COME CLEAN, PART 2 - CALIFORNIA'S LOW CARBON FUEL STANDARD AND WHY IT MATTERS

April 27, 2021

As governments and corporations around the world evaluate methods of decarbonization across sectors, one focus area has been transportation, since the petroleum fuels used to mobilize economies are significant contributors to greenhouse gas (GHG) emissions. California's Low Carbon Fuel Standard (LCFS) is one of the longest-running programs for carbon intensity (CI) reduction targeting the transportation sector and provides an ideal case study to review for a better understanding of how one type of GHG reduction policy is anticipated to work. As many of the principles in this pioneering program are being evaluated for replication elsewhere, its results and consequences are still in the making. In today's blog we'll provide an overview of the Golden State's groundbreaking LCFS, looking at its history, how it functions, and its effectiveness at meeting its goals to date.

This is Part 2 in a blog series on low carbon fuel policies, the mechanisms being evaluated to meet increasingly stringent GHG-related regulations, and the impact these rules could have on refined-products markets. In Part 1, we provided an overview of various policies that have been adopted and are being discussed to reduce GHG emissions from on-road transportation fuel use. We also noted some of the more popular approaches being taken, including fuel economy standards, renewable blending requirements, zero emission vehicle mandates, and clean fuel standards like LCFS programs in California and Oregon, the Canadian province of British Columbia, and the proposed Canadian Clean Fuel Standard. Such LCFS programs are usually established and measured based on the carbon intensity (CI) of fuels used. As we said in Part 1, CI is a measure of the lifecycle GHG emissions associated with producing, distributing, and consuming a fuel, which is measured in grams of carbon dioxide equivalent per megajoule (gCO2e/MJ). (That's the simple version.) Typically, LCFS policies establish downward-sloping carbon-intensity benchmarks for the jurisdiction's total transportation fuel pool, and incentivize the production and blending of lower-CI fuels to meet the benchmarks.

Today, we focus on California's program. We should note up front that the nation's most populous state has been a frontrunner on environmental policies for many decades. Back in 1965, California was the first state to regulate vehicle exhaust by setting limits on carbon monoxide and other hydrocarbon emissions — younger readers may not remember when Los Angeles was as well-known for smog as it was for movie-making. In 1967, the Federal Air Quality Act allowed California to enforce more stringent pollution standards than the federal government, and in the 54 years since, the state has generally had the tightest standards for ozone and particulate emissions. Then came the 2002 enactment of Assembly Bill (AB) 1493, which required the California Air Resources Board (CARB) to begin regulating GHG emissions from cars, SUVs, and pickup trucks. There have been many other laws and regulations since then, including the state's LCFS.

LCFS Background

In 2006, the California state legislature passed the California Global Warming Solutions Act, commonly known as AB 32. The legislation required CARB to develop a Scoping Plan, with updates every five years, that describes the approaches California could take to reduce GHG emissions to 1990 levels by 2020. One of the recommended actions in the first Scoping Plan in 2008 was a LCFS. The primary purpose of the LCFS was to encourage the production and use of cleaner, lower-carbon transportation fuels in California, which would theoretically reduce GHG emissions and decrease the dependence on petroleum-based fuels.

The LCFS was adopted in 2009 and implemented on January 1, 2011, with the initial goal of lowering the CI of California's transportation fuels by at least 10% by 2020. The regulation has been amended and strengthened to include CI-reduction benchmarks of 20% through 2030.

How the LCFS Works

The LCFS assigns a CI value for petroleum-based gasoline and diesel fuels, as well as their substitutes (such as ethanol, biodiesel, etc.). The CI is assigned after evaluating the lifecycle GHG emissions (CO_2, CH_4, N_2O, etc.) associated with the production, transportation, and consumption of the fuels. Two models are used to calculate the direct effects of producing and using the fuels: (1) the California Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (CA-GREET) and (2) the Oil Production Greenhouse Gas Emissions Estimator (OPGEE). Two additional models are used to calculate the indirect effects (think land-use etc.) of the fuels: (1) the Global Trade Analysis Project (GTAP) model and the Agro-Ecological Zone Emissions Factor (AEZ-EF) model. Californians must love acronyms — the longer the better!

