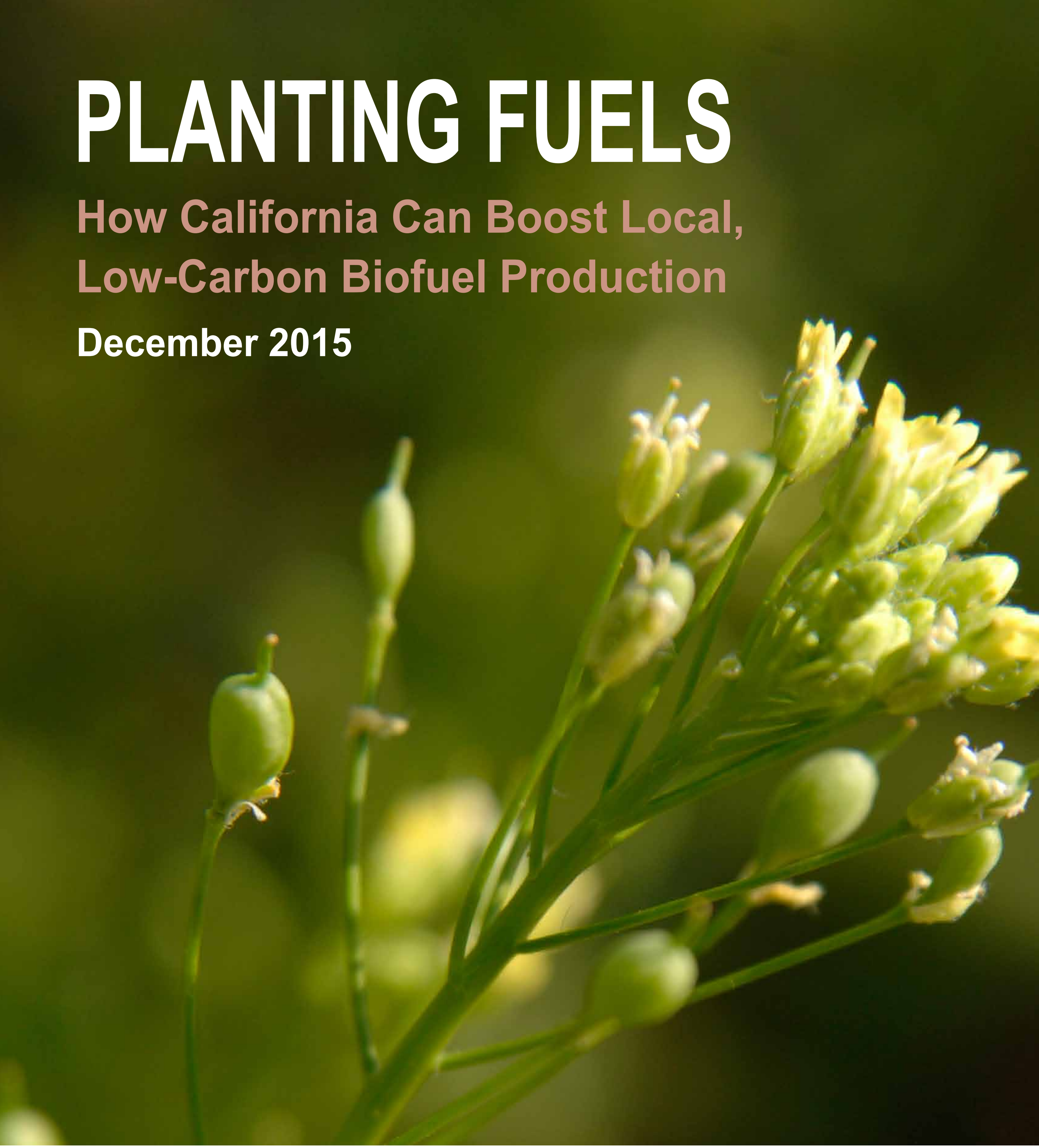
PLANTING FUELS

How California Can Boost Local, Low-Carbon Biofuel Production

December 2015



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About this Report

This policy paper is the sixteenth in a series of reports on how climate change will create opportunities for specific sectors of the business community and how policy-makers can facilitate those opportunities. Each paper results from one-day workshop convenings that include representatives from key business, academic, and policy sectors of the targeted industries. The convenings and resulting policy papers are sponsored by Bank of America and produced by a partnership of the UC Berkeley School of Law's Center for Law, Energy & the Environment and UCLA School of Law's Emmett Institute on Climate Change and the Environment.

Authorship

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This report and its recommendations are solely a product of the UC Berkeley and UCLA Schools of Law and do not necessarily reflect the views of all individual convening participants, reviewers, or Bank of America.

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Glossary of Terms

Air Quality Improvement Program (AQIP): an incentive program with an annual budget of $50 million, administered by the California Air Resources Board, which provides funds for projects that improve feedstocks and sustainable biofuel production, as well as projects that assess the air quality impacts of biofuels.

Alternative and Renewable Fuel and Vehicle Technology Program: an incentive program with an annual budget of $100 million, administered by the California Energy Commission.

California Air Resources Board (CARB): An organization within the California Environmental Protection Agency responsible for providing and maintaining clean air, including enforcement of the state's greenhouse gas reduction law (AB 32).

California Environmental Quality Act (CEQA): A statute that requires state and local agencies to identify the significant environmental impacts of their actions and to avoid or mitigate those impacts, if feasible.

California Global Warming Solutions Act of 2006 (AB 32): California state law which sets the greenhouse gas emissions reduction goal to be achieved by 2020.

Corporate Average Fuel Economy standards (CAFE): A federal fuel economy standard for vehicles that will achieve some of the greenhouse gas emission reductions in the transportation sector.

California Energy Commission (CEC): The state's primary energy policy and planning agency, which includes supporting energy research, developing renewable energy resources, and advancing alternative and renewable transportation fuels and technologies.

U.S. Environmental Protection Agency (EPA): a federal agency created for the purpose of protecting human health and the environment by writing and enforcing regulations based on laws passed by Congress.

Indirect Land Use Change (iLUC): Conversion of lands, such as previously undisturbed lands, to different land uses, other than for the production of biofuels but in connection to the growing demand for biofuels globally.

Low Carbon Fuel Standard (LCFS): California regulation pursuant to AB 32 that requires a reduction in overall greenhouse gas emissions from transport fuels used in California by 10 percent by 2020.

National Environmental Policy Act (NEPA): federal law that establishes national environmental policy and goals for the protection, maintenance, and enhancement of the environment and provides a process for implementing these goals within federal agencies.

Renewable Fuel Standard (RFS): federal fuel standard derived from the Energy Policy Act of 2005 (EPAct 2005) and the Energy Independence and Security Act of 2007 (EISA 2007) to mandate a minimum amount of billion gallons of renewable fuels by 2022.

Renewable Identification Numbers (RIN): numbers assigned to each gallon of biofuel in production or imported to track the amount and type of biofuel in circulation as well as its movement and potential exportation to meet RFS requirements.

Renewable Volume Obligation (RVO): obligated parties demonstrate compliance with their RIN under the RFS by presenting the required amount of renewable identification numbers.

Senate Bill 375: 2008 state law that instructs the California Air Resources Board to set regional emissions reduction targets from passenger vehicles and require Metropolitan Planning Organizations for each region to develop a "Sustainable Communities Strategy" that integrates transportation, land-use and housing policies to achieve the emissions target.

Introduction and Summary: A Vision for In-State Biofuel Production

Transportation fuels from petroleum-based sources represent the single largest source of carbon emissions in California, at more than 37 percent. As a result, state leaders have prioritized petroleum fuel reduction, most recently with Governor Jerry Brown's call to halve petroleum fuel usage by 2030, in order to achieve long-term climate goals.

An important strategy for reducing petroleum fuel consumption is increasing the use of substitute fuels. This report focuses on one such substitute – biofuels, which are derived from a variety of agricultural sources (such as corn, canola and sugarcane), algae, food waste, and forest residue, among other sources. Depending on the source and type, these renewable fuels can be produced locally and burn with fewer net carbon emissions than petroleum fuel.

Yet not all biofuels reduce greenhouse gases equally, and some do not offer any reductions. Cellulosic ethanol from the inedible parts of plants offers greater greenhouse gas reduction benefits as a gasoline replacement than today's conventional biofuels. Biodiesel from used cooking oil or distillers corn oil (a co-product of ethanol production) can provide greenhouse gas benefits from 86 to 96 percent compared to petroleum diesel.[1]

An important strategy for reducing petroleum fuel consumption is increasing the use of substitute fuels like biofuels.

Some biofuels offer additional benefits beyond reduction of emissions during combustion. For example, using particular biofuel feedstocks not only reduces fuel emissions but can also ensure that waste products avoid burning in destructive wildfires or decomposing, thereby reducing associated methane emissions. Biofuel production can also result in a wide range of byproducts or "co-products" that can further reduce net carbon emissions, such as bio char (a soil additive that can sequester carbon) and plastic sheets to bed strawberries and tomatoes. While local feedstock harvesting can reduce carbon emissions by shortening feedstock transportation routes, it can also provide revenue for farmers, foresters and rural residents. Local production can provide jobs and revenue in otherwise economically challenged parts of the state.

Biofuels are in significant use today. Biomass-based diesel constitutes almost three percent of the U.S. on-road diesel fuel, with production and use poised to increase, while fuel refiners commonly blend ethanol with gasoline up to ten percent. Some flex-fuel vehicles can accept ethanol-gasoline blends with up to 85 percent ethanol. Biomass-based diesel, primarily from food waste or byproducts, can be substituted for petroleum diesel wholesale in many diesel engines.

California to date has a small but growing amount of biofuel consumption. Out of 14.5 billion gallons of finished gasoline burned in the state each year, Californians consume approximately 10 percent (1.5 billion gallons) as ethanol fuel (most of which is blended with gasoline). Meanwhile, out of approximately 3 billion gallons of diesel fuel consumed annually, about 2.3 percent (70 million gallons) consists of biodiesel.

California has not yet taken full advantage of the diverse opportunities for biofuel production from in-state biomass.

But California has not yet taken full advantage of the diverse opportunities for biofuel production from in-state biomass. While current policies have put the state on a leadership path with biofuel uses, more federal and state action could ensure that California maximizes both the environmental and economic potential of in-state production.

To develop a vision and policies for producing more low-carbon, in-state biofuels, a group of biofuels producers, experts and public officials gathered at the University of California, Berkeley School of Law in May 2015 for a discussion sponsored by the law school and the University of California, Los Angeles School of Law.

The participants envisioned in-state biofuel production that would provide the maximum environmental and economic benefits through reduced emissions. They foresaw in-state biofuels potentially meeting half the demand for low-carbon fuels in California by 2030, while ensuring that economically disadvantaged areas of the state benefit from the local production.

The following report expands upon some of the key issues identified, needs explored, and solutions discussed.

Top Four Barriers to Boosting In-State Biofuel Production

1) **Policy uncertainty** at multiple levels of government, primarily related to incentive programs, that hinders private investment in biofuels;
2) **Restricted market access** to existing fuel infrastructure and gas stations due to incumbent industry resistance from automakers, gas stations, and petroleum fuel refiners;
3) **Policy misalignment** among various levels of government that may inadvertently limit biofuels deployment; and
4) **Lack of feedstock access** to some of the most promising in-state resources that could result in significant environmental and economic co-benefits.

