

Ethanol Leads LCFS

Here's What California's Low-Carbon Fuel Standard Does

by S. Patricia Batres-Marquez

The Low Carbon Fuel Standard (LCFS) is a regulatory framework adopted by California to reduce greenhouse gas (GHG) emissions in the state. The program encourages the use



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and production of a variety of low-carbon and renewable alternatives such as ethanol, biodiesel, and renewable diesel, which contribute to the reduction of greenhouse gas emissions and replace higher carbon petroleum-based fuels.

The goal for LCFS is to reduce the carbon intensity (CI) of California's transportation fuels by at least 10% by 2020. CI accounts for the carbon dioxide emissions related to the extraction, processing, and distribution (life cycle) of gasoline and diesel and their corresponding substitutes. Hence, alternative fuels with lower carbon intensity, measured in grams of CO₂ equivalent per Megajoule of energy (gCO₂e/MJ), are deemed as contributing more to reach the goal of the program.

Since the LCFS program requires reductions in the carbon intensity of California's transportation fuels over time, a

declining average CI for the pool of the state's transportation fuels is employed to reduce GHG emissions. The CI of gasoline and diesel are 100.53 gCO₂e/MJ and 102.76 gCO₂e/MJ, respectively. The compliance target value for gasoline and fuels used as substitutes for gasoline in 2016 was 96.50 gCO₂e/MJ. This value is 95.02 gCO₂e/MJ in 2017. In the case of diesel and fuels used as substitutes for diesel, the compliance target value in 2016 was 99.97 gCO₂e/MJ. This value is 98.44 gCO₂e/MJ in

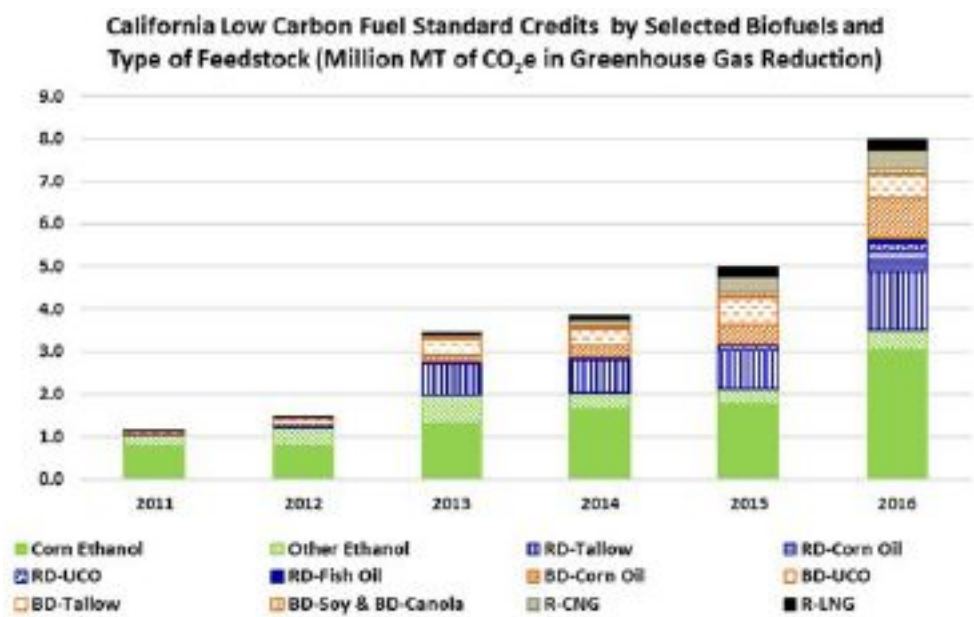
2017. The LCFS compliance schedule for 2011 to 2020 shows the substitute for gasoline, diesel, and other fuels (CARB, 2015).

