

# California's Clean Transportation Technology Industry



TIME TO SHIFT INTO HIGH GEAR

August 2016





## About This Brief

This brief provides an update on California's clean transportation technology industry (CTTI). The brief explores how the CTTI benefits the state, where growth opportunities are found among three key regions, and what role public policies have played and need to play to make the industry succeed—that is, to “shift into high gear.”

This brief was produced by CALSTART. It was written by Ryan Schuchard with contributions from John Boesel, Bill Van Amburg, Chase LeCroy, and Molly Miller.

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Front cover: San Joaquin Regional Transit District passengers boarding an all-electric bus from Proterra in Stockton (top left), a worker at the BYD electric bus factory in Lancaster (top right), a production line for the all-electric Tesla Model S car in Fremont (bottom right), and the ribbon-cutting ceremony for a new biodiesel facility operated by Biodico in Five Points, with Commissioner of the California Energy Commission, Janea Scott (bottom left). Back cover: California map by Michael Thompson and the Noun Project.

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# Executive Summary

**California's growing clean transportation technology industry (CTTI) is ready to shift into high gear on its way to becoming a major economic force in the state and nation.**

To facilitate this transition, the state government must provide support in order to ensure that new technologies developed by CTTI companies, entrepreneurs and investors will become widely used by 2030. This is necessary for California to meet its ambitious, trendsetting air quality and climate protection goals.

More than 300 CTTI companies employ over 20,000 workers in California, and the industry is just getting started. Areas with strong potential for growth include:

**Light-duty electric vehicles:** Tesla Motors, the first start-up auto company in the U.S. since WW II, plans to increase its California employee base from 9,000 to more than 15,000 by the end of 2017. Other auto firms are exploring electric vehicle manufacturing opportunities in the state.

**Clean medium and heavy-duty vehicles:** Several companies have started manufacturing facilities in Southern California to produce clean buses, trucks, components, and fuels.

**Advanced technology engines and components:** Several start-ups are leveraging California engineering and technical talent to build a new generation of engines and parts. For instance, Achates Power, a San Diego firm that is developing a more efficient engine, has secured contracts with major manufacturers around the world.

**Clean, low-carbon fuel production and distribution:** California is now home to over 20 low-carbon biofuel plants. Companies in the San Joaquin Valley (SJV) are producing biofuel with very low lifecycle carbon emissions and making progress toward commercializing carbon-negative renewable natural gas (RNG).

More than 300 Clean Transportation Technology Industry (CTTI) companies employ over 20,000 workers in California, and the industry is just getting started.

**New mobility services:** The Bay Area is a national focal point for the development and growth of ride hailing and new mobility services. The opportunity to link zero-emission cars

with these new services and autonomous vehicle controls could have a major impact on the automotive sector.

**A second automotive center:** Auto design studios have been located in Southern California for decades. Over the last five years, an even greater number of car companies and Tier 1 automotive suppliers have opened Silicon Valley offices. CALSTART estimates that approximately 2,000 autoworkers are now employed in the Bay Area, in addition to those working for Tesla.

## A Center of the Emerging Global CTTI

California's CTTI has grown into a diverse network of vehicle manufacturers, fuel producers, component suppliers, and service providers. These companies are found throughout California, with growth under way especially in the South Coast, San Joaquin Valley, and Silicon Valley (see Figure 1).



*Figure 1: CTTI companies are found throughout California and have strong growth opportunities in the South Coast, San Joaquin Valley, and Silicon Valley.*

Industry executives credit this growth to steps taken by the state's governors, lawmakers, and state agencies. Bold policy goals that support CTTI expansion include: 80% reduction in greenhouse gas emissions by 2050, a 50% petroleum reduction by 2030, and 1.5 million zero-emission vehicles on the road by 2025.

In addition, the state has fueled growth of the CTTI by providing funding for technology development and demonstration, vehicle and infrastructure purchase incentives, job training, and construction of new manufacturing plants.

If sufficient policy support continues, we can expect to see major advances take place over the next 10 to 15 years, with vehicle and fuel technologies that are in early stages of commercialization today becoming widely cost-competitive and attaining mass-market status. Direct job growth in the industry could be measured in the tens of thousands.

### Help is Needed

The CTTI remains a young industry that is just hitting its stride. Achieving continued growth and meeting California's ambitious goals will require ongoing public-private partnership and significant, consistent and sustained commitment. We offer policymakers three main recommendations:

- 1) **Stay on the Pedal by Solidifying Targets and Extending Programs to at Least 2030.** Make California's target of 40% greenhouse gas (GHG) reduction by 2030 a legal statute, while reauthorizing and extending Cap and Trade and the Low Carbon Fuel Standard (LCFS) well beyond 2020.

- 2) **Require Top Performance with Strong Yet Feasible Air Quality and Climate Standards.** Maintain and extend ambitious but feasible standards for Advanced Clean Transit, ZEV Mandate, Phase 2 Medium and Heavy GHG Standard, Light Duty Fuel Efficiency Standards, and the LCFS, while continuing to strive for being technology-neutral and flexible.
- 3) **Give the Needed Boost by Providing Sufficient Incentives to Meet the State's Bold Goals and Mandates.** Increase the amount of funding to Low Carbon Transportation from Cap and Trade while incorporating multiyear funding commitments, with \$2 billion cumulatively for the three years of FY 2016-17, FY2017-18, and FY 2018-19 (an average of \$650-700 million per year).

By implementing these recommendations, California can leverage its leadership in agriculture, energy, technology, and design to both meet its ambitious goals and become a national and international center of the CTTI for decades to come.

# Clean Transportation Technology's Contribution

**California has developed the world's strongest policies to reduce air pollution and greenhouse gas (GHG) emissions from transportation (see Figure 2).**

The state is pursuing these policies for good reason. Eight in ten Californians live with unhealthy air, and the state is home to the five most polluted U.S. cities for ozone and particulate matter, as well as the only two areas with pollution levels classified by the U.S. Environmental Protection Agency as extreme.<sup>1</sup> Since the federal Clean Air Act was established in 1975, California has yet to come into compliance.

Also, California is vulnerable to climate change, which threatens public safety and undermines the economy. Climate change is expected to worsen California's droughts, wildfires, smog, and dust, as well as diminish water supplies from snowmelt and contribute to sea level rise. These effects are already being felt.<sup>2</sup>

## Why Clean Transportation Technology?

California's air pollution is due largely to burning petroleum for transportation. The combustion produces ozone-forming nitrogen oxide (NOx) and particulate matter, better known as smog, that causes cardiovascular and lung disease.<sup>3</sup>

Eight in ten Californians live with unhealthy air, and the state is home to the five most polluted cities in the nation for ozone and particulate matter.

Additionally, transportation accounts for 37 percent of total GHG emissions in California, the largest contributor to global climate change among all sectors in the state.<sup>4</sup> The share is nearly half when considering emissions from the drilling and refining of oil required to produce gasoline and diesel fuel.

California's Clean Transportation Technology Industry (CTTI) is addressing these challenges by producing cleaner and more efficient vehicles and fuels, while creating well-paying jobs throughout the state and improving competitiveness for California as a whole. Today the CTTI in California is made up of hundreds of companies (see Appendix for a list of 300 firms).

## Growth of High Quality Jobs

The CTTI is a major employer in California, providing over 20,000 jobs including around 3,000 in liquid fuels and 1,000 in vehicle charging.<sup>5</sup> The largest of these is Tesla Motors, with 9,000 workers. Tesla aims to grow its workforce to 15,000 by 2017.

Other high tech firms are preparing to produce electric cars, which we estimate could lead to more than 25,000 jobs in zero-emission car manufacturing in California by 2020. These and other CTTI companies are profiled in the following pages.

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<sup>1</sup> American Lung Association (2016). State of the Air 2016.

<sup>2</sup> California Environmental Protection Agency (2012). California's Third Climate Change Assessment.

<sup>3</sup> California Office of Environmental Health Hazard Assessment (October 2014). CalEnviroScreen 2.0.

<sup>4</sup> Air Resources Board (June 2015). California Greenhouse Gas Emission Inventory.

<sup>5</sup> AEE Institute (2016). Advanced Energy Jobs in California.

At the same time, California's CTTI creates jobs in other industries. The state's wider auto sector has expanded by more than 25 percent since 2011 to 47,000 jobs today, due in part to investments in clean transportation technologies.<sup>6</sup>

Similarly, as California pursues the goal of widespread transportation electrification, the state is poised to expand its base of in-state jobs for advanced grid technologies (19,000 jobs today) and advanced energy production (142,000 jobs today).<sup>7</sup>

**FIGURE 2: CALIFORNIA AIR QUALITY AND CLIMATE GOALS**

Ongoing	<ul style="list-style-type: none"> <li>Widespread transportation electrification (SB 350, 2015)</li> <li>25% of Cap and Trade investments providing benefits to, and 10% located within, disadvantaged communities (SB 535, 2012)</li> </ul>
2019	<ul style="list-style-type: none"> <li>Air quality attainment to 35 µg/m<sup>3</sup> 24-hour standard for San Joaquin Valley (ARB, 2014)</li> </ul>
2020	<ul style="list-style-type: none"> <li>GHG reduction to 1990 levels (AB 32, 2006)</li> <li>10% reduction of carbon intensity of transportation fuels (LCFS, reauthorized 2015)</li> </ul>
2021-25	<ul style="list-style-type: none"> <li>Air quality attainment to 12 µg/m<sup>3</sup> annual PM 2.5 standard for four regions (Imperial Valley, San Joaquin Valley, South Coast) (US EPA)</li> </ul>
2023	<ul style="list-style-type: none"> <li>Conversion of heavy duty fleets to New Technology Diesel Engines (NTDE) (ARB, 2014)</li> </ul>
2025	<ul style="list-style-type: none"> <li>1.5 million zero-emission vehicles (ZEVs) on road (Executive Order [EO] B-16-12, 2013)</li> <li>15% of new cars sold by major manufacturers are ZEVs (estimate based on most likely compliance scenario) (ZEV Program, 2012)</li> </ul>
2030	<ul style="list-style-type: none"> <li>40% GHG reduction from 1990 levels (EO B-30-15, 2015)</li> <li>50% petroleum reduction (Commitment in inaugural address, Governor Brown, 2015)</li> </ul>
2031	<ul style="list-style-type: none"> <li>Air quality attainment to 75 ppb 8-hour ozone standard for San Joaquin Valley and South Coast (US EPA)</li> </ul>
2037	<ul style="list-style-type: none"> <li>Air quality attainment to 70 ppb 8-hour ozone standard by 2037 (US EPA)</li> </ul>
2050	<ul style="list-style-type: none"> <li>80% GHG reduction from 1990 levels (EO S-3-05, 2005)</li> <li>100% of new cars are ZEVs (MOU with ZEV Alliance, 2015)</li> </ul>
Additional commitments are being developed for the post-2020 Climate Change Scoping Plan, LCFS, 2030 Mobile Source Strategy, Short-Lived Climate Pollutants Strategy, and Sustainable Freight Action Plan.	