The end result of all this modeling, as we said, is a CI intensity for a variety of transportation fuels. For example, California Reformulated Gasoline Blendstock for Oxygenate Blending (CARBOB, the petroleum-based portion of finished gasoline in California, which accounts for roughly 90% of each gallon) has a CI of ~101 gCO_2e/MJ. As shown in Figure 1, this number is based on the lifecycle analysis performed using the sum of the CI of 1) the average crude oil supplied to California in 2010, 2) the CI of the crude-oil transportation component, 3) the CI of processing the crude oil in California, 4) the CI of transporting the fuel to market, and 5) the CI of burning the fuel in engines, which is the largest component of the GHG emissions.

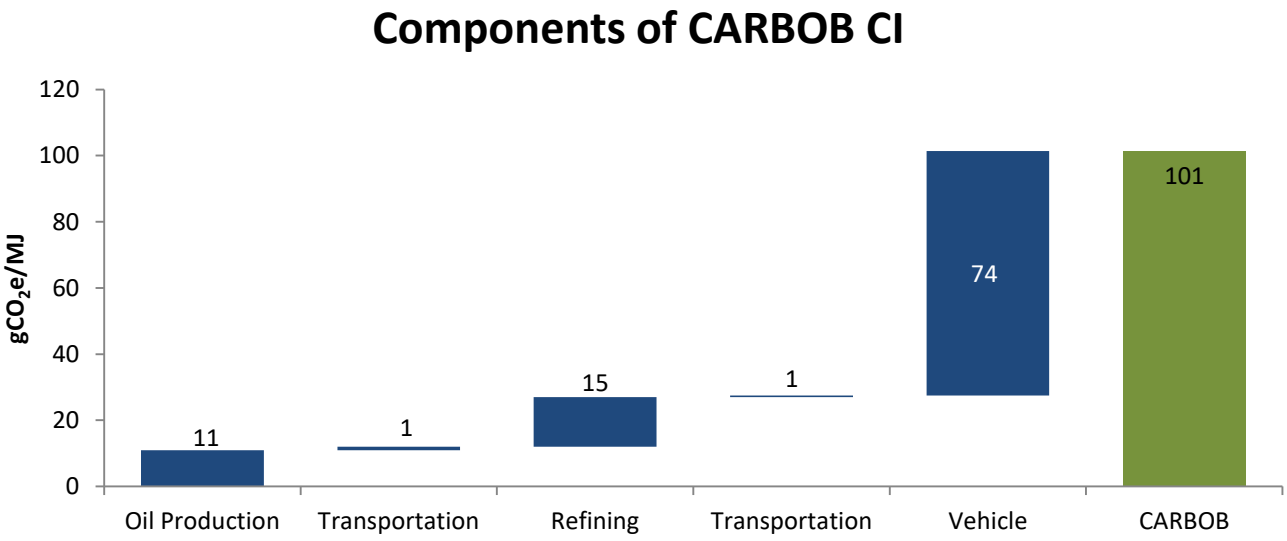

Figure 1. Components of CI for CARBOB. Sources: CARB, Baker & O'Brien

As we discussed in Part 1, the LCFS then sets CI limits on the finished gasoline and diesel fuel consumed in California each year on a gradually declining scale to meet the 2030 goal of 20% CI reduction — note the sloping black line for diesel in Figure 2. Petroleum-based fuels have CIs higher than the annual limits and renewable fuels are generally below the annual limits. If a fuel has a CI above the limit, it generates a deficit and if a fuel is below the line, it generates a credit (more on those in a moment).