"Fuels are an $8 billion nut to crack."

-- Neil Koehler
Pacific Ethanol

Solutions to Overcome the Barriers

- **Greater state support, including cap-and-trade auction revenue, for in-state biofuel production with accurate accounting for carbon intensity**, in order to achieve the greatest environmental and economic benefits from state biofuel policies;
- **Financial incentives for automakers and gas stations to allow and sell greater amounts of certain biofuels and higher blend rates** to overcome incumbent industry barriers and offset potential costs of new infrastructure for biofuels;
- **A state-launched process to study the optimal attainment of nitrogen oxides, greenhouse gas, and petroleum fuel reduction goals**, by determining the amount of each that will achieve the greatest co-benefits and overall pollution reduction; and
- **Improved access to and financial support for in-state feedstock production**, particularly on idled farmland and forest lands to reduce wildfire risks.

The following section summarizes these and other recommendations that are discussed in greater detail in this report, which also contains an overview of policies that affect biofuels.

Federal leaders could:

Ensure biofuel regulations discourage last-minute compliance by regulated parties due to incumbent industries fighting regulations, such as by requiring more gradual and consistent phase-ins of compliance obligations and providing more consistency and certainty for tax and other policies that affect biofuel deployment.

Encourage auto manufacturers to recommend higher biofuel blends in their vehicles through financial incentives and technical support, in order to lessen concerns about vehicle performance.

Help launch a science-based process to achieve the optimal balance among the three federal and state goals of nitrogen oxide, greenhouse gas, and petroleum fuel reductions, since some biofuels may increase nitrogen oxide emissions while decreasing greenhouse gases, other harmful air pollutants, and petroleum usage.

Work with state leaders to improve access to federal lands with the most optimal and environmentally beneficial wood residue as a feedstock, as determined by a multi-stakeholder group relying on a carbon accounting method that satisfies objective requirements for biofuel greenhouse gas reduction benefits.

State leaders could:

Clarify the status of the low carbon fuel standard for the years following 2020, either under existing AB 32 limits or based on new legislation for 2030 and 2050.

Consider strengthening the current low carbon fuel standard to require petroleum fuel providers to blend more low-carbon biofuels into their products as a means to counter petroleum fuel providers' economic disincentive to blend more biofuel.

Develop contingency backup plans in case of federal retrenchment of the renewable fuel standard, including a statement of steps to compensate for the potential loss of federal support for biofuels, such as a blenders' tax incentive or subsidies for low carbon fuel standard compliance.

Create a "carbon intensity group" at the California Air Resources Board to speed determinations of carbon emissions calculations for biofuels and thus more quickly identify the co-benefits from various biofuel deployment scenarios, particularly for in-state providers, such as through better staffing for the life-cycle assessment process.

Develop a funding program for California that enables temporary purchasing of biofuels as a market backstop to reduce uncertainty in the wholesale oil and biofuels feedstock markets, with built-in protections for taxpayers.

Ensure biofuel regulations such as the low carbon fuel standard have compliance periods that discourage last-minute compliance due to incumbent industries fighting regulations, such as by requiring a more gradual and consistent phase-in of compliance obligations.

Include an in-state biofuel production incentive or capital expense support for greenhouse gas reduction funds from the cap-and-trade auction proceeds from transportation fuels, with distinct targets for each biofuel type that match their unique development potential.

Consider stronger incentives for gas stations to provide 85 percent biofuel blends (E85), such as through state grants or tax credits to offset the costs of installing new infrastructure for the biofuels.

Consider approving the sale of higher low-carbon ethanol blends in vehicles, based on calculations for higher-level blends up to E30 in California's regulatory "predictive model," in order to encourage greater use of lower-carbon ethanol above the current ten percent blends.

Establish biofuel goals that better balance the three requirements of nitrogen oxide, greenhouse gas, and petroleum fuel reductions, by working with federal officials who review state Clean Air Act plans to develop a methodology to determine the optimal amount of each goal, while also incorporating economic and job benefits where feasible.

Ensure that both biofuel providers and petroleum refiners are held to the same high standard on underground fuel storage standards, water disposal, and water recycling, specifically with underground leak detection systems that may disproportionately benefit petroleum-based oil refining from weaker oversight.

Develop uniform statewide standards and programmatic environmental review documents for permitting biofuel production facilities, while still preserving local context-specific review, including compliance checklists and processes for local governments to adopt.

Ensure that the low carbon fuel standard more explicitly includes a role for biofuels in addition to zero-emissions vehicles, in order to avoid over-reliance on a single transport fuel to meet state petroleum reduction goals.

Explore loosening restrictions on the use of technologies that can harvest and convert local feedstocks to biofuels in an environmentally and economically beneficial manner, via a multi-stakeholder study group that addresses local pollution and economic development concerns.

Identify optimal locations for wood residue as a feedstock and then coordinate with the federal government to improve access to these sites by launching a multi-stakeholder group to achieve agreement on how forests should best be managed.

Explore ways to make the transport of feedstock residues from around the state more financially viable, either by decreasing the time and uncertainty related to regulatory compliance or by providing financial support.

Investigate options to encourage the reuse of rice straw as a biofuel feedstock, such as by basing capital support and carbon credits on a calculation of the benefits of reduced methane emissions from not returning it to the ground versus potential increased costs.

Study and explore opportunities to encourage purpose-grown crop production for biofuel feedstocks that result in overall greenhouse gas benefits, as well as rural economic benefits.

Biofuels Will Help Meet California's Long-Term Environmental and Economic Goals

No single energy source affects climate change and air quality in California as much as transportation fuel. California's transportation sector represents the largest single source of greenhouse gas emissions in the state, at 37.3 percent (see Figure 1) – greater than the approximately 33 percent nationwide.[2] Significantly, this percentage only refers to tailpipe emissions. Life cycle fuel costs, including oil and gas extraction and refinery processing from the industrial sector, add more than 10 additional percentage points, for a total of almost half of all greenhouse gas emissions in the state from transportation (see Figure 2).

Without reductions from the transportation sector, the state will not be able to meet its goals under the California Global Warming Solutions Act of 2006 (Assembly Bill [AB] 32)

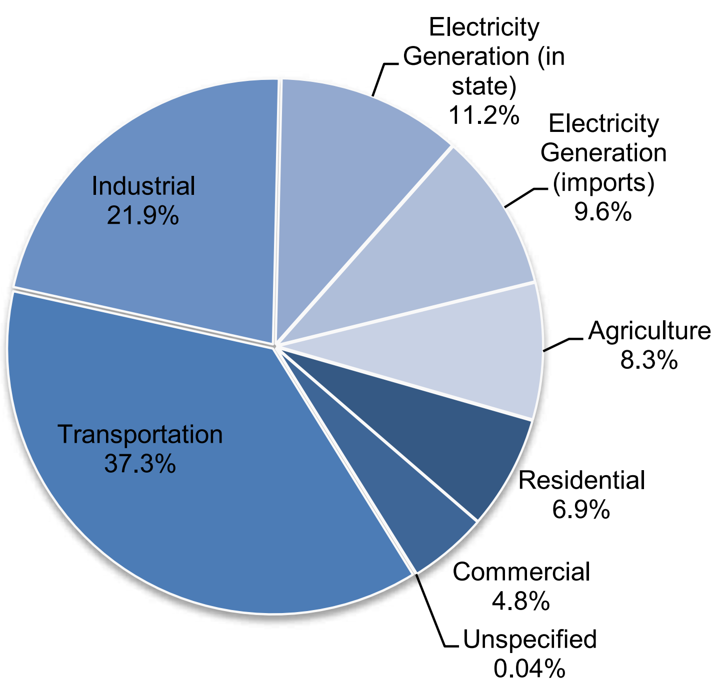


Figure 1. California's Greenhouse Gas Emissions by Sector (2012)
Source: California Air Resources Board

"The state's greenhouse gas goals show that California is in this game to stay, and the state is staying the course on climate. But achieving these ambitious goals will require a sustained effort."

-- Cliff Rechtschaffen
Office of Governor
Jerry Brown

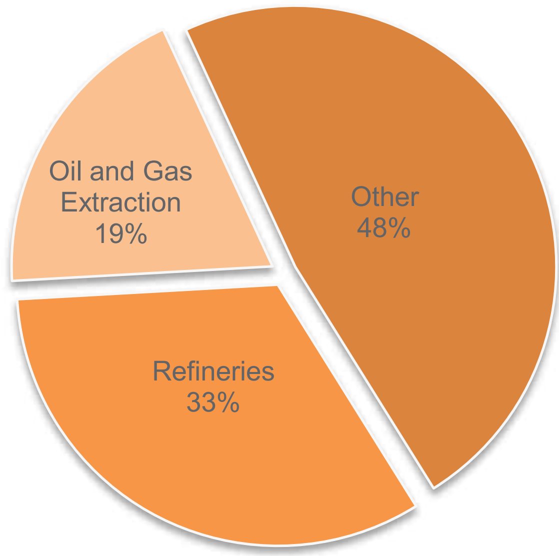


Figure 2. Greenhouse Gas Emissions from California's Industrial Sector

Source: California Air Resources Board

to roll back greenhouse gas emissions to 1990 levels by the year 2020 (equivalent to a 15 percent cutback from the business-as-usual scenario projected for 2020).[3] Former California Governor Arnold Schwarzenegger's Executive Order S-3-05 additionally calls for an eighty percent reduction from 1990 levels by 2050.[4] California reaffirmed this goal in Senate Bill (SB) 391 (Lowenthal, 2009), SB 350 (De Leon, 2015), and in the AB 32 Scoping Plan first update.[5] Meanwhile, Executive Order B-30-15 calls for 40 percent reductions by 2030,[6] while Governor Brown's inaugural address set a goal of 50 percent petroleum fuel reduction.[7]

Biofuels include a wide variety of fuels derived from biomass, which recently captured carbon from the atmosphere that would otherwise return there under natural processes.

