demonstrated the potential to grow while creating products that help the state attain its climate goals and increase local job opportunities. The ARFV industry provides an economic opportunity for California to be the leader in the advanced transportation market.

Regions can leverage local strengths to grow the ARFV industry locally. California is a diverse state and regions have developed specialties that can be assets for the ARFV industry. For example, Los Angeles has a number of large automobile corporations with research and design centers in the area that could be tapped to help develop the local alternative vehicle market. In addition, Silicon Valley has strengths in advanced manufacturing and entrepreneurship that could be leveraged to grow the local electric vehicle sector.

### 2. **Continue to lead in both stimulating market growth and driving innovation to support ARFV businesses and market readiness.**

California is at the forefront of the transition to ARFV, due in part to its supportive policies and programs that encourage market growth. However, other states are also targeting ARFV segments and creating competition for attracting businesses. Iowa, for example, leverages its agricultural strength to target the biofuels sector and their Economic Development Authority has a growth strategy around the biosciences industry.<sup>19</sup> States across the country also have academic partnerships to develop research strengths in ARFV, such as New Mexico State University's Algae Cultivation Testbed which has trained scientists for the algae biofuel sector.<sup>20</sup> California should maintain its leadership role in stimulating the market to provide a consistent market signal to the industry that the state is supportive of ARFV technologies and businesses.

An ongoing commitment to fostering a positive climate for innovation is also critical to the long-term growth of the industry. This includes financing research, development, and deployment projects through grants, loans, or underwriting to help businesses overcome funding hurdles in getting new technologies to commercial scale. AB 118, for example, should be renewed to help develop new ARFV technologies. Fostering innovation also includes development of partnerships at both regional and state levels to help entrepreneurs and scientists commercialize and scale their technologies. UC Davis Institute of Transportation Studies, for example, houses researchers that frequently collaborate with regional and state government and private sector partners on public policy, business and scientific issues.

Policy makers should ensure that ARFV and related policies do not have conflicting requirements or information. Policies and programs should also set firm goals, but strive to be technology agnostic, allowing businesses to innovate and find new solutions for achieving goals.

**3. Strengthen regional efforts to grow and capture the benefits of the ARFV industry for people and communities, leveraging state efforts to stimulate market growth and drive innovation.**

California regions have emerging prospects to advance the competitive position of the industry and increase economic prosperity. Stakeholders at the state level can support regional coalitions that mobilize employers, economic and workforce development organizations, and other partners to grow the local cluster. For example, the AB 118 grant for the RICO initiative is helping advance cluster growth and workforce preparation in the five grantee regions across the state.

Regions should also work with state and business partners to streamline and/or standardize the regulatory process for ARFV facilities and technologies to help companies grow. Site assessments and permitting processes, for example, are often time consuming processes that cost businesses and local officials money, yet are required for activities ranging from building a manufacturing facility or biofuel production site to installing an electric charging station. Regions can help reduce the burden on companies by, for example, providing assistance in shepherding them through the permitting process which can reduce delays that may arise, or creating a requirements checklist to alleviate common challenges. The RICO initiative will work with companies to tackle some of these issues in its five regions throughout the grant period.

Regional ARFV partnerships can also help meet the industry's infrastructure needs by identifying priorities and building support for investments. Infrastructure needs may range from access to water and roads for biofuel production to installing alternative fueling stations for consumers. For example, the Bay Area's Plug-In Electric Vehicle Ready program, led by the BAAQMD, helps prepare the region for EV growth through a needs analysis and recommendations for local and regional governments.

**4. Prepare the state's workforce on the regional level for careers in the local ARFV industry to support business expansion in the region.**

State and regional workforce organizations and academic institutions should prepare new and incumbent workers for local ARFV industry job opportunities. Initiatives such as RICO that bring workforce and economic development stakeholders together can help regional clusters grow and identify career pathways for local workers. Industry and workforce partners can help leverage local competitive advantages, such as the existing pool of higher-tech and engineering workers in Silicon Valley or plant operators and farming industry workers in Imperial County and San Joaquin Valley.