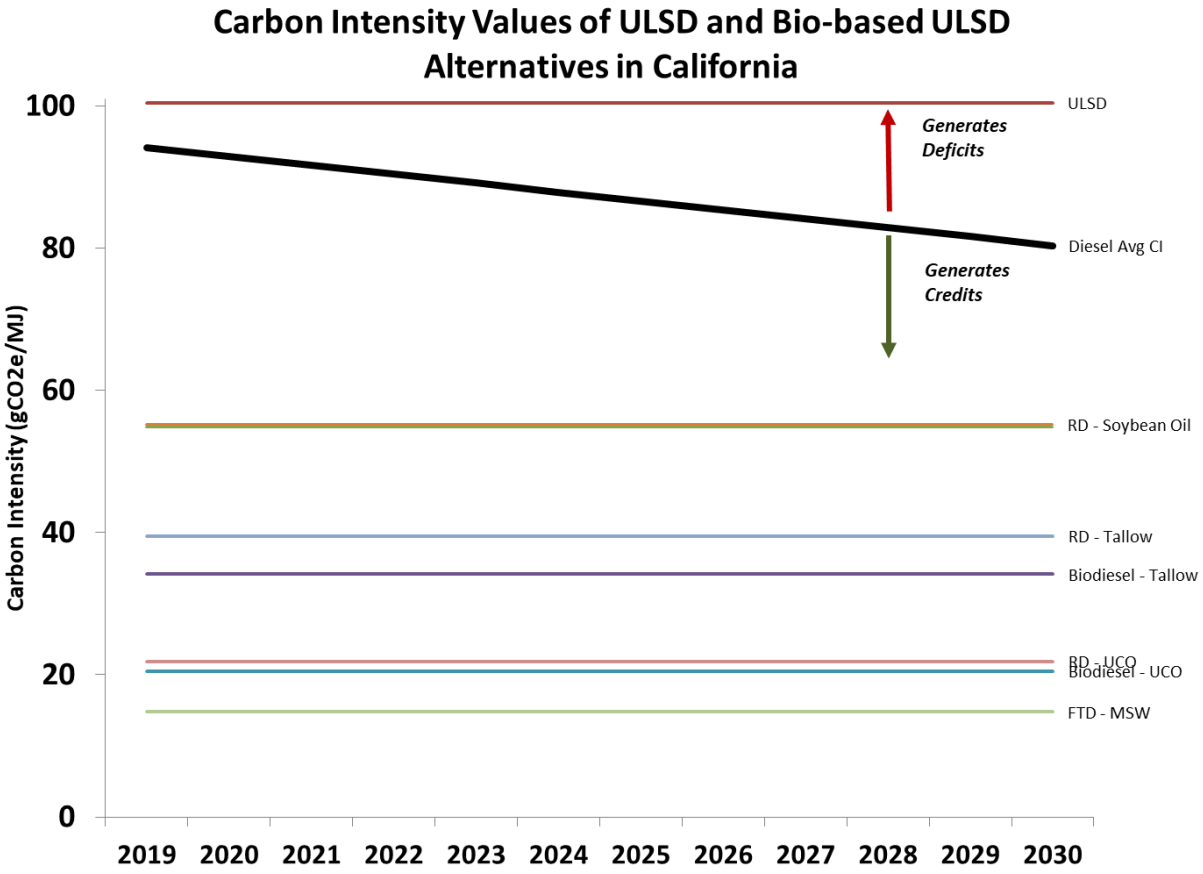

Figure 2. California Carbon Intensity Values. Sources: CARB, Baker & O'Brien

Credits can also be generated by implementing projects at refineries and crude oil production and transportation facilities to lower GHG emissions there ("project-based crediting"), such as carbon capture and sequestration (CCS). Once the project is verified, credits equal to the life-cycle GHG reductions are issued. Finally, credits can be generated by creating zero-emission vehicle infrastructure, such as hydrogen or electric vehicle-charging facilities ("capacity-based crediting").

LCFS credits are reported quarterly. Companies with deficits must retire a number of credits from their credit account to balance their deficit. If they haven't generated enough credits to meet their compliance obligation, they can purchase credits from other parties. For now, this credit market is specific to parties participating in the California market, but CARB is working with Oregon, Washington, and British Columbia to align the GHG reduction policies and eventually integrate the broader West Coast market for low-carbon fuels. As of the end of 2020, there were 438 regulated parties and 82 brokers participating in the credit market.

Fuel Mix Changes Since the LCFS Was Implemented

The LCFS program has incentivized increased blending of gasoline and diesel substitutes as the annual CI targets have become more stringent. However, the program has affected each fuel differently. Figure 3 shows the liquid fuel mix for gasoline and diesel consumed in the transportation sector in California.