Leaders of the California Air Resources Board, the agency charged with implementing AB 32, have developed a suite of policies to reduce petroleum emissions in order to achieve the state's greenhouse gas goals. Battery electric vehicles are projected to make up a significant percentage of the vehicle fleet by 2030, while improvements in vehicle fuel economy due to new federal corporate average fuel economy (CAFE) standards will constitute some of the reductions. In addition, the Air Resources Board projects flattened or even decreasing vehicle miles traveled due to more compact development patterns, as promoted by SB 375 (Steinberg, 2008), and growing demand for non-automobile dependent communities. However, biofuels are still likely to constitute up to half of the long-term petroleum reductions.[8]

Low-carbon biofuel providers use plant matter to neutralize or reduce greenhouse gas emissions for transportation

Biofuels include a wide variety of fuels derived from biomass, which recently captured carbon from the atmosphere that would otherwise return there under natural processes (in contrast to fossil fuels, which extract large amounts of carbon from underground deposits). Although commonly thought of as liquid fuels, biofuels can also be gaseous, such as biomethane and biopropane (sometimes referred to as "bioenergy" and not the subject of this report).[9] Woody biomass, converted to electricity, can also be considered a biofuel feedstock if it is used to power electric vehicles. In the transportation context, the term mostly refers to liquid biofuels, although gaseous biofuels are increasingly considered as alternative transportation fuels. The dominant liquid biofuels are ethanol and biomass-based diesel.[10]

Carbohydrate-Based Biofuels (Ethanol)

Ethanol blended into gasoline is the most common biofuel in use today. It can be produced from soluble carbohydrates such as sugar and starch or insoluble carbohydrates that make up the fibrous parts of plants. Soluble carbohydrates commonly used for ethanol include corn, sugarcane, sorghum and wheat. Insoluble carbohydrates are often referred to as cellulosic feedstocks, including corn, switch grass, and wood fiber. Unlike oil and grains, which have a high energy density and can be transported over a long distance from the place of extraction to a refinery, cellulosic ethanol feedstocks are usually processed into ethanol in nearby plants due to the difficulty of transporting the bulky feedstocks.[11] While most ethanol is produced from corn and sugarcane, cellulosic bioethanol production is still at the pilot stage in many countries, with cellulosic or advanced feedstocks like switch grass, miscanthus, energy cane, short rotation woody biomass (i.e. poplar and willow), forestry residues, other annual and perennial crop species, and algae. To date, these fuels have been more difficult to produce at a commercial scale and reasonable cost.[12]

Producers of ethanol from corn or sugarcane must use the parts of the plants that are rich in starch and sugar. With corn, for example, they mostly use the kernels to produce ethanol. Producers of cellulosic bioethanol, on the other hand, utilize the structural parts of the plants. They process these feedstocks using different methods. Corn, for example, can be processed into ethanol using the predominant dry-milling, which includes milling and pretreatment, fermentation, and distillation or less-common wet-milling. Corn processing also can yield numerous high-value co-products, such as thin film plastics to bed strawberries and tomatoes. Cellulosic ethanol production also includes costlier mechanical and biochemical pretreatments to break up the structural fibers of the plant feedstocks.[13]

The production pathways not only differ in their feedstocks but also in their carbon footprints and costs, depending on the analysis used, since the energy expenditure and additional inputs used during the processing may differ significantly. For example, Brazilian sugarcane ethanol is generally produced with lower carbon intensity than U.S. corn ethanol using the wet-milling process.[14] In general, most dry-milled corn ethanol from the U.S. Midwest typically does not offer significant greenhouse gas reduction benefits, given its land use impacts and production pathways.[15]

Lipid-Based Biofuels (Biodiesel)

Lipid-based biofuels serve as supplements and substitutes for diesel fuel. Biodiesel is the second most commonly used biofuel type in the world. As with ethanol (see sidebar), the first attempts to fuel engines with vegetable oil took place more than a century ago. However, the wide availability of fossil diesel fuel significantly set back the development of biomass-based diesel fuels. Biodiesel did not become widespread until the 1990s, even in countries with higher rates of diesel use.[19] In recent years, novel forms of processing have added to the existing diversity of biodiesel under a larger category of diesel replacements known as biomass-based diesel.

Biomass-based diesel feedstocks include various vegetable oils, animal fats, waste oils, and algae. Internationally, soy, rapeseed and palm oil are the most common feedstocks. In the United States, biomass-based diesel – influenced by federal policy (see below) – comes from soybean oil (42 percent), used cooking oil or recycled grease (19 percent), animal fat (15 percent), inedible distillers' corn oil (14 percent), and canola (9 percent).[20] In order to produce biomass-based diesel, producers collect waste materials or purchase vegetable oil not utilized for food use. The oil molecules can be converted into a pure hydrocarbon with the same properties as petroleum-based diesel fuel. As a result, the process creates a pure "drop-in" renewable diesel fuel that can be blended into petroleum diesel at the refinery and run through existing pipelines and distribution infrastructure.[21]

Early use of ethanol as an engine fuel

At the height of the industrial revolution in the middle of the nineteenth century, Nikolaus Otto, the father of the modern four-stroke engine, used ethanol in an early design of his engine. A half decade later, Henry Ford's transportation revolution starter vehicle, the Model T, was capable of running on both gasoline and ethanol, as the industrialist believed that ethanol was going to become the transport fuel of the future.[16] This belief was not completely ill-conceived, given that oil accounted for less than five percent of the world's energy production at the turn of the century and that oil reserves were thought to be quite restricted. By contrast, new, high-output ethanol production methods were promising to flood the energy market with a cheap and sustainable stream of ethanol.[17]

Ethanol was one of the early candidates to be the most widely used transport fuel. It was not only used as a *substitute* for gasoline but an *additive* to it. Ethanol's chemical properties make it a suitable octane enhancer and an anti-knocking agent for regular gasoline. However, ethanol was displaced in these roles starting in the 1920s with tetraethyl lead (which turned out to be the most harmful component of leaded gasoline) and then in the 1970s with methyl tert-butyl ether (which turned out to be a carcinogenic component of the supplementing unleaded gasoline). Ethanol then re-assumed these roles at the turn of the millennium as policy makers phased out the other compounds in the U.S. due to environmental and health concerns.[18]

Biodiesel production can be economical at a smaller scale than bioethanol production and can be based on more diverse feedstock crops, since it is more dependent on plant availability in different parts of the world.[22] Producers can also use animal fats and waste oils to make biodiesel, which collectively constitute 48 percent of the biomass-based diesel in the United States. Although these fats and oils are beneficial to recycle into fuel rather than discard, further innovations, such as for processing more plentiful brown grease, will be necessary to boost their availability.[23] Algal biodiesel production, however, is still largely at the pilot project stage, as no farming operations currently exist for mass cultivation of algae and several difficult technical challenges remain to be solved.[24]

Animal fats and waste oils collectively constitute 48 percent of the biomass-based diesel in the United States.

Biofuel deployment for gasoline is hindered by the "blend wall"

Blended biofuels can be used in all vehicles present in the U.S. transport sector: passenger vehicles, light- and heavy-duty trucks, buses, trains, ships, and airplanes. However, spark ignition engines are sensitive to the ratio of fuel to air. Beyond low-level biofuel blends, these engines require special equipment to sense the presence of alcohol in the fuel blend and adjust the fuel injection rate accordingly. As a result, not all engines can take the same biofuel-petroleum fuel blends, depending on the type and technology of biofuel involved. Flex fuel vehicles have special equipment to allow blends up to 85 percent ethanol (E85), while up to 15 percent ethanol (E15) can be used in vehicles from model year 2001 and later. The U.S. Environmental Protection Agency limits older vehicles to 10 percent ethanol.[25] Experts have coined the phrase "blend wall" to refer to the limit on higher penetration of ethanol. As a result, low-percentage biofuel blends are common in road transport, but high-percentage biofuel blends are rare. The latter blends are mostly used by committed individuals in passenger cars and by some truck or bus fleet operators.[26]

Newer biofuel technologies of the future may overcome these deficiencies by using non-food organisms or catalytic processes for feedstocks, which require little-to-no arable land for cultivation and could function as drop-in biofuels as well. Regular gasoline or diesel engines should be able to run drop-in biofuels without requiring special equipment for the engine.[27]

Notably, the "blend wall" barrier affects gasoline engines in marine vessels and trains even more significantly, due to their longer life-cycles and warranties.[28] Meanwhile, commercially available biofuels are not yet sufficiently advanced to comply with the stringent requirements imposed on aviation fuels. Besides some demonstration flights, biofuels remain largely unused in aviation to date.[29]

"Johnny consumer doesn't know what E85 [85 percent ethanol blend fuel] is. They don't know if flex fuel and hybrid vehicles are the same. So we need to overcome the lack of knowledge."

-- Dayne Delahoussaye
Neste Oil

By contrast, compression ignition engines are not sensitive to the fuel-to-air ratio as are spark ignition engines. As a result, biomass-based diesel does not require special equipment to sense the presence of different fuel types or alter injection rates as required for gasoline engines. The different combustion characteristics of compression ignition engines, coupled with the different legal classification of biomass-based diesel as a fuel and not an additive, means that biomass-based diesel fuels do not face a "blend wall." Vehicle manufacturers have therefore approved higher blend levels in recent years, with the majority of vehicle manufacturers approving 20 percent or higher blends of biodiesel (B20) and some approving 100 percent biodiesel (B100).

Production pathways and shipping affect the environmental impacts of biofuels

Different types of bioethanol have different carbon footprints, depending on the diverse feedstocks, processing methods, and transportation methods (as mentioned, certain types of Midwestern corn-based ethanol, for example, lack significant greenhouse gas benefits).[30] After the processing in an ethanol plant, producers ship the processed ethanol to blending terminals. They ship the majority of ethanol in the U.S. by rail or cargo tank trucks.[31] Although shipping via oil pipelines would decrease the carbon footprint of the ethanol, this mode would require significant changes in pipelines or building new, dedicated pipelines, due to the corrosive and hydrophilic nature of ethanol.[32] Imported sugarcane ethanol arrives in the U.S. via freighter ships. Upon arriving at blending terminals, ethanol is blended with gasoline.

The biodiesel supply chain differs from that of ethanol. Some biomass-based diesel suppliers are co-located at pipeline terminals. For standalone production facilities, biomass-based diesel is transported to fuel terminals mostly by rail or by cargo tank trucks, then blended with diesel fuel and transported to retailers by cargo tank trucks. Although producers can use existing infrastructure to transport and store biomass-based diesel, they need to check the rubber seals and fittings frequently, as contact with high concentrations (in excess of 50 percent blend) of biodiesel may swell and wear them out. Only blends containing 20 percent or higher biodiesel require new or upgraded fuel pumps.[33] As with ethanol, the California Air Resources Board has established different pathways to determine carbon intensity based on the feedstock production technique and other producer-specific details.[34]

Unlike ethanol, biodiesel causes some environmental and health concerns during consumption, since the use of higher blends in particular results in higher levels of nitrogen oxide emissions.[35] In addition, depending upon biodiesel feedstocks and without further processing and monitoring, blends above B5 may cause a gelling problem in cold weather, since some biodiesel crystalizes at a higher temperature than regular diesel.[36]

Unlike ethanol, biodiesel causes some environmental and health concerns during consumption, since the use of higher blends in particular results in higher levels of nitrogen oxide emissions.

Due to the ongoing need to improve the use of ethanol and biodiesel fuels in today's engines and fueling infrastructure, scientists continue to develop improved production techniques for conventional and advanced biofuels. Although many renewable fuels are still only lab experiments and pilot projects, a few commercial-scale advanced biofuel plants are in operation both in the U.S. and overseas.[37]

California's low carbon fuel standard is critical to boosting biofuel deployment

The low carbon fuel standard (LCFS) is the most important policy tool in California affecting biofuel development and deployment. The regulation was adopted pursuant to Executive Order S-01-07 in 2007 by former Governor Schwarzenegger to meet the greenhouse gas emission reduction requirements set by AB 32. It was most recently re-adopted in September 2015. The low carbon fuel standard requires a reduction in overall greenhouse gas emissions from transport fuels used in California by 10 percent by 2020.[38] Its backers aim to foster technological development in the renewable fuel sector and to reduce the carbon intensity of fuels. The regulation does not expressly limit the use of certain types of biofuels or other energy sources and is technology neutral. The standard also affects other alternative transport fuels, such as compressed and liquid natural gas, electricity, and hydrogen.[39]

The California Air Resources Board (CARB) is responsible for the implementation of the low carbon fuel standard. The agency monitors the activities of regulated parties subject to the standard, including the producers and importers of regular transport fuels (gasoline and diesel), fuel blendstocks (biofuels), and fuel substitutes (biofuels or alternative fuels).[40] Air Resources Board officials ensure that the fuel pool sold on the California market complies with the carbon intensity requirements set in the regulation. The regulated parties ultimately have discretion to decide how to comply with the requirement: by producing, importing or locally purchasing biofuels and blending them in the regular petroleum fuels (gasoline or diesel) they produce or import; by importing or producing biofuels or alternative fuels; or by purchasing low carbon fuel standard credits from producers or importers of biofuels or alternative fuels.[41]

The low carbon fuel standard requires a reduction in overall greenhouse gas emissions from transport fuels used in California by 10 percent by 2020.