### A Rush of New Manufacturing

A rush to develop new vehicle production facilities is under way. Original equipment manufacturers (OEMs) that have recently built plants in the state include BYD, Complete Coach Works, Proterra, Motiv Power Systems, TransPower, Wrightspeed, and Karma—all makers of zero-emission vehicles, or ZEVs (i.e. plug-in electric and fuel-cell vehicles). These investments follow a decade when very few new automotive plants were built in North America.<sup>8</sup>

<sup>6</sup> Jerry Hirsch (November 2015). The Future of the Automobile is Being Reshaped in California. LA Times.

<sup>7</sup> AEE Institute (2016). Advanced Energy Jobs in California.

<sup>8</sup> Robert Carr (December 2015). What's Behind the Recent Rise in Auto Plant Development. National Real Estate Investor.

Proterra, an all-electric bus maker based in South Carolina, has opened a 34,000 square-foot office and R&D center in Silicon Valley, and built a manufacturing plant in Southern California with a grant from the California Energy Commission (CEC). Proterra CEO Ryan Popple predicts, "With transit buses alone, if we hit our 2020 production targets, we will have 1,200 employees at our factory in California."

Proterra shows how successful CTTI businesses create jobs for suppliers, noting, "Our supply chain consists of hundreds of parts and 2,400 jobs could be created as a result of our expansion. That's a total of 3,600 jobs in Southern California and the southern end of the Central Valley." Among those are employees from the company's body components supplier, which has relocated to California.

BYD, a Chinese manufacturer of electric buses, trucks, and cars, has focused its expansion on the Golden State, where it has built an electric bus factory in Lancaster. This is the first Chinese auto manufacturing plant in the United States. BYD opened its doors in 2014 to create 300 jobs in the region, which at the time faced 10.9 percent unemployment. BYD expects to grow its workforce to 900 by 2018.<sup>9</sup>

Proterra and BYD are two of many CTTI firms that have moved to the Golden State. Although California is sometimes labeled as a place where regulations make it hard to do business, CTTI companies say that the state's commitment to forward-looking policies is a top reason that future business opportunities in the state look bright.

### Transformative Investments

California's private and public sectors have made, and continue to make, major investments in CTTI. These include several investments of over \$1 billion in electric car manufacturing alone (see Figure 3). If California stays the course, we can expect to see investments of this size in component and low-carbon fuel production as well.

#### FIGURE 3: BILLION DOLLAR BETS ON CALIFORNIA CAR COMPANIES AND PRODUCTS

The CTTI has generated several investments of more than \$1 billion to launch new electric vehicle manufacturing facilities in and around California:

**Apple** is developing an electric car product that already involves an investment of hundreds of employees, according to news sources. A car could potentially be on the market by 2019.

**Atieva**, a battery company owned by Beijing Automotive Industry Corporation (BAIC) and based in Menlo Park, has announced plans to build electric cars.

**Faraday Future**, backed by Chinese billionaire Jia Yueting, has announced plans to build electric cars with headquarters in California.

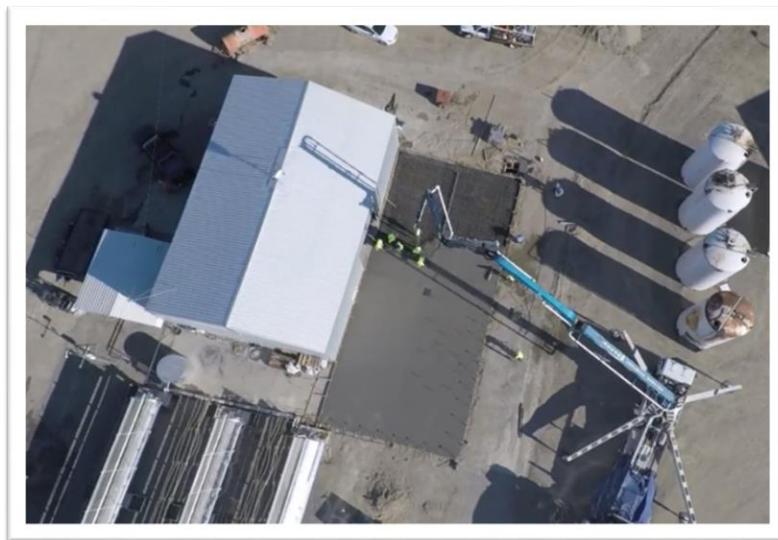
**Google** has made a major investment in autonomous vehicle technology and appears poised to launch a car venture or partnership with an existing OEM.

**Karma** is hiring more than 100 engineers to produce an electric car. Karma has grown out of Fisker, which produced a gas-electric vehicle before it went bankrupt in 2013 and was purchased by Wanxiang Group.

**Tesla** has created 9,000 jobs in California, with 5,000 in manufacturing. Tesla has 80 suppliers in the state.

<sup>9</sup> Kyle Field (October 2015). A Look Under the Hood at the BYD Electric Bus Factory. CleanTechnica.

Fuel producers continue to build major production facilities, with over 20 biofuel production plants throughout the state currently producing what is expected to be 190 million gallons by the end of 2016 (see Figure 4)). Two plants for renewable diesel (biomass-based petroleum diesel) are being developed with support from the CEC.



*Figure 4: Biodico liquid biofuel facility under construction in western Fresno County during 2015. The plant, one of several providing jobs in the San Joaquin Valley, uses energy generated entirely by distributed renewable heat and power.*

The CTTI is a top source of venture capital for California and the U.S. In 2015, clean transportation represented the largest share of venture capital investment in the U.S. (\$3.7 billion), and 90% of the amount (\$3.4 billion) went to California. The same year, 60% of California's clean tech venture capital was for the CTTI.<sup>10</sup>

### **Across the Board Impact**

Companies are developing clean transportation technologies throughout California, bringing capital and opportunities to revitalize communities in Stockton, Riverside, and Lancaster, and stimulating additional regional investment.

About three quarters of companies in California's advanced energy industry have fewer than 25 employees.<sup>11</sup> CTTI firms in this category include biofuel producers and refiners, component and conversion service providers, and entrepreneurs for grid technologies. Additionally, many construction and other short-term positions are opening up as new small business production facilities come on line.<sup>12</sup>

CTTI investments expand existing industries. The information technology (IT) industry has long been a major partner with the automotive industry, and now IT companies are developing software to create networked and automated vehicles, make engines run more efficiently, enable zero-emission and hybrid power trains, and connect electric vehicles to the grid.

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<sup>10</sup> Next 10 (2016). 2016 California's Green Innovation Index.

<sup>11</sup> AEE Institute (2016). Advanced Energy Jobs in California.

<sup>12</sup> For example, see: California Energy Commission (2016). 2016-17 Investment Plan Update for the Alternative and Renewable Fuel and Vehicle Technology Program.

## Benefits for Communities That Need Them

The CTTI is producing technologies that are vital for disadvantaged communities (DAC). In these communities, zero-emission trucks and buses as well as near-zero-emission versions (such as ultra-low-NOx natural gas vehicles discussed later in the South Coast section) immediately reduce pollution by displacing vehicles that create ozone and emit particulate matter.



*Figure 5: San Joaquin Regional Transit District passengers boarding an all-electric bus from Proterra in Stockton, made possible by a grant from the CEC. Other zero-emission bus (ZEB) manufacturers include BYD, Complete Coach Works, ElDorado National, Motiv Power Systems, New Flyer Industries, Nova Bus, TransPower, US Hybrid, and Wrightspeed.*

In addition to SJRTD (see Figure 5), over a dozen California transit agencies have deployed more than 100 electric and fuel cell transit buses. Just a single electric bus manufacturer, BYD, is already providing buses to at least six transit agencies in the South Coast region serving routes in and around disadvantaged communities.<sup>13</sup>

California's public policies such as the Mobile Sources Strategy and Air Quality Improvement Program (AQIP) are successfully using clean transportation technologies to improve air quality.

Policies designed to reduce GHG emissions are cutting air pollution as well. For example, the Low Carbon Fuel Standard (LCFS), which aims to reduce the carbon intensity of California's transportation fuel pool by ten percent from 2010-20, has encouraged the deployment of clean vehicles and fuels which have helped the state to save an estimated \$1.6 billion in potential public health impacts.<sup>14</sup>

Because of the many benefits that clean transportation technologies create for DACs, the CTTI is a powerful ally for helping agencies to comply with Senate Bill 535 (2012), which requires that 25% of Cap and Trade investments provide benefits to DACs and 10% of investments be located within DACs.

## Electric Cars Entering Lower-Income Communities

With support from the California Air Resources Board (ARB), Los Angeles is launching a novel pilot program that has deployed 100 vehicles to provide electric ridesharing

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<sup>13</sup> Transit agencies include Anaheim Transportation Network, Antelope Valley Transit Authority, Gardena Municipal Bus Lines, LA Metro, Long Beach Transit, and UCLA.

<sup>14</sup> Estimate by California Delivers as of June 2016 based on LCFS Compliance Report and Driving California Forward Study

to 7,000 residents. While this initiative is just starting out, it may provide a model for using clean ridesharing to help meet the needs of underserved populations.

At least two electric cars, the Chevrolet Bolt EV and Tesla Model 3, will approach the average new auto price at just under \$35,000 by 2017. Leases for new EVs have been found for \$150 per month. As prices continue to fall and more models enter the market, EVs will become increasingly accessible.

The Enhanced Fleet Modernization Program's "Plus-up" project, a state program, gives the lowest income families up to \$12,000 toward electric car purchase, and battery prices have also dropped, from \$600-\$1000/kwh to less than \$250-\$300/kwh over the past five years.

The Zero-Emission Truck and Bus Pilot Commercial Deployment Project (ZE Truck and Bus Pilot Project), which supports large-scale deployments of commercial zero-emission vehicles, requires that at least half of its funding goes to projects in DACs. Commercial ZE deployments can be targeted to the most affected areas using CalEnviroScreen, a map tool that identifies DACs neighborhood-by-neighborhood.

### **Saving Money with More Advanced Fuels**

Transit agencies report that zero-emission buses are reducing fuel and maintenance costs. For example, SJRTD is using Proterra electric buses that are five times more fuel-efficient than diesel and which will save 520,000 gallons of diesel over their lifetimes.<sup>15</sup> For SJRTD, even without GHG emission and air quality benefits, electric

drivetrains make sense.

The Low Carbon Fuel Standard (LCFS) saves money, reduces dependence on volatile oil imports, and improves air quality.

Still, the adoption of commercial plug-in electric and fuel cell vehicles require high capital costs. The LCFS provides incentives to help offset them. By one estimate, the LCFS reduces costs \$0.07-\$0.14 per mile when the credit price is

in the midrange (\$60-120). Currently, LCFS credits cover 60 to 80 percent of the annual cost of the electricity required to power electric buses for Foothill Transit.

Also, at least five California municipal fleets—Carlsbad, Long Beach, Oakland, San Francisco, and Walnut Creek—have begun using renewable diesel (RD), a biomass-based petroleum diesel with a carbon footprint that is 60-70% lower than conventional petroleum diesel. This switching has been made possible by the LCFS, which makes RD and other biofuels cost-competitive with petroleum-based diesel.

Because the LCFS is such an important driver of fuel savings, a group of transit agencies has recently written to California lawmakers asking for the LCFS to continue well beyond 2020. The letter notes that in addition to saving money, the LCFS reduces dependence on volatile oil imports, improves air quality, and has a negligible impact on the retail price of conventional fuel.<sup>16</sup>

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<sup>15</sup> San Joaquin RTD (February 2015). San Joaquin RTD receives FTA funding for Electric Buses.