Credit Generation

A fuel generates credits if the fuel's CI level is below the mandated average CI. In contrast, a fuel generates deficits if the fuel's CI level exceeds the mandated average CI, in which case deficits must be balanced with credits generated by lower CI fuels. The quantity ►

This article was originally published in the June 2017 Agricultural Marketing Resource Center renewable energy report. It can be found online at www.bit.ly/June2017AgMRC.

Figure 1



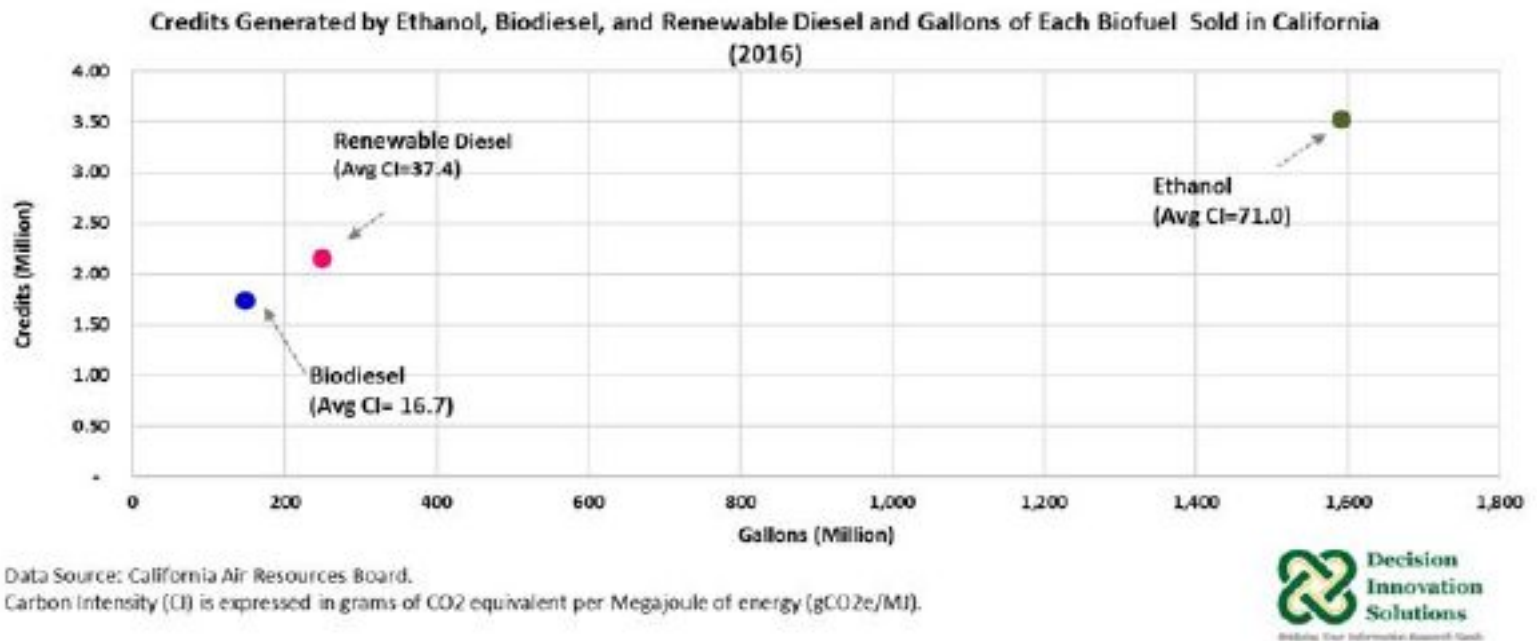
Data source: California Air Resources Board. BD= biodiesel, UCCO= used cooking oil, RD= renewable diesel, R-CNG= renewable compressed natural gas, R-LNG= renewable liquefied natural gas.



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Source: Decision Innovation Solutions

Figure 2



Source: Decision Innovation Solutions

of credits/deficits generated by each fuel is in direct relation to the fuel's CI level relative to the annual decreasing mandated average CI, and how much of the fuel is used for transportation in California.