To comply with the standard, regulated parties need to demonstrate (or get third party certification of) the physical pathway by which the fuel is produced and physically reaches the California market.[42] In addition, regulated parties need to submit to the Air Resources Board quarterly progress reports and annual compliance reports,[43] in which they disclose the fuel volumes that pass through their supply chain, the carbon intensity of these fuels, and the low carbon fuel standard credit or deficit accumulated.[44] These reports enable the Air Resources Board to follow the progress of regulated parties over the year, monitor their compliance at the end of the year, and, if necessary, impose penalties on regulated parties that fall more than 10 percent short of their carbon intensity requirements.[45]

The low carbon fuel standard not only takes into account the emissions resulting from fuel consumption but also the emissions resulting from the production, processing, and transportation of the fuels. Thus Air Resources Board officials track emissions throughout the full life-cycle of the fuels, "from well to wheels," including indirect emissions from biofuels.[46] The low carbon fuel standard regulation contains a "Lookup Table" documenting the carbon intensity of a multitude of regular fuel, biofuel, and alternative fuel production pathways. While regulated parties can calculate compliance with the carbon intensity requirements based on the values specified in the Lookup Table, they can also apply for approval of alternative values or of alternative production pathways.

In the case of biofuels produced from different crop feedstocks, the low carbon fuel standard takes into account the effect of indirect land use change (iLUC).[47] The standard iLUC values associated with various feedstocks are based on economic modeling, and parties cannot change them by applying to the Air Resources Board for alternative values.[48] The inclusion of iLUC effects and the economic models used to estimate the iLUC stirred significant controversy, litigation, and criticism.[49]

Additional California policies promote biofuels

Other policies that affect biofuel development and deployment in California include the Air Quality Improvement Program (AQIP) and the Alternative and Renewable Fuel and Vehicle Technology Program. These programs were established by California Assembly Bill 118, the California Alternative and Renewable Fuel, Vehicle Technology, Clean Air, and Carbon Reduction Act of 2007.[50] The AQIP, an incentive program with an annual budget of $50 million administered by the Air Resources Board, funds projects that improve feedstocks and sustainable biofuel production, as well as projects that assess the air quality impacts of biofuels.[51] Meanwhile, the Alternative and Renewable Fuel and Vehicle Technology Program, an incentive program with an annual budget of $100 million administered by the California Energy Commission, funds research and pilot projects involving the development and improvement of new biofuel types, the production of these fuels in California, and the improvement of alternative fuel infrastructure, among other tasks.[52] The two programs are responsible for funding numerous biofuel-related projects, especially projects involving the production of biofuels in California.[53]

The low carbon fuel standard takes into account the emissions resulting from the production, processing, and transportation of biofuels.

California's biofuel development is also affected by the cap-and-trade program, similarly developed under AB 32 authority.[54] The cap-and-trade program is designed to reduce greenhouse gas emissions by setting a cap on emissions for large polluters and then gradually lowering this cap. Large polluters comply with the requirement by reducing their greenhouse gas emissions or by purchasing emissions allowances at auction or from other covered entities.[55] Although the cap-and-trade program took effect in 2012, transportation fuels only came under the cap starting on January 1, 2015. As a result, fuel suppliers to the California market are now liable for the greenhouse gas emissions from the supplied fuels' combustion and need to obtain emission allowances for the fossil fuels they supply to the California market (see Figure 3).[56] Emissions from the combustion of biofuels are mostly exempt from the cap-and-trade program (methane and nitrous oxide emissions from the combustion of biomass-derived fuels could trigger a carbon obligation under the cap, depending on the volume delivered to market). As a result, the cap-and-trade program will likely increase the retail price of transport fuels and simultaneously lower the low carbon fuel standard credit prices by narrowing the price gap between fossil fuels and biofuels.[57] The cap-and-trade program may therefore non-discriminately increase the amount – and potentially the cost – of biofuels supplied to the California market, since unlike the low carbon fuel standard, cap-and-trade does not differentiate between biofuels with different carbon footprints.

Federal biofuel policies

The federal government promotes biofuel production via various policies. Notably, these policy mechanisms do not include the precise carbon accounting involved with the low

Cap and Trade Expenditure Plan
(Dollars in Millions)

Investment Category	*Department*	*Program*	*2014-15*	*Ongoing*
Sustainable Communities and Clean Transportation	High-Speed Rail Authority	High-Speed Rail Project	$250	25 percent
	State Transit Assistance	Low Carbon Transit Operations Program	$25	35 percent
	Caltrans	Transit and Intercity Rail Capital Program	$25	
	Strategic Growth Council	Affordable Housing and Sustainable Communities Program	$130	
	Air Resources Board	Low Carbon Transportation	$200	Annual Appropriations
Energy Efficiency and Clean Energy*	Department of Community Services and Development	Energy Efficiency Upgrades/Weatherization	$75	Annual Appropriations
	Energy Commission	Energy Efficiency for Public Buildings	$20	
	Department of Food and Agriculture	Agricultural Energy and Operational Efficiency	$15	
Natural Resources and Waste Diversion	Department of Fish and Wildlife	Wetlands and Watershed Restoration	$25	Annual Appropriations
	Department of Forestry and Fire Protection	Fire Prevention and Urban Forestry Projects	$42	
	Cal Recycle	Waste Diversion	$25	
Total			**$832**	

* Emergency drought legislation enacted in February 2014 included $40 million of Cap and Trade funds for water use efficiency projects.

Figure 3. Cap and Trade Funding

Source: California Budget

carbon fuel standard. At the same time, these federal policies help California's efforts, to the extent that low-carbon fuel providers are able to take advantage of federal support.

The renewable fuel standard helps California biofuels but has been implemented unevenly and without guaranteed carbon benefits

The renewable fuel standard (RFS) represents the main federal policy tool to facilitate the production and consumption of biofuels. Congress enacted the Energy Policy Act of 2005 (EPAct 2005) to create the first renewable fuel standard. An initial version of the RFS (later dubbed "RFS1") only applied to the national gasoline supply and mandated that it should contain a minimum of 7.5 billion gallons of renewable fuels by 2012.[58]

The Energy Independence and Security Act of 2007 (EISA 2007) then amended and expanded the renewable fuel standard in several respects. First, "RFS2" covered most of the transport fuels in the United States, not just gasoline. The renewable fuels covered by RFS2 are divided into two main categories: conventional and advanced biofuels. Advanced biofuels are further divided into biomass-based diesels, cellulosic biofuels, and other advanced biofuels. Second, RFS2 extended the policy until 2022 and set a new overall volume target for biofuels and new volume targets for the different categories of biofuels. Third, RFS2 introduced a complex system of requirements for biofuel production and consumption, including life-cycle emission performance requirements and feedstock requirements. These requirements vary for different categories of biofuels covered by RFS2.[59]

The Environmental Protection Agency oversees the implementation of the renewable fuel standard and determines the trajectory of biofuel development by setting annual volume mandates. The agency monitors the renewable fuel standard through a system of "renewable identification numbers" (RINs), which are assigned to each gallon of biofuel in production or imported. The agency can then track the amount and type of biofuel in circulation as well as its movement and potential exportation. Obligated parties demonstrate compliance with their renewable volume obligation (RVO) by presenting the required amount of renewable identification numbers (RINs technically have an expiration date while low carbon fuel standard credits do not). In addition, the Environmental Protection Agency determines renewable volume obligations on an annual basis.

The renewable fuel standard has indiscriminately boosted production of biofuels that may lack significant carbon benefits.

The renewable fuel standard has been subject to criticism from practitioners, politicians, and academics alike.[60] Despite efforts to boost cellulosic biofuel production, supplies remain limited due to the high cost of producing these fuels and the lack of sufficient production technologies.[61] In addition, the 10 percent "blend wall" for ethanol effectively limited the uptake of biofuels in the U.S. fuel market. Although the Environmental Protection Agency introduced a partial waiver program for E15 (15 percent) gasoline-ethanol blends, deployment is limited without further government action.[62] As a result, the hoped-for biofuel volumes in the gasoline pool will likely not be achieved. The biomass-based diesel category, however, has consistently exceeded its statutory volume requirements. Finally, the renewable fuel standard has indiscriminately boosted production of biofuels that may lack significant carbon benefits, such as some Midwestern corn-based biofuels.

Other federal policies affecting biofuels

Biofuel deployment is supported by several tax policies at the federal level. Most policies are aimed at further development and deployment of biofuels via tax credits for producers, blenders, retailers and users. Ethanol production (mostly second-generation ethanol production) and fuel infrastructure are also eligible for tax credits. These tax credit programs were set to expire on December 31, 2013, but Congress extended them through December 31, 2014. Further extensions of the tax credit programs have not been decided yet.[63]

California has a small but growing in-state biofuel deployment

With supportive federal and state policies, California is now one of the leading states in the U.S. for advanced biofuel technology and production, due to its large market and favorable policies.[64] California has the largest motor vehicle pool in the country, with nearly 30 million vehicles and the largest transport fuel market in the United States. According to 2013-2014 data, Californians consume 14.5 billion gallons of finished gasoline and around 3 billion gallons of diesel fuel.[65] Finished gasoline not only contains petrol gasoline but also additives. Therefore, Californians also consume approximately 1.5 billion gallons of ethanol fuel, most of which is blended with gasoline in the form of E10 or higher ethanol-content gasoline blends.[66] In addition, analysts estimate that biodiesel consumption in California is greater than 70 million gallons annually and increasing. As a result, Californians replace more than 1.5 billion gallons of fossil fuel with biofuels each year.[67]

Californians consume approximately 1.5 billion gallons of ethanol fuel.

California also has a small but growing infrastructure catering to those who want to purchase higher biofuel-content fuel. Of the nearly 10,000 fueling stations located in California, roughly 70 offer high-ethanol content gasoline blends and more than 50 offer high biodiesel-content diesel blends. California all together has more than 2,600 fueling stations offering alternative transport fuels, including gaseous transport fuels and electricity.[68]

Yet the state has potential to boost more in-state production and ensure that more of the low-carbon fuel used for transportation comes from local sources, both to achieve lower carbon intensity from the production and shipping but also to ensure greater in-state economic benefits from biofuel policies. The following section details the key barriers to boosting more in-state production and the policies that could overcome them.