<sup>16</sup> Letter to Senate President Pro Tom Kevin De León and Speaker Anthony Rendon (June 16, 2016), titled "California Transit Agencies Support the Low Carbon Fuel Standard." Available at [www.calstart.org](http://www.calstart.org).

# Key Regional Benefits and Opportunities

In order for California to meet its demanding air quality and climate goals, new clean transportation technologies are needed for a wide array of settings, from passenger cars in Los Angeles to big rigs hauling produce from Fresno to the Port of Oakland.



*Figure 6: CTTI growth opportunities are found throughout California's South Coast, San Joaquin Valley, and Silicon Valley.*

Across the range of clean vehicle, fuel, and related transportation technologies, CALSTART has identified key areas of growth potential for California. These opportunities are concentrated in the South Coast, the San Joaquin Valley, and Silicon Valley (see Figure 6).

California's air quality and climate goals call for the commercialization of clean transportation technologies that are in some cases ready for large-scale deployment and in other cases still several stages away from commercial use. In order to achieve the state's goals, coordinated and sustained policy support is needed through sequential stages of technology development (see Figure 7).

The following pages document progress that has been made in the South Coast, San Joaquin Valley, and Silicon Valley, and highlight key growth opportunities that are expected if the industry and policymakers continue to work together to bring new technologies through these commercialization stages to market.

## FIGURE 7: KEY COMMERCIALIZATION STAGES FOR CLEAN TRANSPORTATION TECHNOLOGIES

Stages of development that require coordinated, sustained investment include:

**Fundamental Research and Standardization:** Studies on advanced technology business cases and technology feasibility, and development of standards for operability. Examples: Charging standards and business case for ZE trucks.

**Technology Development:** Development of components, subsystems, and complex drivetrain systems, with focus on performance improvements and cost reduction. Examples: Advanced engines such as opposed-pistons and enabling technologies such as lightweight storage tanks.

**Small Early-Stage Demonstrations:** Integration of new truck and bus technology into 1-5 vehicles in order to evaluate technical performance and identify needed improvements. Examples: Zero-emission "big rig" trucks for short haul and optimized alt fuel engines.

**Larger Pre-Commercial Demonstrations:** Support for larger scale deployments of up to 50 vehicles in order to evaluate real world performance in the field at commercial scale. Examples: Zero-emission buses and trucks for short haul applications.

**Early Commercial Deployment:** Long-term vehicle buy-down incentive programs to increase market penetration; performance-based fuel infrastructure funding tied to vehicle incentives. Examples: Deployment incentives for hybrid, electric, and natural gas trucks.

## THE SOUTH COAST

The South Coast, which includes the counties of Los Angeles, Orange, Riverside, and San Bernardino (see Figure 8), is home to approximately 17 million Californians, or nearly half of the state's population.



Figure 8: South Coast counties.

A birthplace of car culture, the South Coast is a hub of design for the auto industry. Southern California receives 40 percent of the country's freight imports through its two major ports, the Port of Los Angeles and Port of Long Beach.

Although much has improved since the 1950s, when the region became famous for smog, the Los Angeles-Long Beach area still ranks highest in the nation for ozone pollution and fifth highest for particle pollution.

Diesel exhaust is the greatest contributor to the region's persistent air problems, and the greatest source of NOx is vehicles (led by heavy-duty vehicles). Modeling by the

South Coast Air Quality Management District (SCAQMD) indicates that significant penetration of zero or near-zero-emission heavy-duty vehicles is needed to meet federal health standards.

## Providing Hope

California's standards and incentives for low-emission vehicles and low-carbon fuels have supported the early growth of an advanced medium- and heavy-duty vehicle market. They have enabled the purchase of zero-emission trucks and buses from diverse customers, including large corporations such as IKEA, small businesses like Redwood Products, and transit agencies throughout the region (see Figure 9).

To accelerate deployment, the Air Resources Board's California Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP) has provided incentives for the purchase of 2,400 medium and heavy-duty vehicles. Approximately 60% of these fleets are located in underserved communities.



*Figure 9 Award of 2000th HVIP voucher to a nursery supply business which purchased a medium-duty hybrid work truck by Hino. Participants include a staffer of California Assembly member Freddie Rodriguez (second from left), CALSTART Senior Vice President Bill Van Amburg (fourth from left), and California State Senator Connie M. Leyva (far right).*

Through initiatives such as HVIP, and others, the South Coast has become a major player in the global production and distribution of clean commercial vehicles, with over 15 companies now located in the region that are hard at work developing natural gas, hybrid, electric, powertrains, and hydrogen technologies.

## Zero-Emission Buses

The South Coast has become a national center of zero-emission bus development and manufacturing. Proterra (City of Industry), BYD (Lancaster), Complete Coach Works (Riverside), Ebus (Downey) and El Dorado National (Riverside), and US Hybrid (Torrance) are all producing electric or hydrogen fuel cell zero-emission buses for the state and national markets.<sup>17</sup>

Some transit agencies are working to make their fleets completely zero-emission. Earlier this year, Antelope Valley Transit Agency became the nation's first fleet to commit to operating a 100% electric fleet, which it plans to do by 2018. Shortly after, Foothill Transit, which operates more than 330 buses serving routes in Los Angeles,

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<sup>17</sup> The state's largest bus manufacturer, the Gillig Corporation, is based in Hayward (Northern California). Gillig produces a wide array of buses, but does not currently build a zero-emission bus. Gillig employs approximately 500 people.

Orange, and San Bernardino Counties, committed to 100% all-electric by 2030. Foothill has already fully electrified one of its busiest routes.

Other transit fleets in the South Coast Air Basin pursuing zero-emission buses include the City of Gardena (GTrans), Los Angeles Metro, SunLine Transit, Orange County Transportation Authority, Victor Valley Transit Authority, California State University Los Angeles, and the University of California Irvine.

Antelope Valley Transit Authority and Foothill Transit have committed to operating 100% electric bus fleets.

California state investments are helping to spur the growth of the zero-emission bus market. In addition to providing purchase incentives through the HVIP program, ARB is supporting the development of regional clusters of zero-emission buses and trucks

with the ZE Truck and Bus Pilot Project. In the most recent solicitation, the project received 38 proposals ranging from around \$2 million to \$25 million (awards had not yet been announced at the time of writing).

The CEC has enabled Proterra's high-tech electric bus manufacturing plant in the City of Industry; BYD's long-range, 35-foot battery-electric transit bus, serving disadvantaged communities in Los Angeles; the ELDorado National fuel-cell bus for transit operations at the University of California, Irvine (See Figure 10); and New Flyer's fuel-cell bus for SunLine Transit in Coachella Valley.

### Why Are Companies Coming to the South Coast?

"We want to be geographically near talent and near our market of early adopters," explains Proterra's Popple about his company's presence here. "One-third of our customers are in California." With the City of Industry plant, "We are smack dab in the middle of the single largest U.S. market."

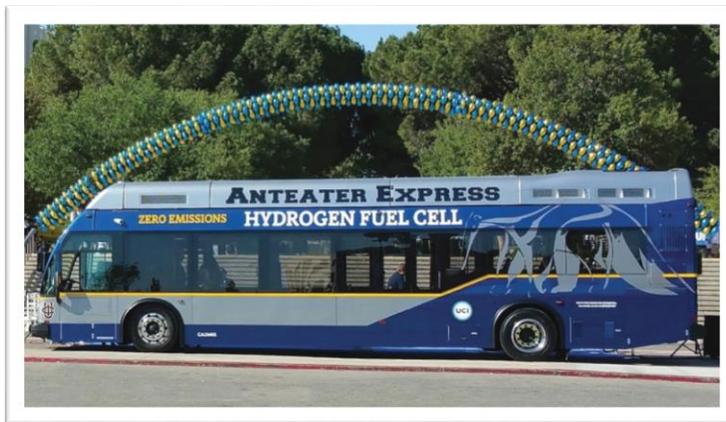


Figure 10: Hydrogen fuel cell electric bus at University of California, Irvine, which is expected to run 4,000 miles per month. Developed in partnership with Anteater Express, Ballard Power Systems, ELDorado National, BAE Systems, and CALSTART, with support from the CEC.

"People want to be able to come kick the tires," Popple continues. "Based on my Tesla experience, I learned that it is critical to get as close to your supply chain as possible for troubleshooting. If they have a question about the technology, we can say to them, 'Get in your car and come down here and we can show you.'"

BYD is a major global manufacturer of batteries, solar panels, and electric vehicles based in China with \$9 billion in revenue worldwide. With 300 employees in the South Coast area, BYD chose California for its first U.S. manufacturing plant because

it has the largest and most attractive market for zero-emission buses. The company, with Warren Buffet as a major investor, is also developing electric trucks and believes California will be the epicenter for that market as well.

“We have been on a pretty aggressive hiring binge,” says Macy Neshati, Vice President of Sales for BYD Motors, headquartered in Los Angeles. “Obviously hiring is based on activity. We have a backlog of 100 buses and climbing,” Neshati said in late 2015.

Start-up TransPower, which launched four years ago in San Diego and with over 40 employees, is developing and building low- and zero-emission tractors and trucks for customers, including firms operating at the Ports of Los Angeles and Long Beach. It is likely that opening facilities in the port area will become a practical necessity for the company in order to provide on-site support, TransPower CEO Mike Simon predicts.

As these manufacturers expand, there will be additional economic benefits for the region as suppliers also increase in size. For example, Los Angeles based Ricon provides passenger windows for BYD’s buses as well as ramps and lifts for the company’s trucks. “As our business grows, so will theirs,” Neshati says, forecasting that the number of direct jobs at BYD will climb to 800 in 2017 and 1,000 to 1,500 within just a few years.

“These are highly desirable jobs,” comments Popple about Proterra’s work. “We’ve learned the hard way that paying minimum wage for production means you get minimum quality. You don’t get true craftsmen until you give benefits and equity.”

“There are no minimum-wage jobs in this model. Even the lowest-rung fabricator has high-caliber welding or wiring skills.”

– Ryan Popple, CEO, Proterra

Simon says that 40% of jobs at TransPower are in engineering and technical management, and about half are in skilled technician roles. “There are no minimum-wage jobs in this model. Even the lowest-rung fabricator has high-caliber welding or wiring skills,” he explains.

### **Zero- and Near-Zero-Emission Trucks at South Coast Ports**

Los Angeles and Long Beach rank number one in the nation in ozone pollution, number three in the nation in year-round particle pollution, and number four in short-term particle pollution.<sup>18</sup> Particle and ozone pollution in particular affect children and the elderly, as well as individuals with lung disease, heart disease, and asthma.

The American Lung Association notes, “People who have lower incomes face greater risk from air pollution. Often, they live closer to the sources of pollution, including near major highways or factories. Sometimes they are more likely to have diseases that put them at higher risk.” Given the Los Angeles Basin’s great population density, this is a serious state health issue.

It is unfortunate that ports, which bring so much economic prosperity to the region, are also major contributors to concentrated pollution. Fortunately, the state has

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<sup>18</sup> The American Lung Association (2015). State of the Air 2015.

made it a priority to reduce harmful emissions in these areas, helping the ports launch a clean truck program in 2012 that has phased out older, high-emissions tractors, lifts, and other harbor vehicles to reduce some pollutants by 80 percent in the first two years.