On May 12, the California Air Resources Board (CARB) released the 2016 Compliance Report (CARB, 2017a) for the Low Carbon Fuel Standard indicating a 100% compliance rate with the regulation during the past year.

There were 224 companies reporting under the LCFS programs in 2016. The report indicated there were 9.061 million credits generated in 2016. Fifty-four of those companies reported a total number of 6.76 million deficits from high carbon fuels.

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Compliance Obligation

The report also indicated all those companies met their 2016 compliance obligation. LCFS 2016 credit average prices ranged from \$122 per credit in February 2016 (i.e. \$122/MT CO₂e in GHG reduction) to \$75 per credit in August 2016 (CARB, 2017b).

CARB quarterly data indicates 2016 total ethanol credits represented 38.8% (3.519 million credits) of all 2016 credits. Overall in 2016, corn ethanol credits made up 86.6% (3.048 million credits) of all 2016 ethanol credits and 33.6% of total 2016 credits. Current approved pathway CI values for corn ethanol produced in the Midwest (Iowa, Nebraska, Minnesota, and Illinois) range from 85.58 to 59.60 gCO₂e/MJ.

Ethanol, biodiesel, and renewable diesel credits combined generated 7.397 million credits in 2016 (see Figure 1), and represented 81.6% of all 2016 credits. Renewable diesel and biodiesel shares of the 2016 total credit pool were 23.7% (2.15 million credits) and 19.1% (1.728 million MT), respectively. Renewable diesel (RD) products made from tallow (RD-tallow) and corn oil (RD-CO) generated 15% (1.37 million credits) and 5.1% (464,000 credits) of total 2016 credits, respectively. RD-tallow contributed the most to the RD credits pool, with 63.7% of all 2016 RD credits. Among biodiesel fuels, biodiesel made from corn oil (BD-CO) and used

cooking oil (BD-UCO) generated 10.4% (0.943 million credits) and 6% (540,000 credits) of 2016 credits, correspondingly. Of all biodiesel fuels, 55% were from BD-CO.

The number of total credits generated in 2016 was up 64% compared with 2015 (5.522 million MT) (see Figure 1).

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Substantial Increase

The substantial increase in credits generated in 2016 was due mainly to the implementation of an updated model that calculates the GHG emission of fuels (CA-GREET 2.0 model).

In the case of ethanol, using the new model meant that the CI of ethanol declined mainly via the reduction in the indirect land use change (ILUC).

This indirect component is only added to the CI of fuel produced from crops. The CI of ethanol fuels used in 2016 averaged 71 gCO₂e/MJ, showing a decline of 10.57 points, on average, compared with 2015 (81.57 gCO₂e/MJ).

Despite the lower estimated CI of ethanol, because the CI of renewable diesel (37.4 gCO₂e/MJ) and biodiesel (16.7 gCO₂e/MJ) are much lower than that of ethanol, these two biofuels require fewer gallons of each fuel to generate credits (see Figure 2).

In 2016, as Figure 2 shows, 1.596 billion gallons of ethanol were used to generate 3.519 million credits (452.5 gallons/credit, on average).

On the other hand, 249.3 million gallons of renewable diesel generated 2.15 million credits (116 gallons/credit, on average) and 149.5 million gallons of biodiesel generated 1.726 credits (86.5 gallons per credit, on average).

Ethanol Credits

As Figure 3 shows, the cumulative number of ethanol credits since 2011 equaled 11.912 million, representing 46.4% of all credits during the six-year period (25.647 million credits).

Corn ethanol alone made up 36.3% (9.308 million credits) of all credits and

78.1% of all ethanol credits during that period. This aggregated data indicates ethanol has been the number one credit-generator fuel in the LCFS program.

In addition, renewable diesel and biodiesel generated 19.2% (4.913 million credits) and 17.4% (4.460 million credits) of all credits from 2011 to 2016, respectively.

The number of ethanol gallons going into the California market from 2011 to 2016 equaled 8.63 billion gallons with 7.627 billion gallons of that being corn ethanol.