Barrier #1: Policy Uncertainty at Multiple Levels of Government

Financing typically depends on certainty, in both the long-term market and policy landscape. In the biofuel world, much of that certainty depends on steady and consistent policies at various levels of government, particularly federal and state. Yet participants at the convening cited uncertainty at both the federal and state levels that affects their ability to secure needed financing for biofuel facilities. At the federal level, the Environmental Protection Agency's renewable fuel standard has been plagued by litigation,[69] delay, and uncertainty.[70]

At the state level, the low carbon fuel standard has been the primary driver of biofuel deployment. But industry leaders express concern that the statutory authority for the program under AB 32 will only cover emissions leading to the 2020 levels. Although the California Legislature is debating more aggressive greenhouse gas emissions reductions beyond that year, the future of the program beyond 2020 remains unclear, barring further agency clarification. In addition, the California Air Resources Board revisits the low carbon fuel standard from year-to-year, creating another layer of uncertainty. Industry leaders also note that the agency may lack sufficient staff resources to make speedy determinations regarding program compliance and carbon accounting. Finally, industry leaders point to the lack of certainty about whether funds from allowance auctions under the state's cap-and-trade program can be applicable to biofuel providers. Eligibility for these funds could greatly improve the financial prospects of many biofuel facilities, while uncertainty around how the state will spend the funds means biofuel producers cannot rely on them to secure financing.

"Our state grant was awarded in 2010, but the facility permission was obtained only in 2014. So it's great to have a good policy, but there is a need for better implementation."

-- Lyle Schlyer Calgren Renewable Fuels

SOLUTIONS

The California Air Resources Board should clarify the status of the low carbon fuel standard for the years following 2020. AB 32 sets an emissions reduction goal for the year 2020, but the statute presumably locks in the 1990 emissions level for the years following 2020, indefinitely. Meanwhile the California Legislature will debate legislation in 2016 for greenhouse gas emissions targets in 2030. Given the current and proposed legislation, biofuel investors and financiers will need clarification about what to expect beyond 2020. Agency leaders should announce what the broad goals of the low carbon fuel standard program are likely to be in the years following 2020, based on AB 32 emissions levels in effect during that time period, and what factors would lead to changes in the program. This information could be helpful to provide more certainty and therefore secure more financing for the industry.

The California Air Resources Board and possibly the state legislature should develop a contingency plan and state policy backups in case of federal retrenchment of the renewable fuel standard. In-state biofuel providers could be financially harmed by the aforementioned uncertainty with the federal renewable fuel standard, including calls to repeal or severely limit it. Because California relies on federal policy to help lower the economic and carbon cost of compliance with state regulations, any

changes to it could increase the costs and uncertainty related to state policies. In addition, a change in federal policy could create a strong incentive for advanced biofuels from Brazilian sugar-based ethanol to flood the California market, limiting the opportunities for domestic biofuel development and increasing the potential carbon footprint due to international shipping. To reassure the industry and its investors, the state could develop a statement of steps it would take to compensate for the potential loss of federal support for biofuels. Such backup policies could include a blenders' tax incentive or subsidies for low carbon fuel standard compliance.

State leaders should create a "carbon intensity group" at the California Air Resources Board to develop pro-active decisions on biofuels and determine carbon emissions calculations faster. Such a work group, with sufficient resources, could more quickly study and identify the co-benefits from various biofuel deployment scenarios and therefore credit biofuel providers more accurately, particularly those that locate in-state. Many participants at the convening believed their products provide more emissions reductions and economic benefits than are currently captured in the existing models, including in CalEnviroScreen project scoring. More staff resources for this workgroup, as well as independence from market actors, could potentially lead to policy changes that would result in more in-state biofuel production, with attendant economic and environmental co-benefits.

The state legislature should consider developing a funding program for California that enables temporary purchasing of low-carbon biofuel as a market backstop to reduce uncertainty. Given the flux of the wholesale oil and biofuel feedstock markets, biofuel providers could potentially secure greater access to financing if California were to develop a limited fund to purchase low-carbon biofuels in case of market downturns. Such a policy-based market "floor" could catalyze more private investment, functioning as a type of insurance program with built-in protections for taxpayers. As a related measure, AB 692 (Quirk), which Governor Brown signed in October 2015, requires the state to utilize biofuels in its fleet, leading to guaranteed in-state demand for biofuels that could be construed as a type of market floor.[71]

United States Environmental Protection Agency and California Air Resources Board leaders could ensure biofuel regulations have compliance periods that discourage last-minute compliance by regulated parties. Some participants noted that incumbent industries like petroleum fuel providers often fight regulations that benefit biofuels until the last minute of their compliance obligation. As a result, the uncertainty around compliance undercuts investment, since biofuel providers often lack sufficient time to prepare their product to meet the uncertain demand. Last-minute compliance means that many petroleum fuel providers, for example, start buying biofuels or low carbon fuel standard credits only after the California Air Resources Board quarterly reports come out. Clean fuel suppliers may then be "starved" of demand until the last minute. A sudden increase in production and shipping places an extra cost on many providers, particularly those who are located out-of-state. As a result, policy makers should consider more gradual and consistent phase-ins of compliance obligations, such as via more and shorter time intervals.

The governor and legislature should include an in-state biofuel production incentive or capital expense support in the investment strategies for greenhouse gas reduction funds from the cap-and-trade auction proceeds from transportation fuels. Such funding for in-state producers of biofuels would help them expand their ability to produce and distribute low carbon transportation biofuels necessary for the success of the low carbon fuel standard. State leaders could ensure that the funding is contingent upon increased production levels and technologies that lower the carbon intensity of in-state produced biofuels or based on capital expense needs to offset costs related to permitting. Because each biofuel type (such as biodiesel and ethanol, as well as biogas) has different characteristics and needs, state leaders may want to consider establishing distinct targets for each type that match their unique development potential and carbon benefits.

Barrier #2: Restricted Market Access

Participants noted that incumbent industries, including retail gas stations, petroleum fuel providers, and automakers, have little incentive to allow biofuel providers access to their market. Retail gas station owners face the disincentive of having to invest in new storage infrastructure in order to store higher ethanol blends; even tanks used for storing lower ethanol blends need to be checked for corrosion and water contamination more frequently.[72] With lower blends, producers can use the regular gasoline distribution infrastructure to distribute the blend to retailers. But the hydrophilic quality of ethanol still poses a possible water contamination problem. While higher blends are also available at some gas stations, these ethanol-gasoline blends are currently unregulated.[73] As a result, most gas station owners are unwilling to invest in new storage and pumping equipment, particularly with uncertain demand for the product.

Automakers also lack incentive to allow higher blends of biofuels in their vehicle engines. Most current gasoline engines cannot run on bioethanol alone but rather on various blends of ethanol and gasoline.[74] The highest ethanol-content blend that is generally available commercially is E85 (maximum 85 percent ethanol, minimum 15 percent gasoline), which can only be used in flex fuel vehicles and represents the highest ethanol-content blend that flex fuel vehicle owners are currently allowed to use. Flex fuel vehicle engines, fuel lines and seals are specifically designed by the manufacturers to be able to handle the corrosive nature of ethanol and to exploit the higher compression ratio ethanol can endure.[75] But these designs cost extra money, with uncertain demand for the flex fuel capacity.

"If the 2030 goals are achieved, the petroleum industry will be changed. They either will be out of business or they will have to change their business."

-- Eric Bowen
Renewable Energy Group

Even lower-blend biofuels require engine modifications and pose some risk to performance in the event of a mistake. The most common ethanol-gasoline blend is E10 (maximum 10 percent ethanol, minimum 90 percent gasoline), which can be used in most commercially available gasoline vehicles (higher blends of 20 or 30 percent could provide even greater fuel economy and emissions benefits).[76] As mentioned, the U.S. Environmental Protection Agency recently approved E15 (maximum 15 percent ethanol, minimum 85 percent gasoline) as an accepted blend, but only for vehicles from the model year 2001 or later. Automakers had to design engines and fuel lines in vehicles from that model year and onward to handle the slightly higher ethanol content gasoline. Notably, this latter blend spurred controversy due to the potential for misfueling and subsequent engine damage. Although scientists are working on drop-in biofuels (renewable gasoline) that can substitute for gasoline without the need for engine modification, these biofuels are not yet commercially available at scale.[77]

Biodiesel poses fewer challenges for automakers and retail gas station owners, but producers still face barriers to market entry. Biodiesel is commonly available when blended with regular diesel fuel and is chemically more similar to diesel than ethanol is to gasoline. As a result, until recently, retail stations were able to offer unblended B100 biodiesel under a variance from the California Department of Food and Agriculture, Division of Measurement Standards. With federal and state performance specifications for diesel fuel including blends up to B5 (maximum 5 percent biodiesel, minimum 95 percent diesel), all vehicle manufacturers approve at least 5 percent in their vehicles. Nearly 80 percent of vehicle manufacturers recommend use of biodiesel blends up to B20 (maximum 20 percent biodiesel, minimum 80 percent diesel).[78] Some automakers used to allow the use of B100 (maximum 100 percent biodiesel) in older diesel vehicles. However, the practice has largely stopped for vehicles from model year 2007 and later that are equipped with particulate filters, because particulate filters are more sensitive to the different chemical and physical characteristics of biodiesel.[79] Given this array of technical and economic barriers, automakers have little incentive to make their products as biofuel-friendly as possible.

Petroleum fuel providers also face a disincentive to blend biofuels because it reduces their profits on petroleum products, which face declining demand anyway. In addition, petroleum fuel providers face costs in blending the biofuels at terminals before shipping to retail outlets, although in some cases they can pass these costs along to consumers. As a result, the petroleum fuel industry also has little incentive to accommodate biofuel blends.

"There's no way truck operators would use un-recommended blends on $150,000 truck equipment. So now they can't go above B5 [biodiesel blend]."

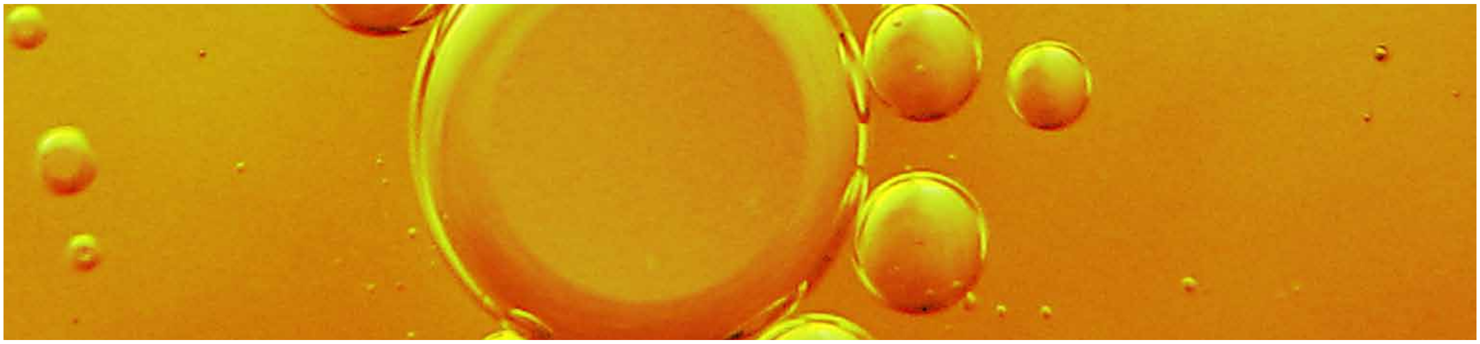
-- Chris Shimoda
California Trucking Association

SOLUTIONS

State leaders should consider stronger incentives for gas stations to provide E85 fuels. Due to the cost of installing the infrastructure, state grants or tax credits may be necessary to encourage retail station participation. Incentives could also include "detaxing" biofuels or taxing petroleum-based transportation at a higher rate. The state could also guarantee a rate of return on biofuel investments with a variable tax rate that rises or decreases with market conditions. In addition, the state could consider an overhaul of the excise tax system to encourage biofuel deployment at retail gas stations. Of note, some participants also wanted the state to consider a mandate for the installation of E85 infrastructure, although others disagreed.