“The LA region is clearly the hub for this technology,” says Simon. “The Port of LA and the Port of Long Beach are in an area that has major environmental and traffic problems, but over the last five years or so there has been a lot of money invested for decreasing emissions throughout the South Coast. This has been one of our biggest sources of funding and the ports are an increasingly important part of our business.”

Currently, 45 percent of the vehicles manufactured by TransPower are intended for use in the LA area. “In terms of dollars, it’s more like two-thirds of our business,” Simon explains.



*Figure 11: All-electric class 8 drayage (short distance good movement) truck from TransPower that hauls 80,000 lbs. loads for the Ports of Los Angeles and Long Beach.*

With the help of funding from SCAQMD, CEC, and ARB, companies are developing zero and low emission drayage trucks to service ports. Recent advances include an all-electric Class 8 drayage truck by TransPower (see Figure 11), an all-electric and range-extended hybrid drayage truck by Artisan Vehicle Systems, a plug-in hybrid-electric Class 8 drayage truck by Volvo, a natural gas range-extended electric drayage truck from Kenworth and BAE Systems, and an all-electric drayage truck from BYD.<sup>19</sup>

The above examples demonstrate the potential for California public agencies and industry to create real new vehicle technologies together, and show that ARB’s use of Cap and Trade funds is successfully driving serious new industry commitments.

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<sup>19</sup> TransPower’s headquarters is in Poway, Northern San Diego County. To date most of its vehicles have been deployed in the South Coast Air Basin and, as a result, the company is hiring people in the region to provide service and support.

## **Clean, Low-Carbon Fueling Systems**

The South Coast hosts a nascent industry of production for clean, low-carbon fuel. For instance, CR&R is producing renewable natural gas from mixed municipal solid waste (MSW) in Los Angeles, with support from a CEC grant and motivation by a state law requiring landfill operators to divert 75% of organics by 2020. With this project, waste is injected into the Sempra natural gas pipeline for Shell Energy North America's use as a transportation fuel.

The nation's largest developer and operator of natural gas vehicle fueling stations, Clean Energy Fuels, provides both compressed and liquefied natural gas for operators of transit and trucking fleets.

GreenKraft and Quantum Technologies, both based in Orange County, are also active in the natural gas vehicle industry. GreenKraft adds natural gas and other alternative fuel systems to existing car, van, and truck classes for commercial fleets (called "upfitting"), and Quantum provides natural gas and hydrogen cylinders to leading suppliers for the truck and bus markets. IMPCO, headquartered in Santa Ana, creates bi-fuel engines and other systems that reduce vehicle emissions.

Recently, Cummins Westport Incorporated has commercialized a natural gas engine for heavy-duty trucks that produces 90% fewer NOx emissions (0.02 grams per brake horsepower-hour). This "ultra-low" NOx engine, developed with support from investments made by public agencies, meets a Near Zero certification by ARB which is equivalent to a 100% battery truck using electricity from a modern combined cycle natural gas power plant.

## **A Center of Deployment for Hydrogen and Fuel Cells**

With over 50 hydrogen stations, the South Coast has one of the largest networks anywhere. Fuel cell bus maker US Hybrid is based in the area, and hydrogen fuel systems producers Air Products, Linde, and Praxair are local employers. The region is poised to be a center for expansion and export of hydrogen as the market grows.

## **Kudos to the South Coast Air Quality Management District**

Much of the progress described is a result of steady efforts by the South Coast Air Quality Management District (SCQAMD) over the years. For nearly two decades, the district's Technology Advancement Office has provided important seed funding to allow companies to develop and bring cleaner transportation technologies to the market.

SCAQMD investment played a critical role in the development and improvement of the heavy-duty natural gas engine. First deployed in the region's transit sector during the 1990s, the trucking industry has begun to diversify its fuel stream over the past decade, making wider use of natural gas as a strategy to both improve emissions and save money. SCAQMD also deserves credit for fostering the cluster of advanced medium and heavy-duty vehicle technology companies in the region.

## What's Needed in the South Coast?

As policymakers seek to promote development of the CTTI in the South Coast, they should:

- 1) **Continue to target incentive funding across the multiple stages of technology commercialization.** Incentive funding is needed to build critical mass in the marketplace for early-commercial electric drive, fuel cell, and range-extended electric vehicles, as well as very low-carbon fuels and transportation systems that increase system efficiency through automation, routing, and mode-shifting.
- 2) **Ensure that public investments will be sustained over many years. California's ambitious air quality and climate goals call for incentive funding** and other investments that will change as new technologies mature, but the general need for shared public-private investment will continue for several years if not decades to come.
- 3) **Develop strong but flexible, long-range GHG regulatory requirements**, including fuel economy rules for 2027 onwards, which encourage investment and innovation in the region that will keep California on a path for 2050 GHG reduction goals. Investments made in this space will assist the air district in its long standing effort to meet federal air quality and health standards.

The payoff for investing in South Coast's CTTI includes cleaner air and GHG reduction, as well as development of a major economic hub. If California is successful, the South Coast will become a key exporter of clean transportation technologies as other states and countries, too, address major impacts from freight and other aspects of transportation.

## THE SAN JOAQUIN VALLEY



Figure 12: San Joaquin Valley counties.

The San Joaquin Valley, home to Fresno, Stockton, Modesto, Bakersfield, and many smaller towns (see Figure 12), has approximately four million inhabitants. The SJV is well known for its agriculture industry, and is also a major transportation corridor. It is home to 23 of California's most underserved communities.

The San Joaquin Valley (SJV) has some of the highest air pollution levels in the nation, with Fresno/Madera ranking as the most polluted metropolitan area for both year-round and short-term particle pollution.

The SJV's air pollution is due to emissions from vehicle tailpipes, agriculture, and petroleum production, as well as surrounding mountain ranges and weather inversions that inhibit air circulation.

Transportation causes 80 percent of the region's NOx emissions, half of which are from heavy-duty trucks. Off-road vehicles specifically are major contributors to the region's emissions of NOx, PM 2.5, and volatile organic compounds.<sup>20</sup>

The San Joaquin Valley Air Pollution Control District (SJVAPCD) has made significant progress against these challenges. In 2015, the district provided over \$21 million to support purchases of 1,153 clean cars and 444 clean trucks, and \$1.4 million in incentives to install 140 Level 2 and Level 3 electric vehicle chargers.



*Figure 13: Class 8 All-Electric Yard Hostler from TransPower at IKEA distribution center in Lebec. Made possible with funding from the U.S. EPA and the San Joaquin Air Pollution Control District.*

Through the Ag Tractor Replacement program, SJVAPCD has provided \$80 million for small farmers to replace more than 2,200 SJV-based agricultural tractors. The SVJAPCD has also funded an all-electric TransPower yard hostler at the IKEA distribution center in Lebec (see figure 13).

### **Liquid Biofuels**

The most significant CTTI activity in the Valley has been the growth of the biofuel industry. Companies producing clean, low-carbon fuel are developing new facilities, including plants for biodiesel (see Figure 14) and ethanol, and more recently, renewable natural gas.

"Agriculture generates a significant amount of biomass which can serve as a feedstock for current and future lower carbon fuels," says John Boesel, CEO of CALSTART. "In addition, given the region's relatively lower costs, there could be some good opportunities for advanced vehicle and component manufacturing in the Valley."

Many of the biofuel producers already providing manufacturing jobs are using waste material as feedstock, thereby helping to eliminate waste and create clean new energy sources at once.

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<sup>20</sup> San Joaquin Valley Air Pollution Control District (2016). Report to the Community 2015-16.

**FIGURE 14: SELECT BIOFUEL PRODUCERS IN THE SAN JOAQUIN VALLEY**

- AltraBiofuels (Goshen)
- Biodico (Fresno)
- Calgren Renewables (Pixley)
- Community Fuels (Stockton)
- Crimson Renewable Energy (Bakersfield)
- Greenbelt Resources (Paso Robles)
- Pacific Ethanol (Madera and Stockton)

According to CEO Harry Simpson, Crimson Renewables spent \$42-\$45 million in 2015 to operate a Bakersfield plant that employs 30 and is currently producing approximately 25 million gallons of biodiesel per year. The company is making improvements expected to increase production by 2 million gallons per month.

Biodico, a company that uses cooking oil collected at local restaurants as the feedstock for its biofuel production, recently completed an economic analysis of its 10 million gallon-per-year biofuel facility near Fresno. "If you include construction, transport of goods, and services, the plant has a \$40 million annual economic impact and that is just counting direct expenditures," says Russ Teall, the firm's CEO. The total economic impact is approximately \$165 million annually. On average, a biodiesel plant of this size supports 70 direct jobs and 274 indirect jobs, and generates approximately \$11 million in annual tax revenue.

Crimson Renewables, Biodico, and other biofuel producers are operating in the SJV in part because of California state policies. The LCFS, outlined earlier, has been instrumental for encouraging development of the biofuels industry in the SJV and statewide, according to a recent letter on behalf of 57 low-carbon fuel producers.<sup>21</sup>

Teall and Simpson are optimistic about the potential for further growth of the biofuel industry in the Valley. "If the LCFS is extended to 2030 there would be a need for 540 million gallons of diesel equivalents with a carbon intensity under 20—just for diesel compliance," says Simpson. "California can meet the target with approximately half of those fuels produced in-state given the right circumstances."

Simpson would like to see the Central Valley agriculture community, municipal fleets, and other fleet operators move toward a blend of 10-20 percent biodiesel. Several Pilot / Flying J truck stops and independent truck stops along Interstate 5 and Highway 99 already sell blends of biodiesel greater than 5 percent.

"Truck stops and agricultural users benefit from LCFS and RFS (Renewable Fuel Standard) credits that result in biodiesel being cheaper for them compared to an equivalent volume of petroleum diesel. We should do some education targeted at

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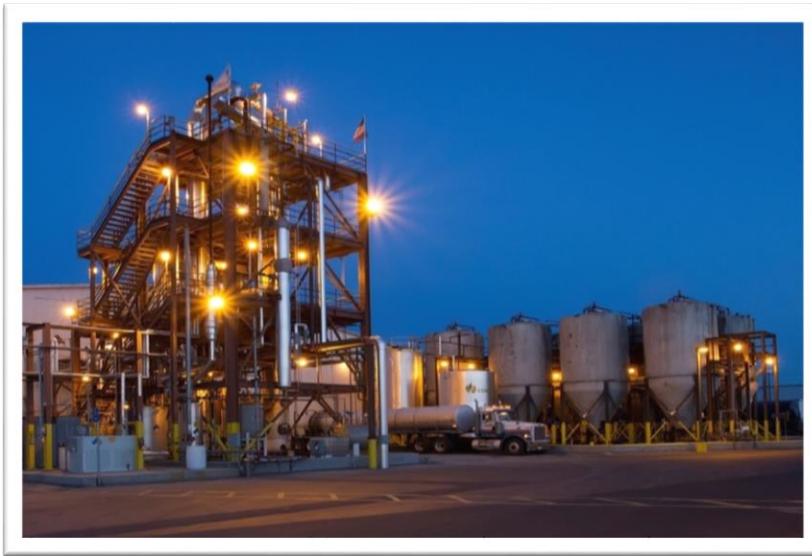
<sup>21</sup> Letter to Senate President Pro Tom Kevin De León and Speaker Anthony Rendon (July 6, 2016), titled "California Fuel Producers Support the Low Carbon Fuel Standard." Available at [www.calstart.org](http://www.calstart.org).

retail fuel station operators and large agricultural concerns to achieve increased biodiesel blending," Simpson recommends.