The ARFV industry presents new opportunities for workers across the spectrum, but these workers will need help identifying these career options and using their existing skills to transition to ARFV jobs. For example, an elevator installer may have electrician skills that could be used in installing electric vehicle charging stations with some retraining classes. Workers that are in declining occupations should be tapped for potential transition into ARFV jobs. In addition, ARFV occupations that are projected to grow should have an outreach and training strategy to build the local workforce. Regional workforce needs will depend on local opportunities, and workforce organizations should work directly with industry partners to develop recognized credentials and/or skill requirements for ARFV jobs.

The last decade experienced significant growth in the ARFV industry across California, bringing economic, social, and environmental benefits. Continued growth in the industry will depend on sustained partnerships and policy leadership to stimulate growth in the market, advance innovation, and ensure that economic benefits are captured in regional economies across California.

## APPENDIX

### Region Classifications

Regions are classified by using the five regions included in the AB 118 Regional Industry Clusters of Opportunity grant, and adding the rest of the Greater Bay Area region and the Rest of California where applicable.

For regional analyses, California counties are grouped into the following regions:

- **Bay Area without Silicon Valley:** Alameda, Contra Costa, Marin, Napa, San Benito, San Francisco, Santa Cruz, Solano, and Sonoma Counties;
- **Silicon Valley:** San Mateo and Santa Clara Counties
- **Orange and Los Angeles Counties:** Orange and Los Angeles Counties;
- **Sacramento Region:** El Dorado, Placer, Sacramento, Sutter, Yolo and Yuba Counties
- **San Diego Region:** Imperial and San Diego Counties;
- **San Joaquin Valley:** Fresno, Kern, Kings, Madera, Merced, San Joaquin, Stanislaus and Tulare Counties;
- **Rest of California:** All other counties.

### Investment in Advanced Transportation

Advanced transportation investment data are provided by CB Insights™ (www.cbinsights.com) and includes disclosed investment deals in private companies. Advanced transportation investment data is through December 2012. All figures have been adjusted for inflation using the U.S. city average Consumer Price Index of all urban consumers, published by the Bureau of Labor Statistics.

Each investment was reviewed and classified in one of the six categories based on primary company activities. The categories include: Vehicle Component/Engines, Batteries, Logistics, EV Charging Infrastructure, Electric & Hybrid Vehicles, and Biofuels.

Venture capital data includes Angel, Seed, Series A-E+, Growth Equity, Bridge, and Incubator series types. Public financing includes only grants and debt series with government entities listed as investors. Private financing includes venture capital, debt (excluding those with government investors), corporate investment, and unattributed series. Totals may not be the same across charts because of different investment types included.

### Advanced Transportation Patents

1790 Analytics developed and performed the search of U.S. Patent data from the U.S. Patent & Trade Office based on search criteria defined by Collaborative Economics for solar, wind, hydro and geothermal energy, batteries, fuel cells, hybrid systems, water, and energy infrastructure. Collaborative Economics used this clean technology patent database to identify those patents related to advanced transportation into five categories: Electric Vehicles, Fuel Cells, EV/Hybrid Battery, Hybrid Systems, and Biofuels. Fuel Cell patents include only those technologies related to vehicles (not stationary fuel cells). Biofuel patent were identified by analyzing Biotechnology patents that were fuel-related.

### Alternative Vehicle Registrations

Alternative vehicles included in the analysis are based on fuel types promoted in AB 118 using vehicle registrations by fuel type and by county, provided by the California Energy Commission.

### Clean Vehicle Rebates

Rebate data is provided by the Center for Sustainable Energy California for the Clean Vehicle Rebate Project and includes data available as of June 17, 2013. The Chevy Volt was not eligible for the rebate until February 2012; approximately 2,300 Chevy Volt's were sold in California before the Volt became eligible for the CVRP and, therefore, these vehicles are not reflected in the database. Data includes completed (paid), approved, and pending rebate applications, grouped by the date on which the application was received. Commercial zero emission vehicles are included under the separate Hybrid Voucher Incentive Program.