Also, 591.491 million gallons of renewable diesel and 429.553 million gallons of biodiesel have been sold into the California market under the LCFS program since 2011.

LCFS Credits

As indicated by CARB's data, there have been 25.647 million credits generated from 2011 to 2016 compared with 15.919 deficits over the same period.

This indicates the LCFS program

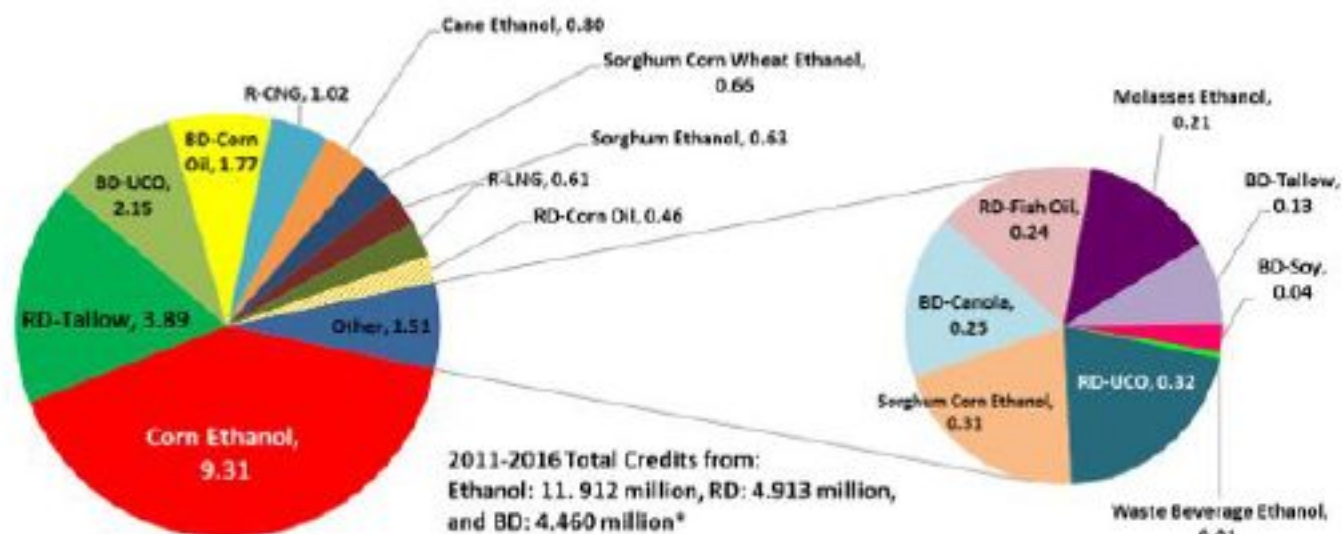
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has over-complied with 9.728 million metric tons of green-gas emission reduction, with ethanol as the largest contributor to the success of the LCFS program. Since LCFS is a state program, it remains in force with no impact from the recent announcement of the U.S. withdrawal from the Paris Climate Agreement. ■

Sources: California Air Resources Board, (2015), Low Carbon Fuel Standard Regulation. (2017a), 2016 LCFS Compliance Information and Credit Clearance Market Information. (2017b), Monthly LCFS Credit Transfer Activity Reports.

Figure 3

2011-2016 California Low Carbon Fuel Standard Credits by Type of Fuel and its Feedstock (Million MT of CO₂e in Greenhouse Gas Reduction)



Data source: California Air Resources Board.

BD= biodiesel, UCO= used cooking oil, RD= renewable diesel.

R-CNG= renewable compressed natural gas, R-LNG= renewable liquified natural gas.

*"Other" category (shown in the small pie chart) includes biofuel with less than 320,000 credits.

*CARB's feedstock data indicates 4.348 million BD credits from 2011 to 2016; however the actual total number of BD credits was 4.460 million. The difference is based on credits reported for which reporting parties did not specify the BD feedstock used in the BD production.



Source: Decision Innovation Solutions