Teall adds that employees can live near a biodiesel facility where they work without health risk, which is not necessarily the case with a petroleum refinery.

The CEC has supported the growth of the industry by providing targeted grants through competitive solicitations to help cover the capital costs associated with plant construction.

At the Port of Stockton, Community Fuels operates an advanced biorefinery with a production capacity of 25 million gallons per year and a storage terminal that can distribute more than 70 million gallons per year (see Figure 15). The biodiesel is sold to the petroleum industry, where it is blended with diesel fuel in order to meet the requirements of multiple state and federal regulations.



*Figure 15:  
Biodiesel  
production facility  
with a capacity of  
25 million gallons  
per year, operated  
by Community  
Fuels in Stockton.*

Mortenson sees the Stockton operation as a hub of economic activity, with indirect regional jobs created for suppliers and contractors serving the plant. The company chose the location because of its strong logistics and scalability to support future expansion of the business.

Ethanol plants are also operating in the SJV. The nation's sixth-largest producer, Pacific Ethanol, produces 40 million gallons per year at its Madera plant and 60 million gallons per year in Stockton. The firm deploys pioneering cellulosic technology from EdeniQ which helps reduce its carbon intensity. Neil Koehler, Pacific's President and CEO, says the company aims to be the leading producer and marketer of low-carbon renewable fuels in the country.

## Renewable Natural Gas

Facilities for renewable natural gas (RNG) production, which capture biomethane from waste and convert it into fuel, are emerging in the SJV. RNG can be derived from wastewater treatment plants, landfills, and dairy farms,

RNG is already used to generate stationary power in the SJV. For example, in Tulare, Colony Energy Partners is producing 400 million cubic feet per year of RNG with anaerobic digesters to process dairy manure, food and agricultural processing residuals, restaurant and cafeteria food scraps, restaurant grease trap residuals, and organic municipal solid waste. In Pixley, Calgren Renewables and Pixley Biogas are producing RNG using anaerobic digesters to process cow manure from three local dairies.

RNG projects like these could become models for creating transportation fuel, and indeed, "RNG to transportation fuel" demonstrations are under way around the region. Harvest Power Tulare is developing a digester-to-pump biomethane project for on-site Compressed Natural Gas (CNG) fueling.

Just outside the Valley, Clean World Partners is developing RNG for the Yolo County Transit District and Sacramento South Area Transfer Station from two Sacramento landfill gas projects, and Recology is fueling its CNG fleet using a developing anaerobic digester in Vacaville.

Michael Boccadoro, President of West Coast Advisors, thinks there is a future for developing and using RNG for transportation fuel in the SJV. "There is a lot of trucking in the Valley for agriculture. Heavy-duty truck operations and the dairies,

"The payoff (for dairy digesters) is huge just for the upstream benefits alone. Every \$2-4 of Cap and Trade funding would result in a ton of carbon dioxide equivalent pollution."

- Michael Boccadoro, President, West Coast Advisors

farms, orchards, and wineries all have trucks that could use renewable CNG," Boccadoro said.

All classes of trucks and buses can use RNG, including buses with compressed natural gas (CNG) engines that are found in about half of the state's transit agencies. For these vehicles, RNG has extremely low GHG emissions, because capturing and combusting RNG as a fuel prevents methane, which is a highly potent greenhouse gas, from entering the atmosphere.

According to ARB's scoring, the carbon intensity of RNG fuel is negative, because the production process leads to emissions with lower net climate impacts.

State funding is supporting the growth of RNG in the SJV. With revenue generated from California's Cap and Trade Program in 2015, the Department of Food and Agriculture awarded \$11 million to fund several digesters which are scheduled to be built by the end of 2016.

To drive further expansion, Boccadoro notes that more state funding is required to support new capital expenditures at dairies. "We need more than 5-6 digesters. We need [to build] 20-40 a year," he says. "The payoff is huge just for the upstream benefits alone. Every \$2-4 of Cap and Trade funding would result in a ton of carbon dioxide equivalent pollution."

In addition to environmental benefits, RNG is an opportunity for job creation. According to an estimate by the Coalition for Renewable Natural Gas, the development of RNG production facilities can create as many as 120 direct and indirect jobs per project. With the right combination of incentives and state investments, the SJV could become the state's biggest center for RNG production and jobs.

### **Vehicle Technologies**

To meet the growing demand for electric vehicles, Tesla Motors opened a 431,000-square-foot specialized production facility in Lathrop, near Stockton, in 2015. By mid-2016, it has created more than 300 jobs.

The SJV has also become a key test and proving ground for new zero-emission trucks and buses. IKEA and two of the region's largest agricultural producers, Harris Ranch and Grimmway Farms, are in the early stages of piloting all-electric, Class 8 yard tractors, funded by the SJV Air Pollution Control District and the CEC.

At the end of 2015, the first of these tractors, built by TransPower, had been in operation at IKEA's California distribution center in Lebec for 18 months and had accumulated more than 20,000 miles of use. Now, Ikea is actively pursuing other projects and is very interested in deploying electric yard tractors throughout the U.S. and Canada.

Several school districts in the state have begun using electric buses built by Motiv Power Systems, including the Kings Canyon Unified School District in Reedley. Even in rural areas, zero-emission buses and trucks contribute to improving the SJV air quality. As a direct result of CEC funding, the San Joaquin Regional Transit District (SJRTD) deployed the first two zero-emission, electric buses ever placed into revenue service in the SJV. As a result of their impressive performance, the SJRTD has been successful in securing additional funding and is now expanding its zero-emission bus fleet.

These clean vehicle demonstration and deployment projects, supported by CEC and ARB (and funded by Cap and Trade), are playing a key role in developing the next generation of cost-effective, reliable, and durable commercial vehicles. Many of these vehicles operate frequently in the SJV's underserved communities (DACs), and the development and growth of the clean commercial vehicle sector will provide direct and measureable benefits for the many such communities in this region.

### **A Clean Transportation Center**

In 2015, CALSTART, with funding from the CEC, launched the San Joaquin Valley Clean Transportation Center with aims to rapidly deploy cleaner vehicles and fuels and to identify and develop CTTI growth opportunities for the SJV (see Figure 16).

Working with local fleets and stakeholders, as well as CALSTART's 150 member companies, the organization will help to that deployment of advanced, clean and low-carbon vehicles in the SJC DACs is a high priority. As of June 2016, in less than

one year of operation, the SJV Center had already succeeded in securing more than \$8 million in new state clean transportation technology grants for the region.



*Figure 16: Plug-in hybrid electric car (Chevy Volt) at the San Joaquin Valley Clean Transportation Center in Fresno, which was launched in 2015 by CALSTART with support from the CEC.*

"We are aiming to generate a multiple of at least ten-to-one on the CEC investment in the SJV Center," says Boesel. "We might have been able to hit that target in the first year if the amount of Cap and Trade funding allocated to low-carbon transportation had been higher. We had some really strong projects that not only would have reduced greenhouse gas emissions, but also cut smog forming

We are aiming to generate a multiple of at least ten-to-one on the CEC investment in the SJV Center."

- John Boesel, CEO, CALSTART

emissions." With the ideas developed and the teams formed, the Center will pursue other funding sources, Boesel adds.

The opportunity for growth of the CTTI in the SJV is additive to the existing primary source of transportation energy in the region. Oil production in the SJV,

particularly in the south, is largely responsible for California's rank as the third largest oil-producing state in the nation. Approximately half of the oil consumed in California is produced in state, while the other half is imported from abroad.<sup>22</sup>

Therefore, nearly half of the money Californians pay for crude oil is going overseas. For quite some time, the state will continue to need and benefit from the oil produced in the SJV. There is an economic opportunity to be seized by replacing the imported oil with in-state produced, low-carbon transportation fuels.<sup>23</sup> The growth of the low-carbon fuel industry in the region will have the benefit of keeping our transportation energy dollars in the state, generating direct regional economic benefits.

### **What's Needed in the San Joaquin Valley?**

To support continued growth of the CCI in the SJV, state policymakers should:

- 1) **Extend the Low Carbon Fuel Standard (LCFS) well beyond 2020.** The LCFS already provides meaningful economic value and encourages production of low-

<sup>22</sup> Imported oil accounts for about 40 percent of oil consumption nationally and nearly 50 percent in California.

<sup>23</sup> Low-carbon fuels are creating meaningful new business lines for conventional fuel distributors such as Golden Gate Petroleum and retailers like Pilot Flying J.

carbon fuels in the SJV. Continuation is needed to spur further investment and production.

- 2) **Continue to invest in match-funding programs that defray start-up capital costs** of demonstration and pilot plants for newer low-carbon fuel technologies.
- 3) **Prioritize the development of clean fuel infrastructure**, which stimulates construction jobs and helps to keep transportation energy funds in the region. Continuing grant funding from the CEC and encouraging utilities to invest in infrastructure will support CTTI growth in the SJV.
- 4) **Continue to support expansion of the early EV market**. With its 150+ national company members, CALSTART will be working closely with the Governor's Office of Economic Development (GoBiz) to pursue new CTTI manufacturing opportunities like the one made by Tesla Motors in Lathrop.

Executives at CTTI companies say that SJV has a lot to offer and they express interest in developing new facilities in the region. Executives are optimistic about their prospects to improve air quality and to grow high-quality manufacturing jobs if the state continues its commitment to strong goals, standards, and incentive funding.

## SILICON VALLEY



Figure 17: Silicon Valley counties.

Silicon Valley includes Alameda, Santa Clara, and San Mateo Counties at the southern end of the San Francisco Bay Area (see Figure 17). The region has a population of approximately 3 million and is known worldwide as the center of the information and communication technology (ICT) industry. It is also a major hub for venture capital and biotechnology.

Over the past few years, the region has become a major source of growth for the national CTTI. Start-ups and Fortune 500 firms alike have moved to the area to leverage its engineering and intellectual talent.

There is consensus among the CEOs of the world's largest automotive companies that the next 10 years will see more change than in the entirety of the previous century.

To be a change leader in the transportation sector, many are tapping the innovation culture in Silicon Valley.

The growth of the CTTI in Silicon Valley has been most significant in four areas: (1) Electric vehicles (EVs) and related components and services; (2) Advanced vehicle and engine controls and systems; (3) Transportation Network Companies (TNCs); and (4) Car company and Tier 1 auto supplier R&D centers.

### **Electric Vehicles and Related Components and Services**

Tesla Motors is the largest generator of jobs in California's CTTI. Prior to the successful announcement of its third car, the Model 3, Tesla was employing over 9,000 skilled

workers in the state. According to executives at the firm, more than 65 percent of its employees self-reported as non-Caucasian.

Based on the very positive response to the Model 3, there are now reports that Tesla is seeking to fill 6,000 additional jobs in California for a total of more than 15,000. At its manufacturing plant in Fremont, there are more Tesla Motor employees working on a daily basis than ever employed when the plant was owned and operated by a joint Toyota-GM joint venture (see Figure 18).