### Alternative Fueling Stations

Alternative fuel station installations include all public access stations as of July 2013 as identified by U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Alternative Fuels Data Center's Alternative Fueling Station Locator database. Biodiesel stations only includes those stations offering biodiesel blends of 20 percent (B20) and above. An electric charging station is listed as one location, regardless of the number of charging outlets at that location. The number and type of charging outlets available are available as additional details in the database.

### Biofuel Projects

Renewable fuel projects as of July 2013 include pilot, demonstration, and production plants for renewable and alternative fuels. Fuel types include biodiesel, ethanol, biomethane, and next generation biodiesel and ethanol (such as algae or cellulosic biofuel). Projects include announced, commissioned, under-construction and permitted initiatives, and exclude abandoned or suspended projects.

Projects were identified from multiple sources, including Bloomberg New Energy Finance, Environmental Entrepreneurs, Renewable Fuels Association, Biodiesel Magazine, and National Biodiesel Board. Projects were screened to remove duplicate entries if identified on multiple sites. Data is compiled by city and labeled by county, using regional classifications.

### Core Employment

Collaborative Economics has developed an approach for identifying and tracking the growth of businesses with primary activities in the Advanced Transportation industry. This methodology is based on the work carried out on behalf of Next 10, a California-based nonprofit, and published in the California Green Innovation Index and Many Shades of Green (2008, 2009, 2010, 2012, and 2013). Building on the resulting database, the Green Establishment Database, Collaborative Economics designed and conducted the nationwide analysis of green business activity on behalf of the Pew Charitable Trusts. The Pew Center on the States reformatted the results of the analysis and developed the report, The Clean Energy Economy (June 2009).

The accounting of Advanced Transportation establishments and jobs is based multiple sources (including standard industrial classification codes, Bloomberg New Energy Finance, CB Insights and CALSTART) for the identification and classification of advanced transportation businesses and also leveraged a sophisticated internet search process. Collaborative Economics designed the parameters of the internet search platform which was engineered by PlanetMagpie. The operational definition of advanced transportation is based on the technologies identified in AB 118, and is divided into five primary segments: Alternative Motor Vehicles & Equipment, Alternative Fuels, Fueling Infrastructure, Alternative Transportation Energy Storage, and Logistics. These categories are adapted from the Green Establishment Database segments, which were originally defined based on categories identified by the Cleantech Group,™LLC.

The National Establishments Time-Series (NETS) database, based on Dun & Bradstreet business-unit data, was sourced to extract business information such as jobs. The jobs numbers reported in the database reflect all jobs at each business location in January of that year. In the case of multi-establishment companies, only the advanced transportation-related establishments are included. While this approach does not examine specific occupations that are appearing across the entire economy (such as Chief Sustainability Officer), it does account for the businesses behind the products and services that these new professionals need to use in their jobs (such as high-efficiency materials in batteries, engineering for advanced vehicles, and electricians to install charging infrastructure).

The multi-layered process involves both automated and manual verification steps of business establishments and their activities. In cases where the results were uncertain and the activities of a business establishment could not be verified (e.g. on a company's website), the establishment was dropped from the database. Therefore, the database offers a conservative analysis for the numbers of establishments and jobs in the Advanced Transportation industry.

### Occupations

Occupation data is based on the Bureau of Labor Statistics analysis of key occupations in green careers, as listed in "Careers in Biofuels" (January 2013) and "Careers in Electric Vehicles" (September 2011). These analyses include occupations throughout the value chain, ranging from research and design, to production, to deployment and maintenance.

The key occupations identified were cross referenced by Standard Occupation Classification code with multiple data sources to show skills and education required, current employment characteristics, and future demand projections. Additional data sources included:

- Bureau of Labor Statistics "Education and training categories by detailed occupation" employment matrix
- O\*NET Green Economy, green occupation research and screening analysis
- California Employment Development Department, "Projections of Employment by Industry and Occupation" and "Occupational Employment Statistics (OES) Survey Results, Employment and Wages by Occupation."

## ENDNOTES

1. Governor's Interagency Working Group on Zero-Emission Vehicles. "ZEV Action Plan – A roadmap toward 1.5 million zero-emission vehicles on California roadways by 2025." February 2013. Office of Governor Edmund G. Brown Jr. [www.opr.ca.gov](http://www.opr.ca.gov)
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