Federal and state leaders should encourage auto manufacturers to recommend higher blends in their vehicles through financial support or guarantees. Without incentives or requirements to allow these higher blends, automakers may be unwilling to recommend them for their engines. The federal or state government could encourage a higher blend capacity through tax or other financial incentives or by providing a financial backstop or insurance for any damage that may result from the use of higher-blend fuels. As a first step, the California Air Resources Board could address the E10 "blend wall" barrier by rewriting policy based on an E15 and E30 "predicted model" and therefore allowing higher blends to be sold. This model would be used to calculate compliance with the low carbon fuel standard and would therefore encourage fuel providers to ensure that automakers allow for higher blends.

The California Air Resources Board should strengthen and maintain the current low carbon fuel standard to require petroleum fuel providers to blend more low-carbon biofuels into their products. Given the oil industry's lack of incentive to blend more biofuels, the low carbon fuel standard is one of the most effective policies to overcome this resistance. State leaders should strengthen it as appropriate and build in more certainty for the program following 2020, as discussed above.



Barrier #3: Misaligned Policies at Multiple Levels of Government

Federal, state, and many local governments have laws and policies that sometimes inadvertently send mixed messages regarding biofuel deployment. For example, at the federal level, Clean Air Act regulations limiting nitrogen oxide emissions may also limit the production of biofuels, which sometimes produce nitrogen oxide but also result in decreases in other harmful emissions, including greenhouse gases, by displacing petroleum fuels. At the state level, laws such as the California Environmental Quality Act (CEQA) can be used to challenge permitting decisions related to biofuel infrastructure, while the state's cap-and-trade program may inadvertently limit some refiners from blending more biofuels. State laws regarding wastewater treatment may also disproportionately hurt biofuel producers compared to petroleum fuel refiners. Finally, some local governments may prohibit or limit biofuel-related infrastructure necessary to achieve greater deployment statewide.

SOLUTIONS

State leaders should ensure the cap-and-trade program treats biofuels consistently. Some participants noted that the state cap-and-trade program may cover activities related to some biofuel production or refining that produces methane and nitrous oxide emissions (depending on the volume delivered to market) but then provide credits for reduced carbon intensity from the same fuels. The state should correct any inconsistent treatment, based on current carbon accounting.

State leaders, with support from the U.S. Environmental Protection Agency, should launch a process to re-examine how biofuel targets may affect the three requirements of nitrogen oxide, greenhouse gas, and petroleum fuel reductions. Efforts to achieve all three goals individually may conflict with each other, particularly given that some biofuels may increase nitrogen oxide emissions. However, these biofuels could also decrease greenhouse gases and other harmful air pollutants associated with petroleum fuel production and combustion. As participants noted, the state cannot necessarily balance all three objectives equally due to federal requirements under the Clean Air Act and concerns about local pollution impacts. As a result, state leaders, together with federal officials who review state Clean Air Act plans, could convene experts for a science- and technology-based process to determine the optimal prioritization and flexibility needed to maximize air pollution reduction, given the three goals. To ensure that optimal greenhouse gas emission reductions can be balanced with attainment of air quality standards while reducing reliance on petroleum, state leaders at the California Air Resources Board and federal leaders at the U.S. Environmental Protection Agency could use this information to develop a methodology to determine the optimal targets for balancing each goal. Concurrently, the state can explore improved engine standards, such as selective catalytic reduction, which can improve nitrogen oxide emissions, or expanded use of renewable diesel fuels, which reduce nitrogen oxide emissions compared to petroleum fuels.

"California is too California-centric. There are some better examples in other states. Some have up to a 30 cent production incentive. A per gallon production incentive here could help overcome the finance barrier."

-- Lisa Mortenson
Community Fuels

The California Water Resources Control Board should ensure that both biofuel providers and petroleum refiners are held to the same high standard on underground fuel storage standards, water disposal and water recycling. The state board maintains the underground leak detection systems for fuel refiners. However, participants noted that petroleum-based oil refining faces weaker oversight of underground fuel storage than biofuel providers, as well as for water disposal and recycling. Policy makers should ensure that both types of providers are held to the same standard in order to level the playing field for fuels in California.

The state legislature and possibly the Governor's Office of Planning and Research should develop uniform statewide guidelines for permitting biofuel refining facilities. Greater permitting certainty at the state level, while still preserving local, context-specific review, would greatly facilitate the siting of in-state facilities, both to lower the carbon footprint of the fuels, reduce the cost and time needed for new facility development, and to boost the local economic gain. The state, possibly through the Governor's Office of Planning and Research, could develop uniform compliance checklists and processes for local governments to adopt.

The California Air Resources Board should ensure that the low carbon fuel standard more explicitly includes a role for biofuels in addition to zero-emissions vehicles. Many participants felt that the state's emphasis in meeting the low carbon fuel standard too strongly relies on electric and hydrogen fuel cell vehicles and not enough on biofuels, which are not specifically mentioned in the regulations and lack dedicated funding. They noted that biofuels currently generate almost 90 percent of the low carbon fuel standard credits and are likely to continue at this rate through 2020. Participants also believed the cumulative low carbon fuel targets may not be achievable with a single transport fuel and that the state should therefore utilize multiple low-carbon fuels to achieve the goals.

Barrier #4: Lack of Feedstock Access

Biofuel feedstocks could be from urban sources, forest biomass, or agricultural crops and residues like straw and manure. Each type of biomass feedstock has its own constraints and benefits. To maximize local economic development and lower the carbon intensity of biofuels, state leaders should encourage the development of in-state feedstocks. Such feedstocks could provide significant co-benefits, including an economic boost to the agricultural sector and rural, disadvantaged communities and environmental remediation or protection. These benefits assume that farmers can grow feedstocks that complement current cropping practices or collect and use residues in an efficient manner that would not undermine food production. In-state woody biomass feedstock use could also lead to reduced wildfire risk and the associated carbon emissions (black carbon) by harvesting excess biomass buildup in the state's working and forested lands.

However, according to participants, California's biofuel policies do not recognize the full range of benefits that might flow from more in-state feedstock production. As a result, farmers and others with working lands (including agricultural and rangelands) that could potentially produce biofuel feedstocks currently lack incentives to do so. The state therefore loses the opportunity to achieve co-benefits, such as carbon reduction from reduced wildfire risk, economic gain from domestic feedstock production, and environmental benefits from certain agricultural practices related to feedstock production.

Federal and state policies on forest lands also complicate access to feedstocks. Due to restrictions on forest access, such as on roads and the ability to selectively log certain forests to reduce fuel loads, biofuel feedstock producers are unable to access much of the densest forested areas on public lands. Finally, as described above, the difficulty in siting local biofuel facilities reduces the demand to harvest local feedstocks that would be their primary inputs.

"We have wildfire problems resulting from fuel-dense forests, and there are public benefits from reducing forest density to maintain forested ecosystem health and associated ecosystem services. These co-benefits should be taken into account since they could be solved in part through biofuels."

-- Steve Kaffka
UC Davis

SOLUTIONS

State leaders should explore loosening restrictions on or otherwise encouraging technologies that can harvest and convert local feedstocks to biofuels in an environmentally and economically beneficial manner. More of these facilities would improve the market for local feedstock production. The state could begin by launching a multi-stakeholder study group to determine whether certain feedstock processing technologies might meet standards related to local pollution and economic development. New technologies and practices might limit many of the harmful impacts that have previously hindered the in-state deployment of these technologies.

State leaders should develop a process to identify optimal locations for wood residue as a feedstock and then work to improve access to the most environmentally beneficial sites. Wood residue, in the form of branches, needles, leaves, stumps, roots, low grade and decayed wood, slashings and sawdust, holds tremendous potential as a source of biomass-based energy. Yet small, privately owned forest parcels with the fewest legal restrictions to accessing this forest biomass supply may be the most difficult to access in practice due to their isolation. Meanwhile, small state forests and large federal forests may have the best access to biomass feedstocks but the most legal restrictions and the potential for conflict with other resource protection needs, making it uncertain whether biofuel providers can remove the biomass for energy purposes. As a result, federal and state leaders should begin a process, with expert input from academic researchers and other stakeholders, to assess the environmental benefits and costs (including via carbon accounting) of harvesting biomass from the most optimal areas. These leaders should then develop a process to encourage harvesting of only the most environmentally beneficial biomass feedstocks, where removal of biomass will both provide a net lifecycle carbon benefit and also benefit the local ecosystem.

"If farmers can't make money on energy crops, they won't grow them."

-- Leon Woods
Mendota Advanced Bioenergy Beet Cooperative

State leaders should explore ways to make the transport of feedstock residues from around the state more financially viable. In-state biofuel refiners may need to access feedstock from relatively far-flung corners of the state. Yet transport costs may be financially prohibitive. As a result, the state should explore ways to make this transport more economically viable, either by decreasing the time and uncertainty related to regulatory compliance or by providing financial support, such as through the use of cap-and-trade funds for capital expenses. The funds could also be used to return the forest to its original state after harvesting biomass for biofuel feedstocks, including for reducing wildfire risks and severity.

State leaders should encourage the reuse of rice straw as biofuel feedstock in order to boost in-state agricultural feedstocks. Otherwise, the rice straw is typically returned to the ground, where it increases methane emissions. The California Air Resources Board and Department of Food and Agriculture could calculate the benefits from the reduced methane emissions versus any increased costs from a higher price.

California Air Resources Board and Department of Food and Agriculture should study and explore opportunities to encourage purpose-grown crop production for biofuel feedstocks that result in overall greenhouse gas benefits. Growers could utilize purpose-grown seeds on all idled farmland or in orchards and vineyards during winter dormant periods, such as for canola and camelina. With recent water shortages, many acres of previously productive farmland are idle or underutilized, presenting an opportunity for winter crops that rely on rainfall to be grown in rotation. The greenhouse gas reduction benefits could include the lack of indirect land use impacts, because the land would not otherwise be utilized or is underutilized during slack periods. Growers would benefit economically from the additional revenue, and the land would remain economically productive.

Conclusion: Clean, Economically Beneficial Local Biofuels

California already has favorable policies in place to encourage a transition from petroleum to low-carbon fuels, particularly biofuels. However, state leaders could do more to ensure not only greater deployment but that the local economy benefits from additional in-state production. Through targeted policies that encourage and reward deployment with environmental and economic co-benefits, California could better ensure that residents receive more economic value from biofuel programs. While the long-term future for other low-carbon fuels, such as for electric vehicles, and vehicle fuel efficiency remains bright, biofuels will constitute an important part of the fuel mix needed to achieve the state's carbon reduction goals. Biofuel producers can also uniquely benefit local economies, reduce fuel loads in the state's forested landscapes, and provide revenue for the agricultural sector and rural communities throughout the state. Given these and other potential benefits, policy makers should prioritize in-state production of these fuels to achieve a low-carbon and economically successful future.

"Our vision is to have 50 percent of the biofuel that is consumed within California… to actually be produced in California, benefitting California taxpayers."