Relative to the state's air quality and climate goals, the significance of Tesla Motors goes well beyond its 9,000 to 15,000 employees in California and the tens of thousands of cars on the state's streets. Tesla is driving innovation throughout the entire automotive industry, and motivating other auto manufacturers to innovate at a quicker pace. Tesla says that it now plans to make pickups, buses, and heavy duty trucks.



*Figure 18: Tesla Motors electric car manufacturing facility in Fremont. Tesla has announced plans to build a pickup truck, passenger bus, and heavy duty truck.*

From 1985 to 2005, many large auto firms closed down plants in the Midwest and reopened in the South to take advantage of lower cost labor and more favorable regulations. It appears now that the next generation of carmakers sees a California location as desirable because it will help them to take advantage of the state's

Tesla is driving innovation throughout the entire automotive industry, and motivating other auto manufacturers to innovate at a quicker pace.

talent and culture of innovation, as well as to be close to the nation's largest electric vehicle market.

Tesla Motors has played an important role in driving major new automotive investments in the area, which include new entrants from China, Faraday Future, Atieva, and NextEV.

Silicon Valley is not just the home to new EV ventures, but it has also spawned two new firms developing electric propulsion systems for trucks and buses. Launched by a Tesla co-founder, Wrightspeed Electric is developing range-extended, electric-drive retrofit kits for Class 3-6 trucks, and in mid-2016, announced deals to provide hybrid electric propulsion systems to a New Zealand

bus builder and to Mack Trucks, a division of AB Volvo. Wrightspeed has 40 employees, but imagines a workforce of 6,000 with high market penetration.

Motiv Power Systems (Motiv PS), with offices in Foster City and Fremont, is developing a portfolio of scalable electric drive systems and seeks to be a global manufacturer of engines for the commercial vehicle sector—a “zero-emission version of Cummins” (see Figure 19).

Among others, Motiv PS is now used in all-electric shuttle buses serving employers in Silicon Valley as well as in all electric trucks operated by a large national uniform supply firm. Motiv has benefited from CEC grants to build these vehicles as well as to establish their manufacturing plant in Fremont.

Silicon Valley is a new leading center of the EV battery industry. Tesla Motors developed its battery in Palo Alto, and advanced battery start-ups in the region include QuantumScape (in which VW has recently made equity investments) and Amprius. EV battery development relies on software and electrical engineering skills, which the region is known to have in abundance.

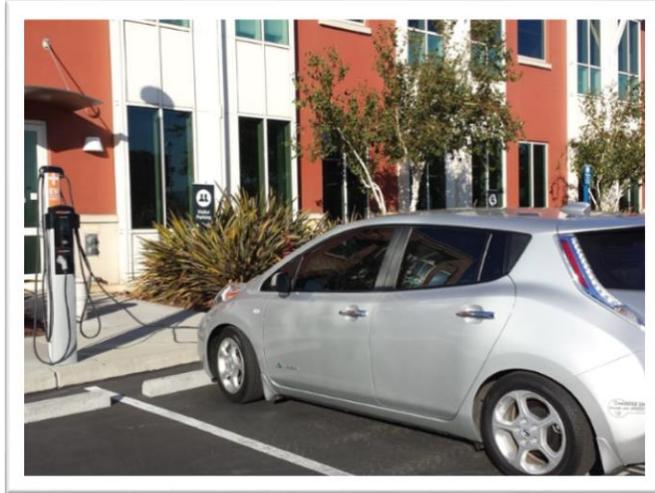


*Figure 19: All-electric delivery van by Motiv on a Ford F59 Chassis being operated by AmeriPride.*

The region is home to fast growing firms developing electric vehicle supply equipment (EVSE, better known as EV chargers)—and vehicle-to-grid interface (VGI) technologies. ChargePoint, headquartered in Campbell, is the world’s largest Electric Vehicle Service Provider (see Figure 20), and several others, including Greenlots, are in San Francisco, where smart EV charging and grid solutions for storage and demand reduction are in place.

Additionally, the state’s burgeoning renewable energy industry includes companies that are seeking to provide energy storage and distributed energy to promote widespread vehicle electrification.

The Bay Area Air Quality Management District (BAAQMD) has further supported the development of the region’s EV industry by providing funding for electric charging stations and all types of zero-emissions vehicles, from cars to airport equipment.



*Figure 20: ChargePoint EVSE charging a Nissan LEAF.*

### **Advanced Vehicle and Engine Controls and Systems**

Silicon Valley is the birthplace of many computing technologies and a place where technologies are constantly undergoing improvement. As computing miniaturizes and becomes more powerful, and sensors become more advanced, traditional car and engine manufacturers are looking to the region for opportunities to increase the efficiency of their products.

Large auto companies and suppliers are searching for start-ups that can help them meet stringent fuel economy and GHG standards, not only in the United States, but also in Japan, China, and the European Union. One budding success story is San Jose's Tula Technology. With investment from GM and Delphi, Tula is providing smart cylinder-management software that could enable a 20 percent fuel saving improvement.

### **Transportation Network Companies**

Silicon Valley, San Francisco and Oakland have collectively become a major global hub for new ride hailing services, or as Uber and Lyft are now often described, Transportation Network Companies (TNCs). Besides tremendous growth in these firms, much of the drive in this area is about creating new software for "connected cars," which includes both automation and advanced data sharing between vehicles.

Connected cars offer many potential benefits, including increased system efficiency (made possible by allowing closer, safer driving), reduced vehicle-miles traveled (via carpooling and freight sharing), less congestion (by better routing, scheduling, and navigation to parking, as well as improved communication among vehicles and between vehicles and infrastructure), and better diagnostics (through the integration of approximately 50 computers currently on board passenger vehicles).

Peloton Technology of Mountain View, while best known for a system which allows trucks to travel in groups to save fuel (platooning), is working broadly to create the "software defined vehicle," and other companies may soon follow.

General Motors, which owns the all-electric Chevrolet Bolt EV, has invested \$500 million in Lyft and acquired Cruise Automation, an autonomous vehicle technology

The combination of zero-emission, networked, and autonomous vehicle technologies could create powerful synergies.

firm with approximately 30 employees in San Francisco. Terms of the deal were not disclosed, but one report indicated that GM paid around \$1 billion.

The combination of zero-emission, networked, and autonomous technologies could create powerful synergies, including an ability to increase the exposure of ZE technologies to the public and thereby accelerate ZE technology adoption.

### Large Car Company and Tier 1 Auto Supplier R&D Center

As cars have increasingly taken the form of electronic communication devices with seats and wheels, large global automotive companies have been opening and growing their operations in Silicon Valley. Since 2011, BMW, Honda, Hyundai, Mercedes-Benz, Nissan-Renault, GM, Ford, and Toyota have all opened R&D centers in the area.<sup>24</sup> Many major mainstream auto suppliers, such as Bosch, Continental, and Denso, have also opened offices.

Many of these firms have located to Silicon Valley in order to explore opportunities to collaborate with start-ups. For example, BMW's Silicon Valley office is conducting a pilot program with ChargePoint and PG&E to test a system whereby EV drivers can receive financial incentives by agreeing to have the rate at which their cars charge fluctuate according to the demands on the electricity grid.

We estimate that the number of "big auto" jobs in Silicon Valley, now at approximately 2000, will be expanding. Ford alone has more than 200 employees. Adding to this is a surge of auto-related business in the information technology industry, which has quietly made the region a major part of the automotive industry for years, with companies like Nvidia and Intel supplying components and software.

As California increases its commitment to addressing air quality and climate change, Silicon Valley could become the cradle of a new national or even global automotive industry combining clean technologies with smart technologies (i.e. automation and sharing) that may allow the market to grow even faster.

### What's Needed in Silicon Valley?

As policymakers consider opportunities to promote the growth of the CTTI in Silicon Valley, they should aim to:

- 1) **Maintain and strengthen vehicle efficiency standards over the long-term** in order to ensure that the best Silicon Valley has to offer is directed toward solving the environmental and public health challenges facing the transportation sector.

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<sup>24</sup> Lucas Merean (December 2015). Why Detroit is moving to Silicon Valley. Computer World.

- 2) **Sustain and expand policies that encourage the growth of the EV market to 2025 and beyond.** The Silicon Valley could become a major hub of EV development in the state and nationally.
- 3) **Continue and increase incentive funding for purchases and infrastructure** to make up for the fact that zero-emission cars, trucks, and buses provide many social and economic benefits that are not reflected in their purchase price, as well as to jump start the zero-emission vehicle industry.<sup>25</sup>
- 4) **Promote higher numbers of vehicles on the road that use less or no oil.** A pro-EV pricing policy will encourage the market to grow and firms to locate and expand in the state with the largest market. A mileage fee, for example, could be structured to recognize the external costs of higher-polluting vehicles.

Silicon Valley is rapidly becoming a new global auto center in California. Recent investments made are especially notable because North America has seen so little recent investment in new auto plants. With the right policies in place, investment in clean transportation technology in the region will continue to unfold.

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<sup>25</sup> The need and level for incentive funding vary by sector. If the performance of EV cars advances in the next five years as much as it has in the last five years, purchase incentives could decline on a per-vehicle basis after 2020. However, helping the goods movement sector move towards zero emissions will require a longer-term investment horizon.

# Recommendations to Policymakers

As a result of California's commitment to address air pollution and climate change, the state has created a burgeoning clean transportation technology industry that is on the verge of becoming a major source of jobs and a national economic power.



*Figure 21: Refuse hauler operated by Waste Management that runs on renewable natural gas.*

The Golden State is already home to Tesla Motors, the first new U.S. car company created since the end of World War II, and dozens of transportation technology companies have sited manufacturing facilities in the state. Zero-emission transit buses and yard tractors are working in routine service.

Many producers and distributors of biofuel are operating in California, and in-state renewable natural gas is starting to be used as a transportation fuel (see Figure 21). Ultra-low NOx engines are expected to soon be deployed in large numbers in heavy-duty truck and bus fleets.

This report has identified six areas where California has a running start and, with the right support, could generate tens of thousands of jobs over the next 5-10 years:

- Electric vehicles, components and services
- Clean, medium and heavy-duty vehicles
- Advanced technology components and engines
- Cleaner, low-carbon fuel production and distribution
- New mobility services
- A second global automotive center

These growth areas create opportunities throughout the state, and are found in particular in the South Coast, San Joaquin Valley, and Silicon Valley.

## **Policies That Have Mattered**

Leaders in the clean transportation industry give credit to ambitious policies that have been created by California's governors and lawmakers, and implemented by

agencies such as the ARB and CEC and air quality management districts, notably the BAAQMD, SCAQMD, and SJVAPCD.

Policies that have been instrumental include the California Global Warming Solutions Act of 2006 (AB 32), Clean Energy and Pollution Reduction Act of 2015 (SB 350), the Cap and Trade and the LCFS programs, and incentive funding from Low Carbon Transportation, AQIP, and ARFVTP.<sup>26</sup>

“California continues to display amazing leadership from the governor on down through the legislature. It’s great that they have the vision for getting off fossil fuels and the will to support and nourish green technologies.”

- BYD Vice President Macy Neshati

Industry leaders have been impressed with California’s approach to date. Says BYD’s Neshati, “California continues to display amazing leadership from the governor on down through the legislature. It’s great that they have the vision for getting off fossil fuels and the will to support and nourish green technologies.”