Let's start with gasoline (left chart). The gasoline pool is shown to be made up of petroleum-based fuel (CARBOB, blue bar segments), ethanol (red segments), and renewable naphtha (green segments — you may need to zoom in to see them). Total consumption (the sum of the three bars) generally increased or held steady between 2011 and 2019. 2020 was an outlier because consumption obviously declined due to COVID-related impacts. During the 2011-20 period, ethanol blending stayed relatively constant at 10.2% of the total pool. The overall CI of the pool (purple line) declined slightly (~2%), primarily due to lower-CI ethanol sources being utilized as blendstocks. Imports of sugar-based ethanol with a lower CI can displace domestic corn-based ethanol, a topic we will cover in a later blog.

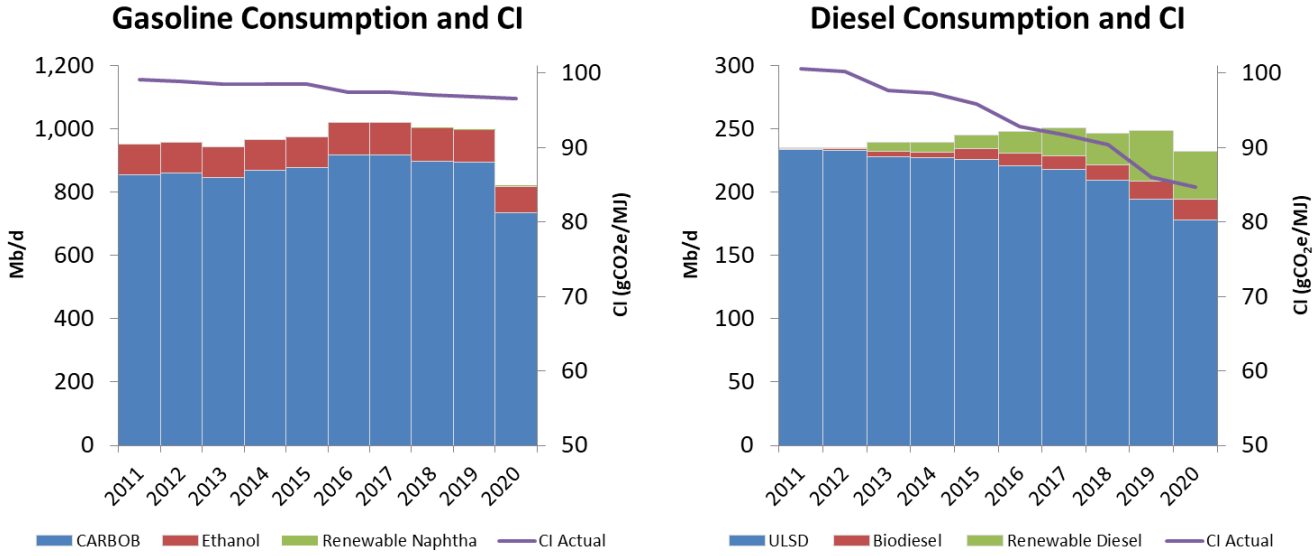

Figure 3. California's Gasoline and Diesel Consumption and CI. Sources: CARB LCFS Quarterly Summaries, Baker & O'Brien

The changes in the diesel pool (right chart), on the other hand, have been more dramatic. Similar to gasoline, the consumption of diesel in the transportation sector increased between 2011 and 2019 and slipped in 2020. However, biodiesel blending (red bar segments) has increased from 0.4% to nearly 7% in 2020 and renewable diesel (green segments) has increased from 0.1% to over 16% in 2020. Putting these two fuels together, the bio/renewable component of the diesel pool was ~23% in 2020. This has caused the calculated CI of the diesel pool (purple line) to decline approximately 16%.

So why is there a discrepancy between the changes in the gasoline and diesel pools? Well, ethanol properties are different than gasoline and above certain levels (known as the "blend-wall"), ethanol can be detrimental to certain vehicle engines. In 2011, ethanol was already being blended to the current maximum of 10%. Therefore, the only way to reduce the gasoline pool's CI was to blend lower-CI ethanol or start using renewable blendstocks without the blend-wall limitations.