-- Russell Teall
Biodico

Participant Bios

Dan Adler
Energy Foundation

Dan Adler is Vice President of Power Strategies at the Energy Foundation, a nonprofit, philanthropic organization that promotes the transition to a sustainable energy future by advancing energy efficiency and renewable energy. Mr. Adler was formerly the Managing Director of the California Clean Energy Fund (CalCEF), a nonprofit, evergreen venture capital fund created to accelerate investment in California's clean energy economy. Prior to joining CalCEF, he was a senior analyst in the Division of Strategic Planning at the California Public Utilities Commission, where he was responsible for the design and implementation of California's Renewables Portfolio Standard and was senior staff for climate change policy. In addition to energy issues, Mr. Adler has professional experience in international trade policy and socially responsible investment. He has a B.A. in Political Science from the University of California at Berkeley and an M.A. in Public Policy from Harvard University.

Wes Bolson
Cool Planet

Wes leads business development, marketing & communications, government affairs, and project financing in his role at Cool Planet. He joined the company at their global headquarters in Denver, CO after serving on the executive team of public company Codexis (CDXS) as their CMO. He was one of the founding executives at Coskata, serving as the CMO in addition to leading business development and government affairs. Prior to Coskata he was the CFO at ICM, Inc. in Colwich, KS. He has been an executive board member at RFA, the Co-Chair of the biofuels working group at BIO, and a board member at the Advanced Biofuels Association. He holds a BS in Electrical Engineering and a MBA from Stanford's Graduate School of Business.

Eric Bowen
Renewable Energy Group

For more than 10 years, Eric Bowen has been at the forefront of development for start-up companies with an emphasis on biofuels. Mr. Bowen is an expert within the management and legal fields with an emphasis on venture capital financings, mergers and acquisitions, joint ventures and IPOs. Prior to joining REG, Mr. Bowen was Founder, President & CEO of Tellurian Biodiesel, Inc. (acquired by REG). He has also led Sigma Capital's biodiesel project finance group and practiced law in Silicon Valley at Venture Law Group. Mr. Bowen served as Chairman for the California Biodiesel Alliance until 2012.

Tim Brummels
Cool Planet

Timothy R. Brummels is the CEO and President of Canergy, LLC for the past 5 years. Canergy is a Biotechnology company with a focus that encourages a healthy environment by combining efficient use of sustainable non-food energy crops with innovative patent pending proprietary process cellulosic conversion technology. Canergy has been working on developing a 25 million-gallon-per-year cellulosic biorefinery in the Imperial Valley of California, which will produce a ultra low carbon footprint of ~10 CI per gallon. Previously, over the past 15 years, Mr. Brummels has worked for his own consultancy, Edgewater Company and for a number of companies generally as a project development executive, including 2 corn ethanol generation one biofuels projects, one Advanced Biofuel project as well as EVP and Director of Advanced Business Sciences, Financial Management position with Berkshire Hathaway Homestate Companies and Conagra. Mr. Brummels has a BS Business Administration degree from the University of Nebraska.

Dayne Delahoussaye
Neste Oil

Dayne currently serves as the legal counsel and regulatory affairs manager for Neste Oil's North American business groups supporting both petroleum and renewable product lines. In addition to traditional in-house counsel commercial responsibilities, Dayne oversees the company's US and Canadian regulatory compliance programs and manages the company's North American governmental affairs efforts. Prior to joining Neste Oil, Dayne was in private law practice. Dayne lives in Texas with his wife and is wrapped around the little fingers of two little girls who, unfortunately for Dayne, realize they are cute.

Rob Elam
Propel Fuels

Rob Elam is an entrepreneur focused on applying innovative business methods toward projects and companies that embody ideals of sustainability, high quality of life, and healthy communities. Rob is founder and CEO of Propel Fuels, California's largest biofuel retailer. He is the lead inventor on several patents in the area of carbon accounting and behavioral GIS methodologies. Rob also serves as the President of the Native Fish Society; a Portland based wild salmon conservation organization.

Tom Fulks

Mightycomm

Tom is a principal with Mightycomm, a public relations / public policy firm with offices in Sacramento, Silicon Valley and Southern California. Tom's recent work includes providing media management, public relations and public policy support for clients such as the Diesel Technology Forum, Robert Bosch Diesel Systems, Volvo Group, Propel Fuels and Neste Oil's renewable diesel fuel program. Tom is a graduate of Cal Poly San Luis Obispo and began his career in communications in 1981 as a city beat reporter for Copley Newspapers in Los Angeles. Later he worked with the J.P. Scripps Newspaper group (Scripps-Howard) on the Central Coast of California. He maintains homes in Sacramento and San Luis Obispo County, where he is an established strategic and communications consultant for a variety of local political and issue campaigns. He also is a biweekly political columnist for the San Luis Obispo Tribune, a McClatchy daily newspaper.

Joe Gershen

Mr. Gershen has been a leading biodiesel marketer since 2002, pioneering efforts to develop the industry in California and around the country. He has been instrumental in facilitating numerous fleet transitions to biodiesel, including municipal and transit bus fleets of Santa Monica, Inglewood, Beverly Hills, Pasadena and the CLIF Bar distribution fleet. In partnership with McDonald's supply chain partner, Golden State Foods, Mr. Gershen created a successful closed-loop solution to recycle their fryer oil into biodiesel used to power their distribution fleets. This resulted in carbon reduction and cost savings for the company. Strong adherence to quality control and assurance, as well as handling and use protocols have helped earn him an industry reputation for quality, service and reliability. Mr. Gershen sits on the California Energy Commission's Alternative and Renewable Fuel and Vehicle Technology Program Advisory Committee and is Vice-Chair of the California Biodiesel Alliance. He regularly works with customers and partners in the petroleum and fuel logistics industries, and has provided business development, supply chain, logistics and customer relationship management solutions for companies in the biofuels industry

Steve Kaffka

UC Davis

Stephen Kaffka is Director of the California Biomass Collaborative and extension specialist in the Department of Plant Sciences at the University of California, Davis. He is chair of the BioEnergy Work Group for the University of California's Division of Agriculture and Natural Resources. He has advised the California Energy Commission on agricultural and sustainability issues, and serves as an ex officio member of the Bioenergy Interagency Work Group. He is a member of the National Research Council's committee on Economic and Environmental Impacts of Increasing Biofuel Production. From 2003 to 2007 he was director of the Long Term Research on Agricultural Systems Project. His commodity assignments include sugar and oilseed crops, and has worked on agriculture and water quality projects. He has Ms and Ph.D. degrees from Cornell University in agronomy and a B.S. from the University of California at Santa Cruz in biology.

Neil Koehler

Pacific Ethanol

Neil Koehler has over 30 years of experience in ethanol production, sales, and marketing in the western United States. He was co-founder and general manager of Parallel Products, California's first ethanol production company, which he sold in 1998. He also founded Kinergy Marketing, an ethanol sales and distribution firm that was acquired by Pacific Ethanol in March 2005. Mr. Koehler is a Renewable Fuels Association board member and the Director of the California Renewable Fuels Partnership. He is a sought-after speaker on the issue of renewable fuels. Mr. Koehler has a BA degree in Government from Pomona College.

Ryan McCarthy

California Air Resources Board

Ryan is the Science and Technology Advisor to the Chair at the California Air Resources Board, where he primarily focuses on transportation, energy and climate policy issues. Prior to his appointment at ARB by Governor Jerry Brown, McCarthy was chief writer of Taking Charge, a strategic plan for accelerating electric vehicle markets in California produced by the California Plug-In Electric Vehicle Collaborative. He was a Science and Technology Policy Fellow of the California Council on Science and Technology, where he worked in the office of California Assembly Member Wilmer Amina Carter and advised her on energy, environmental, and transportation issues, among others. McCarthy holds master's and doctorate degrees in civil and environmental engineering from UC Davis, and a bachelor's degree in structural engineering from UC San Diego.

Belinda Morris

Packard Foundation

Belinda joined the Packard Foundation in January 2014 as the program officer for climate and land use in the Conservation and Science Program. She oversees grantmaking for the Foundation's efforts to reduce greenhouse gas emissions resulting from global deforestation and unsustainable agricultural practices across the world. Prior to joining the foundation, she was the California Director for the American Carbon Registry (ACR), an enterprise of Winrock International and a leading carbon offset program, where she was responsible for guiding ACR's activities in California's carbon market. She has also worked for organizations including the Environmental Defense Fund, The Nature Conservancy, and the World Wildlife Fund on forest, wetland, and water conservation, agricultural greenhouse gas emissions reduction, and the design of market based approaches to conservation. Belinda received a M.S. in Environmental and Resource Economics from University College London, and a B.A. in Political Science from the University of North Carolina at Chapel Hill. She serves on the board of Ag Innovations Network.

Lisa Mortenson

Community Fuels

Lisa Mortenson has served as Chief Executive Officer since Community Fuels was formed in 2005. She has led all efforts to develop the business from start-up to an industry-recognized leader in the commercial production of advanced biofuels. Community Fuels designed, built and operates an advanced bio-refinery at the Port of Stockton. The company's fuel is approved by multiple major oil companies and Community Fuels is the first in the industry to earn both BQ-9000 producer and laboratory certifications. Ms. Mortenson has held board-level positions with multiple organizations engaged in renewable energy, energy efficiency, and sustainable building as well as board positions with governmental and non-governmental organizations focused on the development of good jobs. Her involvement with multiple organizations has helped her identify obstacles and opportunities for developing businesses that are commercially viable while also being environmentally and socially responsible. Ms. Mortenson earned her MBA from San Diego State University and graduated with honors from the University of Arizona where she earned her BSBA in Finance and Business Economics.

Tim Olson

California Energy Commission

Tim Olson has held several management and policy positions at the California Energy Commission and previously served as a policy advisor to Commissioners James Boyd and Carla Peterman on transportation, climate change, energy research and development and international affairs topics. He also served as manager of the Emerging Fuels and Technology and Transportation Energy Offices. He represents the Energy Commission as a member of several technical advisory committees and presents information in several forums, including U.S. Congress. He currently leads the Energy Commission's strategic planning for emerging fuels and technologies to develop alternative fuel growth scenarios, facilitate private investment in California projects, and conduct technology merit reviews. This work is included as part of the annual Integrated Energy Policy Report to the Governor and Legislature and investment plans for the annual $100 million Alternative and Renewable Fuels and Vehicle Technology Fund. Mr. Olson received a bachelor's degree in Environmental Studies/Biology from UC Santa Barbara and serves as an appointed member of the Sacramento Metropolitan Air Quality Management District Hearing Board

Cliff Rechtschaffen

Office of the Governor

Clifford Rechtschaffen is a senior advisor in the Office of California Governor Jerry Brown, working on climate, energy and environmental issues. In 2011, he served as Acting Director of the California Department of Conservation. From 2007 to 2010 he was a special assistant attorney general on climate and energy issues for Attorney General Jerry Brown. He currently is on leave from Golden Gate University School of Law, where he taught environmental law and directed the environmental law program from 1993 to 2007. Prior to becoming a professor at Golden Gate, he worked in the Environment Section of the California Attorney General's Office from 1986 to 1993. He is a graduate of Princeton University and Yale Law School.