Mike Britt, Director of Advanced Engineering for UPS, encourages other nations to develop programs and policies similar to California’s. He

attributes the state’s incentive programs as a leading reason for his company’s use of more alternative fuels in California than in any other state and encourages other states to follow California’s lead.

### Remaining Challenges

Nonetheless, the clean transportation industry is still infant, and challenges remain.

#### **Challenge #1. Low oil prices hurt the business case for more efficient and cleaner vehicles and fuels.**

Following a nine percent decline in gasoline consumption from 2004 to 2012, a more recent period of extended low oil prices and economic expansion has led consumers to drive more and buy larger vehicles. In 2015, sales of gas-powered trucks and SUVs grew 10 percent nationally, while sales of hybrid vehicles declined.<sup>27</sup> Consumption of gasoline and diesel in California and the nation have risen steadily over the past four years.

Over the same period, many promising next generation biofuel technologies have also stalled as they have been unable to compete with oil prices in the \$30-50/barrel price range. Global oil production is remaining high enough over demand that the U.S. Energy Information Administration predicts that low prices will continue for some time.<sup>28</sup>

Additionally, the full societal costs of oil are not reflected at the pump, and therefore the public at large is still paying for environmental impacts and security risks that are associated with petroleum. These impacts are largely or fully remedied by zero and low emissions technologies. However, even when global oil prices

<sup>26</sup> The Alternative and Renewable Fuels and Vehicle Program (ARFVTP) was established by Assembly Bill 118 and extended, along with the Carl Moyer Program, through 2023 with Assembly Bill 8. CALSTART co-sponsored both bills.

<sup>27</sup> Schrempf, Gordon (February 2016). “Recent Trends for Petroleum, Electricity, & Renewables” (online presentation). California Energy Commission.

<sup>28</sup> U.S. Energy Information Administration (2015). Short-Term Energy Outlook as of December 2015.

eventually rise, zero and low emissions sources will continue to face a price disadvantage in the absence of stringent pollution and carbon pricing.

**Challenge #2. Companies and investors continue to perceive policies as uncertain.**

In order to plan investments that bring clean transportation technologies through multiple stages of commercialization, companies need policies that provide

CTTI companies and investors need policies that provide a stable and consistent outlook over several years.

an outlook over several years. Explains Crimson Energy's Simpson, "If we green-light a project in 2016, it won't be finished until 2019." However, CTTI executives say that despite California's ambitious goals, an ongoing climate of policy uncertainty persists. Two examples are illustrative.

Between 2010 and 2015, opponents of the LCFS sued to block the program. This led to uncertainty about the LCFS's future, and because multi-year certainty is needed to secure project financing, investments in new fuel facilities slowed.

Then in 2015, the LCFS was ruled legal and the program was reauthorized. Credit prices rose and investments in low-carbon fuel increased.

However, as 2020 approaches, fuel producers are anxious for certainty about the status of the LCFS after that time. Without a stable and predictable program well into the future, producers say they will be unable to make the capital investments that are needed to support California's goals.

Executives also point to challenges with incentive funding. In 2015, the governor proposed \$350 million for Low Carbon Transportation. In response, fleet operators and ZEV manufacturers created partnerships and developed proposals for needed vehicle pilot projects. However, the legislature appropriated just \$90 million, eliminating 75% of the resources anticipated and which the industry needed.

The next year, in 2016, the Governor proposed a \$500 million budget, which designated funding to backfill some of the previous year's program. However, by the time of the 2016 summer recess, the legislature had not appropriated funding. During the recess, funds for the popular HVIP program ran out, causing buyers to choose between waiting until the program is potentially funded again and simply taking a conventional vehicle now. Most, if not all, will choose the latter option.

As Low Carbon Transportation funding stays in limbo, clean vehicle purchases and pilots that could immediately reduce emissions and draw private sector investment sit dormant. Concurrently, companies are asking whether incentive funding for clean transportation is something they can count for their own capital planning.

**Time to Shift into High Gear**

California policymakers can address these challenges and ensure that clean transportation fulfills the state's goals and continues on a path of tremendous growth in the coming decades. Following are our recommendations to help the state's legislators and agency leaders help shift the industry into high gear.

**RECOMMENDATION #1: STAY ON THE PEDAL BY SOLIDIFYING TARGETS AND EXTENDING PROGRAMS TO AT LEAST 2030**

Our first recommendation is to ensure that the state's climate program is firmly rooted as we march toward the 2050 goal of reducing GHG emissions by 80% below 1990 levels. To do this, the emission reduction target of 40% by 2030 set in Governor

Cap and Trade has proven to be an effective tool for reducing emissions, and it has led to a burgeoning CTTI industry that is creating jobs and poised to become a significant source of exports.

Brown's 2015 executive order needs to be made a permanent law, as proposed by SB 32.

Additionally, Cap and Trade and the Low Carbon Fuel Standard (LCFS) should be reauthorized and extended well beyond 2020. Cap and Trade has proven to be an effective tool for reducing emissions, and it has led to a burgeoning CTTI industry that is creating jobs and poised to become a significant source of exports. A departure

from Cap and Trade, which is a centerpiece of California's climate initiatives, could undermine investor confidence that is needed to help achieve the state's goals.

Extending the LCFS, meanwhile, is a must for unlocking in-state capital for clean fuel production. The LCFS encourages innovation from all fuel technologies, creates minimal net cost to consumers, and provides financial incentives that help fleets invest in low-carbon fuels and zero-emission vehicles.

**RECOMMENDATION #2: REQUIRE TOP PERFORMANCE WITH STRONG YET FEASIBLE AIR QUALITY AND CLIMATE STANDARDS**

Our second recommendation is to maintain and extend strong, science-based air quality and climate change standards for the long-term. Over the next one to three years, the Air Resources Board, U.S. Environmental Protection Agency, and National Highway Safety Administration (NHTSA), will review existing standards and establish new ones (see box). Key standards under development include:

- Advanced Clean Transit Rule, which includes the Zero Emission Bus Regulation
- Zero Emission Vehicle (ZEV) Program, which includes the ZEV Mandate
- Light Duty Fuel Efficiency Standards (2023-25)
- Phase 2 Medium and Heavy GHG Standard (2018-27)

Vehicle and fuel technologies have undergone significant development over the past few years, and strong standards are needed to ensure their future progress. Whenever possible, these standards should be technology-neutral, give industry maximum flexibility, and provide greater incentives for higher performance.<sup>29</sup>

<sup>29</sup> CALSTART will provide detailed comments on individual proceedings separately.

Strong standards are even more important amidst the decline in global oil prices. Standards promote continued investment certainty and protect against large potential investment reverses. Even with lower oil prices, standards can create fuel savings and pollution reduction benefits well in excess of costs, and provide strong energy security and environmental benefits.<sup>30</sup>

***RECOMMENDATION #3: GIVE THE NEEDED BOOST BY PROVIDING SUFFICIENT INCENTIVES TO MEET THE STATE'S BOLD GOALS AND MANDATES***

Our third recommendation is to create a continuous allocation for Low Carbon Transportation incentive funding that is equivalent to 15-25 percent of overall CCI funding. More specifically in the near term, we recommend a cumulative amount of \$2 billion for the three years of FY2016-17, FY2017-18, and FY 2018-19 (an average of \$650-700 million per year).<sup>31</sup> Such an allocation will create a more predictable stream of incentives which best support California's climate goals.

With a meaningful multi-year stream of incentive investments, agencies can more effectively support sequential, ongoing developmental among multiple technologies, while project developers can make greater commitments of their own resources to develop projects that stand to be the most transformative. Ultimately, this will reduce the time needed before state investments can level off and decline.

Investments in the CTTI create significant co-benefits, including air quality improvement in disadvantaged communities. By providing a meaningful ongoing funding allocation, the legislature has an opportunity to give a major confidence boost to the industry and provide significant encouragement for future investment and job growth in the state.

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<sup>30</sup> Varun Sivaram and Michael A. Levi (November 2015). Automobile Fuel Economy Standards in a Lower-Oil-Price World. Council on Foreign Relations.

<sup>31</sup> Based on demand from the private sector to participate and overall impact towards climate policy goals. More information can be found in CALSTART's public comments on the Low Carbon Transportation Investment Plan.

# Appendix: 300 California Clean Transportation Technology Companies

Following is a list of over 300 companies developing clean transportation technologies in California. The list is grouped by Northern California, Central California, and Southern California, and then organized into ten smaller regions.

## I. NORTHERN CALIFORNIA

**SAN FRANCISCO AND NORTH/EAST BAY /** Alameda (northern), Contra Costa, Marin, Napa, San Francisco, Solano (western), and Sonoma counties.

- Amyris (Emeryville)
- Applied Intellectual Capital (Oakland)
- Automated Energy and Agriculture (Clayton)
- Bay Biodiesel (Martinez)
- BioFuel Oasis (Berkeley)
- Biostar Systems (Sonoma Valley)
- Blue Line Transfer (South San Francisco)
- Cruise Automation (San Francisco)
- Curtis PMC (Livermore)
- Darling International (San Francisco)
- Dogpatch Biofuels (San Francisco)
- Electric Motorsport (Alameda)
- Equilibrium\* (San Francisco)
- FreeWire Technologies (San Leandro)
- Fulcrum Bioenergy (Pleasanton)
- Golden Gate Petroleum (San Francisco)
- Hexcel Composites (Dublin)
- Kaiser Aluminum (South San Francisco)
- Las Gallinas Valley Sanitary District (San Rafael)
- Lit Motors (San Francisco)
- Pacific Gas and Electric (San Francisco)
- Peloton Energy (Petaluma)
- People's Fuel Cooperative (San Francisco)
- PolyPlus (Berkeley)
- Proterra (Burlingame)
- REG Life Sciences (South San Francisco)
- RIX Industries (Benicia)
- Sequential Pacific Biodiesel (Richmond)
- Skip to Renew (San Rafael)
- Simbol Materials (Pleasanton)
- Solazyme (South San Francisco)
- Solvay (Martinez)
- Sunspeed Enterprises (Point Reyes Station)
- Sylvatex (San Francisco)
- TerViva (Oakland)

- Vantage Point Venture Partners (San Bruno)
- Viridis Fuels (Oakland)
- Waste Management (Altamont)
- Whole Energy (Richmond)
- ZAP Jonway (Santa Rosa)

**SILICON VALLEY /** Alameda (southern), Santa Clara, and San Mateo counties.

- Aemetis Advanced Fuels (Cupertino)
- Altex Technologies (Sunnyvale)
- Apple (Cupertino)
- Atieva (Menlo Park)
- BASF Catalysts – Engelhard (Fremont)
- BMW Group – Technology Office (Mountain View)
- Bosch – Research and Technology Center (Palo Alto)
- Capricorn Investment Group\* (Palo Alto)
- Cenergy Solutions (Fremont)
- ChargePoint (Campbell)
- Charles River Ventures (Menlo Park)
- Coast Oil Company (San Jose)
- Cobalt Technologies (Mountain View)
- Codexis (Redwood City)
- Continental Intelligent Transportation Systems (Santa Clara)
- Denso (San Jose)
- Draper Fisher Jurvetson\* (Menlo Park)
- DuPont – Genencor (Palo Alto)
- EIG America (Mountain View)
- Efficient Drivetrains Inc. (Milpitas)
- Elektrobit (San Jose)
- EVGRID (Palo Alto)
- Ford Research and Innovation Center (Palo Alto)
- General Motors Advanced Technology (Palo Alto)
- Google (Mountain View)
- Intel (Santa Clara)
- Intelligent Energy (San Jose)
- International Rectifier (San Jose)
- Intersil (Milpitas)
- Johnson Matthey (San Jose)

- Khosla Ventures (Menlo Park)
- Kleiner Perkins Caufield & Byers\* (Menlo Park)
- LeEco (San Jose)
- Maxim Integrated (San Jose)
- Mercedes-Benz Research and Development North America (Sunnyvale)
- Microvi (Hayward)
- Mohr Davidow Ventures (Menlo Park)
- Motiv Power Systems (Foster City)
- NextEV USA (San Jose)
- NovaTorque (Fremont)
- nVidia (Santa Clara)
- QuantumScape (San Jose)
- Renesas Electronics (Santa Clara)
- Saba Motors (San Jose)
- Seeo (Hayward)
- Sequoia Capital\* (Menlo Park)
- Silver Spring Networks (San Jose)
- SINOEV Technologies (Sunnyvale)
- TerViva (Oakland)
- Tesla Motors† (Palo Alto)
- TUV SUD America (Fremont)
- Tula Technology (San Jose)
- Venrock\*(Palo Alto)
- Western States Oil Company (San Jose)
- Wrightspeed (San Jose)
- ZeaChem (Menlo Park)
- ZipCar – Local Motion (San Mateo)

- Teledyne Technologies (Thousand Oaks)
- Turbonetics (Moorpark)
- Volvo Monitoring and Concept Center (Camarillo)
- Zero Motorcycles (Santa Cruz)

**SACRAMENTO VALLEY /** Butte, Colusa, Glenn, Placer, Sacramento, Shasta, Solano (eastern), Sutter, Tehama, Yolo, and Yuba counties.

- Atlas Refuel (Sacramento)
- Battery M.D. (North Highlands)
- Clean Energy Systems (Rancho Cordova)
- Clean World Partners (Sacramento)
- ClipperCreek (Auburn)
- Gas Technology Institute (Davis)
- InterState Oil Company (Sacramento)
- Navistar (Sacramento)
- Northstate Rendering Co (Oroville)
- Novozymes (Davis)
- Pacific Ethanol (Sacramento)
- Propel Fuels (Sacramento)
- ProTec International LLC (Placerville)
- Ramos Oil Company (Sacramento)
- SacPort Biofuels (Sacramento)
- Siemens Rail Systems (Sacramento)
- Sierra Energy (Davis)
- Springboard Biodiesel (Chico)
- Transfer Flow (Chico)
- West Biofuels (Woodland)
- Zivan USA Electric Conversions (Sacramento)

**OTHER NORTHERN CALIFORNIA /** Mendocino and Plumas counties.

- Eel River Fuels (Ukiah)
- Simple Fuels (Chilcoot)

## 2. CENTRAL CALIFORNIA

**CENTRAL COAST /** Monterey, San Luis Obispo, San Benito, Santa Barbara, Santa Cruz, and Ventura counties.

- Ag Waste Solutions (Westlake Village)
- Agron Bioenergy (Watsonville)
- Artisan Vehicle Systems (Camarillo)
- CDTi (Oxnard)
- Cryogenic Experts (Oxnard)
- Electro Automotive (Felton)
- Farm Fuel (Watsonville)
- The Green Station (Santa Cruz)
- Kavlico (Thousand Oaks)
- MicroBio Engineering (San Luis Obispo)
- NGEN Partners\*(Santa Barbara)

**SAN JOAQUIN VALLEY /** Fresno, Kern, Kings, Madera, Merced, San Joaquin, Stanislaus, and Tulare counties.

- A-1 Alternative Fuels Systems (Fresno)
- AltraBiofuels (Goshen)
- Biodico Sustainable Refineries (Five Points)
- Calgren Renewable Fuels (Pixley)
- California Bioenergy (Bakersfield)
- Community Fuels (Stockton)
- Crimson Renewable Energy (Bakersfield)
- EdeniQ (Visalia)
- Electric Vehicles International (Stockton)
- ER Vine & Sons (Ceres)
- Eslinger Biodiesel (Fresno)
- First Priority GreenFleet (Stockton)
- Great Valley Energy (Bakersfield)
- Greenbelt Resources (Paso Robles)
- GreenPower Bus (Porterville)
- Harvest Power (Fresno)
- Honda Proving Center (Cantil)
- Mendota Advanced Bioenergy (Mendota)

- New Flyer Industries (Fresno)
- Robert V. Jensen, Inc. (Fresno)
- Pixley Biogas (Pixley)
- Tesla Motors† (Lathrop)
- Valley Pacific Petroleum Services (Stockton)

### 3. SOUTHERN CALIFORNIA

#### FAR SOUTH / San Diego and Imperial counties.

- ACCU CHEM Conversion (El Centro)
- Achates Power (San Diego)
- Alliance Air Products (San Diego)
- American Battery Supply (Escondido)
- Battery Equaliser (San Marcos)
- BioFuels Energy (Encinitas)
- Biovia / Accelrys (San Diego)
- Border Valley Trading (Brawley)
- Buster Biofuels (Escondido)
- Canergy (San Diego)
- Cellana (San Diego)
- Clean Air Power (Poway)
- DCL International (Oceanside)
- Ebert Composites Corporation (Chula Vista)
- Fallbrook Technologies (San Diego)
- Flux Power (Vista)
- Green Star Products (Chula Vista)
- Hydrogenics (San Diego)
- Kyocera America (San Diego)
- Magnetic Transport Systems (San Diego)
- Maxwell Technologies (San Diego)
- New Leaf Biofuel (San Diego)
- Nissan Design America (San Diego)
- North American Repower (San Diego)
- Pearson Fuels (San Diego)
- Oberon Fuels (San Diego)
- Omnitek Engineering (Vista)
- Quantitative BioSciences (San Diego)
- Sapp0hire Energy (San Diego)
- Sempra Energy – includes SoCalGas and San Diego Gas & Electric (San Diego)
- SG Biofuels (San Diego)
- The Soco Group (Carlsbad)
- Synthetic Genomics (La Jolla)
- TransPower (Poway)
- Verdezyne (Carlsbad)

#### INLAND EMPIRE / Riverside and San Bernardino counties.

- American Custom Golf Cars (Chino)
- Biotane Fuels (Coachella)
- Complete Coach Works (Riverside)

- Downs Energy (Corona)
- EIDorado National (Riverside)
- Global Clean Air Technologies (Menifee)
- Hino Motors (Ontario)
- Huss Inc. (Palm Desert)
- ITM Power (Riverside)
- Imperial Western Products (Coachella)
- Karma Automotive† (Moreno Valley)
- Luxfer Gas Cylinders (Riverside)
- North American Bus Industries (Mira Loma)
- Phoenix Motorcars (Ontario)
- Superform USA (Riverside)
- ACE Cogeneration Company (Trona)
- Vantage Vehicle International (Corona)
- Verdant (Rancho Cucamonga)

#### LOS ANGELES / Los Angeles County.

- AC Propulsion (San Dimas)
- Advanced Power Products (Azusa)
- AECOM (Los Angeles)
- AeroVironment (Monrovia)
- Agile Turbine Technology (Manhattan Beach)
- Air Liquide (Los Angeles)
- Air Products (Los Angeles)
- AltAir Fuels (Paramount)
- Altitude Fuel (Los Angeles)
- Angeleno Group\* (Los Angeles)
- Audi Design Center (Santa Monica)
- Aura Systems (El Segundo)
- BAE Systems (Los Angeles)
- Baker Commodities (Vernon)
- Balqon Corporation (Harbor City)
- Bio-Friendly Fuel Partners (Los Angeles)
- Bus and Coach America (Azusa)
- BYD (Los Angeles)
- California Lithium Battery (Los Angeles)
- CalNetix (Cerritos)
- Clean Fuel Connection (Arcadia)
- Colony Energy Partners (Newport Beach)
- Concorde Battery (West Covina)
- Costello (Redondo Beach)
- Ebus (Downey)
- EcoTech Fuels (Sherman Oaks)
- Electra Craft (Westlake Village)
- EV Connect (El Segundo)
- FirstElement Fuel – includes True Zero (Newport Beach)
- Faraday Future (Gardena)
- Gentherm (Azusa)
- Global Clean Energy Holdings (Long Beach)

- H2 Frontier, Inc. (Gardena)
- H2Safe (Los Angeles)
- Honeywell Turbo Technologies (Torrance)
- HRL Laboratories (Malibu)
- HyGen Industries (Los Angeles)
- The Linde Group (Torrance)
- Landi Renzo USA (Torrance)
- Linde (El Segundo)
- Los Angeles Biodiesel Cooperative (Los Angeles)
- Materia (Pasadena)
- Motivo Engineering (Gardena)
- Pareto Point (San Pedro)
- PlugShare – formerly Recargo (Venice)
- Praxair (Los Angeles)
- Quallion (Sylmar)
- Renewable Energy Group (Santa Monica)
- Rustic Canyon Partners\* (Santa Monica)
- SAFCell (Pasadena)
- Soligen Technologies (Northridge)
- Southern California Edison (Rosemead)
- Superior Industries International (Van Nuys)
- Swagelok (Los Angeles)
- Toyota Corporate Office† (Torrance)
- Toyota Technical Center† (Gardena)
- Trojan Battery Company (Santa Fe Springs)
- UrbanX (Long Beach)
- US Hybrid (Torrance)
- Volkswagen Design Center (Santa Monica)
- Vycon (Cerritos)
- Worthington Industries (Pomona)
- Clean Energy Fuels (Newport Beach)
- CR&R (Stanton)
- Delcan (La Palma)
- Eaton (Irvine)
- Exova (Anaheim)
- FirmGreen Power Partners (Newport Beach)
- Greenkraft (Santa Ana)
- Hitachi Automotive Systems America (Cypress)
- Honeywell UOP (Anaheim)
- Horiba Instruments (Irvine)
- Hyundai (Fountain Valley)
- Hyundai-KIA America Technical Center (Irvine)
- i.i. Fuels (Huntington Beach)
- IMPCO Technologies (Santa Ana)
- Karma Automotive† (Costa Mesa)
- Kia (Irvine)
- Mitsubishi Electric (Cypress)
- Parker Hannifin (Irvine)
- Prometheus Energy (Irvine)
- Proton OnSite (Irvine)
- Quantum Sphere (Santa Ana)
- Quantum Technologies (Irvine)
- SC Fuels (Orange)
- T3 Motion (Brea)
- Targray Industries (Laguna Niguel)
- Taylor-Dunn (Anaheim)
- Tellus Technology (Aliso Viejo)
- ZeroTruck (Santa Ana)

#### **ORANGE COUNTY / Orange County.**

- Adomani (Orange)
- Aria Group (Irvine)
- AVL California Technology Center (Lake Forest)
- BI Technologies (Fullerton)
- Bluefire Renewables (Irvine)
- Cally Design Research / Toyota (Newport Beach)

#### **NOTES**

This list is not exhaustive. It does not attempt to count vehicle dealers, professional services organizations, industry associations, or fleets.

Venture capital firms are denoted by an asterisk (\*), and companies with multiple entries are signified with a dagger (†).