Lyle Schlyer

Calgren Renewable Fuels

Lyle Schlyer holds degrees in chemical engineering and law to complement his nearly 45 years of experience in various aspects of the chemical and fuels industries. He has been President of Calgren Renewable Fuels since 2006. Calgren owns and operates a fuel ethanol production facility in Pixley, CA. Because the facility generates its own power via two state-of-the-art cogeneration units fueled in part by digester gas, Calgren's facility has an extremely low carbon footprint. Mr. Schlyer is also president of Pratt energy, LLC, which owns and operates a sister facility in Pratt, KS. Mr. Schlyer previously practiced chemical engineering for BF Goodrich Chemical; was Assistant General Counsel for Tosco Corporation; and served as General Counsel of USA Petroleum Corporation. Mr. Schlyer is a member of the California Bar (inactive) and the U.S. Patent Bar.

Janea Scott

California Energy Commission

Janea A. Scott is one of five Commissioners on the California Energy Commission. Ms. Scott was appointed by Governor Edmund G. Brown Jr. in February 2013 to serve as the Commission's public member. She is the lead Commissioner on transportation and western regional planning, and last year Ms. Scott led the 2014 Integrated Energy Policy Report Update. Ms. Scott serves as the chair of the California Plug-In Electric Vehicle Collaborative, a public/private organization focused on accelerating the adoption of PEVs to meet California's economic, energy and environmental goals. She is also a member of the U.S. Department of Energy's Hydrogen and Fuel Cell Technical Advisory Committee. Prior to joining the Energy Commission, Ms. Scott worked at the U.S. Department of the Interior in the Office of the Secretary as the Deputy Counselor for Renewable Energy and at Environmental Defense Fund in both the New York and Los Angeles offices as a senior attorney in the climate and air program. Ms. Scott earned her J.D. from the University of Colorado Boulder Law School and her M.S. and B.S. in Earth Systems from Stanford University.

Chris Shimoda

California Trucking Association

Chris Shimoda is the Director of Policy for the California Trucking Association and is responsible for overseeing the CTA's public policy development and implementation. He has been with CTA since 2007 and has previously managed both the Association's Safety and Environmental Policy. Throughout his career Chris has worked with California agencies including the California Air Resources Board and California Highway Patrol on the development and implementation of major programs and regulations impacting the trucking industry. He is a graduate of UC Davis.

Harry Simpson

Crimson Renewables

Mr. Simpson is a senior operating executive with 20 years of broad management, financial and technology experience. He has served in a variety of capacities including President, COO, CFO, and Senior VP of Marketing & Business Development. Highlights of his prior experience include managing foreign exchange derivatives trading operations that transacted over $350 billion annually and founding an online financial services company, leading it through multiple rounds of financing and a public listing. In addition to his significant early-stage company development and fund-raising experience, he has also been active as an investor in, and consultant to several early-stage technology companies. Mr. Simpson is a graduate of Indiana University with a BS in Finance. As President of Crimson Renewable Energy, L.P., Mr. Simpson is focused on financial and operational management, and also leads its sales, marketing and business development activities.

Mary Solecki

Environmental Entrepreneurs

Mary is the Western States Advocate for Environmental Entrepreneurs (E2), covering state legislative and regulatory issues in California, Oregon and Washington. E2 is a non-profit advocacy organization whose business members support policy with both economic and environmental benefits. Mary researches, informs and advocates for environmental policies that will drive economic opportunities. Her work includes clean fuel standards, carbon reduction programs and water efficiency. She is a topic expert on the Low Carbon Fuel Standard. Mary has been consulting on energy policy since 2008, and has a background in sales and communications. She received her BS in Business from Indiana University and got her MBA from Presidio Graduate School in San Francisco.

Russell Teall

Biodico

Russell Teall is the President of BIODICO a company which he founded for the purpose of developing and commercializing bioenergy system technology. Under Dr. Teall's leadership Biodico has successfully evolved patented biorefinery production techniques for a wide variety of feedstocks. Beginning with laboratory-scale demonstrations, these technologies eventually led to full-scale commercial operations in California, Nevada, Colorado, Texas and Australia. These plants utilized Teall's patented process with capacities of 3-10 million gallons per year and produced biodiesel predominantly from recycled fryer oils, with the capability of using a wide variety of other feedstocks, including crude vegetable oils and animal fats. BIODICO is continuing to actively develop improvements to the bioenergy system platform in conjunction with the U.S. Navy at the Naval Facilities Engineering Expeditionary Warfare Center at Naval Base Ventura County in Port Hueneme, California where a production unit is being used for research and development involving innovative renewable energy technoloogies. The most recent generation of equipment, the ARIES© Platform brings automation and remote real-time sensing to bioenergy production as part of an integrated self-sustaining system, utilizing anaerobic digestion, gasification, solar, combined heat and power, and advanced algae cultivation (algaculture).

Floyd Vergara

California Air Resources Board

Floyd Vergara is Chief of the Industrial Strategies Division at the California Air Resources Board (ARB). He oversees several of ARB's key climate change and air quality regulatory programs, including Cap-and-Trade, the Low Carbon Fuel Standard, conventional fuels regulations, energy sector programs, and oil and gas production measures. Floyd has been at ARB for over 27 years developing regulations on transportation fuels, advanced clean cars, oceangoing vessels, and other mobile or stationary sources. He received his B.S. in chemical engineering from U.C. Berkeley, his Juris Doctor from the University of the Pacific, McGeorge School of Law, and is licensed to practice in California as a professional engineer and lawyer.

Leon Woods

Mendota Advanced Bioener

Endnotes

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60 *See* Farm Industry News, “EPA Postpones Finalizing 2014 Renewable Volume Obligations in RFS until 2015,” Farm Industry News, 2014. Available at http://farmindustrynews.com/blog/epa-postpones-finalizing-2014-renewable-volume-obligations-rfs-until-2015 (accessed July 7, 2015). *See also* Daniel Looker, “EPA Angers Farmers Again,” Agriculture.com, 2015. Available at http://www.agriculture.com/news/policy/epa-gers-farmers-again_4-ar47224-2?print (accessed July 7, 2015). *See also* Gabriel E. Lade, C. - Y. Cynthia Lin, Aaron Smith, “Policy Uncertainty and Tradable Credits under Market - Based Regulations: Evidence from the Renewable Fuel Standard,” conference proceeding at the Agricultural & Applied Economics Association’s 2014 AAEA Annual Meeting, Minneapolis, MN, 2014. Available at: http://ageconsearch.umn.edu/bitstream/170673/2/Lade_Lin_Smith_2014_AAEA_Submission.pdf (accessed July 7, 2015).

61 Congressional Research Service, pp. 11-12.

62 *See* U.S. Environmental Protection Agency website, “E15 (a blend of gasoline and ethanol).” Available at: http://www.epa.gov/oms/regs/fuels/additive/e15/ (accessed March 31, 2015).

63 *See* U.S. Department of Energy website, “Alternative Fuel Data Center – Federal Laws and Incentives for Ethanol.” Available at: http://www.afdc.energy.gov/fuels/laws/ETH/US (accessed March 30, 2015). *See also* U.S. Department of Energy website, “Alternative Fuel Data Center – Federal Laws and Incentives for Biodiesel.” Available at: http://www.afdc.energy.gov/fuels/laws/BIOD/US (accessed March 30, 2015).

64 *See* Mary Solecki, Anna Scodel, and Bob Epstein, "Advanced Biofuel Market Report 2013 – Capacity through 2016," 2013. Available at: https://www.e2.org/ext/doc/E2AdvancedBiofuelMarketReport2013.pdf (accessed July 7, 2015).

65 Timothy O'Connor et al., "Driving California Forward – Public Health and Societal Economic Benefits of California's AB 32 Transportation Fuel Policies", 2014, p. 2. Available at: http://www.edf.org/sites/default/files/content/edf_driving_california_forward.pdf (accessed July 7, 2015).

66 However, it should be noted that E15 is not an approved gasoline-ethanol blend in California.

67 *See* U.S. Energy Information Administration database, "State Energy Data System (SEDS)." Available at: http://www.eia.gov/state/seds/ (accessed March 30, 2015).

68 *See* U.S. Department of Energy website, "Alternative Fuel Data Center – Alternative Fueling Station Locator." Available at: http://www.afdc.energy.gov/locator/stations/results?utf8=%E2%9C%93&location=california (accessed March 30, 2015).

69 U.S. Environmental Protection Agency (EPA), the American Fuel & Petrochemical Manufacturers (AFPM), and the American Petroleum Institute (API) reached an agreement regarding a schedule for EPA to propose and finalize renewable fuel standards for 2014 and 2015. AFPM and API sued EPA in the federal district court for the District of Columbia in March seeking to compel EPA to fulfill its obligations to promulgate the standards. The proposed consent decree—notice of which was published in the Federal Register on April 20—requires EPA to propose renewable fuel obligations for 2015 by June 1, 2015 and to finalize them by November 30, 2015. EPA would also have until November 30, 2015 to finalize the obligations for 2014 and to respond to the plaintiffs' request for a partial waiver of renewable fuel applicable volumes for 2014. EPA also indicated that it was its intention to propose and finalize the renewable fuel volumes for 2016 in the same timeframe as it was addressing the 2015 volumes. *American Fuel & Petrochemical Manufacturers v. EPA*, No. 1:15-cv-394 (D.D.C., proposed consent decree filed Apr. 10, 2015).

70 The Environmental Protection Agency waived the initial volume mandates for cellulosic biofuels on multiple occasions due to the lack of available production and slower-than-expected capacity development, including retroactively for 2013. Agency leaders then postponed the publication of the 2014 biofuel volume mandates from 2013 until they published the 2014-2015-2016 volume mandates in early 2015.

71 Chapter 588, Statutes of 2015. Available at: https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201520160AB692 (accessed October 21, 2015).

72 U.S. Energy Information Administration, "Biofuels Issues and Trends," 2012, pp. 12-14. Available at http://www.eia.gov/biofuels/issuestrends/pdf/bit.pdf (accessed July 7, 2015). *See also* U.S. Department of Energy, "Handbook for Handling, Storing, and Dispensing E85 and Other Ethanol-Gasoline Blends," 2013, pp. 10-14. Available at: http://www.afdc.energy.gov/uploads/publication/ethanol_handbook.pdf (accessed July 7, 2015).

73 U.S. Environmental Protection Agency website, "Fuels and Additives – E15 (a blend of gasoline and ethanol)." Available at: http://www.epa.gov/oms/regs/fuels/additive/e15/ (accessed March 30, 2015).

74 *See* U.S. Department of Energy website, "Alternative Fuel Data Center – Ethanol Blends." Available at: http://www.afdc.energy.gov/fuels/ethanol_blends.html (accessed March 30, 2015).

75 *See* U.S. Department of Energy website, "Alternative Fuel Data Center – Flexible Fuel Vehicles." Available at: http://www.afdc.energy.gov/vehicles/flexible_fuel.html (March 30, 2015).

76 In countries such as Germany, E10 blends have to be specially marked at the fueling pump, while in the U.S., E10 blends do not need to be specifically marked. *See* U.S. Department of Energy website, "Alternative Fuel Data Center – Ethanol Blends."

77 Mary Solecki, Anna Scodel, and Bob Epstein, p. 7.

78 U.S. Department of Energy website, "Alternative Fuel Data Center – Biodiesel Blends." Available at: http://www.afdc.energy.gov/fuels/biodiesel_blends.html (accessed March 30, 2015).

79 Biodiesel.org website, "OEM Statement Summary Chart." Available at: http://www.biodiesel.org/using-biodiesel/oem-information/oem-statement-summary-chart (accessed March 30, 2015).

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