On the diesel side, there are also limits to how much biodiesel can be blended into petroleum-based ultralow sulfur diesel (ULSD) due to its high cloud point (the point at which the diesel starts to solidify), thus limiting the amount that can be blended in the winter. In contrast to ethanol and biodiesel, renewable diesel has properties similar to ULSD and can be used in greater proportions.

The LCFS has also increased the number — and production — of gasoline and diesel substitutes

such as electricity, CNG/LNG, hydrogen, propane, and, due to recent adjustments to the LCFS program, sustainable aviation fuel, or SAF. As a comparison, the sum of all of these substitutes, on a gasoline or diesel gallon equivalent basis (see Figure 4), is slightly larger than the biodiesel market in California. All of these substitutes generate credits that can be sold to regulated parties with CI deficits to meet the requirements for gasoline and diesel. For example, while jet fuel is not a regulated fuel under the LCFS, blending sustainable aviation fuel into jet fuel can generate credits under the program.

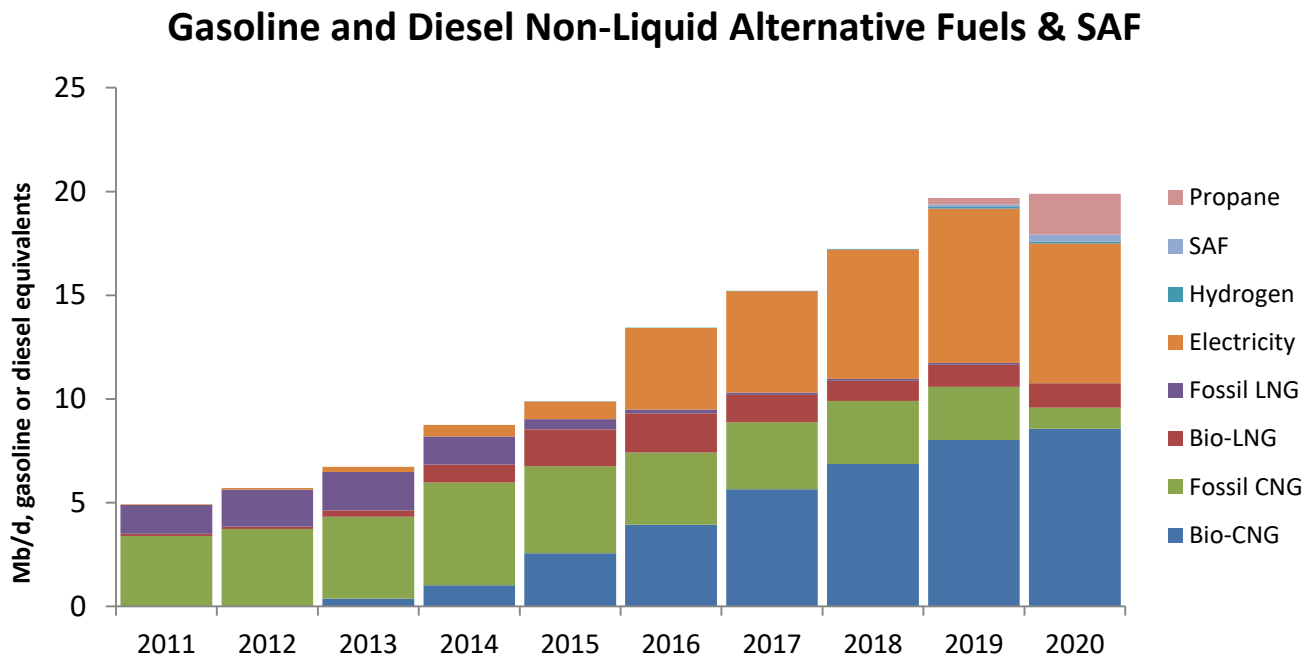

Figure 4. Production of Gasoline and Diesel Alternative Fuels. Source: LCFS Quarterly Summaries

The Credit Market

Back to the credits, since that is how the market keeps track of whether the CI goals are being met. Through 2016, regulated parties were blending more renewable fuels or utilizing more alternative fuels than required to meet the CI reduction goals. Therefore, during that time period, the credit bank — or cumulative surplus of credits over deficits (green line in Figure 5) — was growing. However, things started to take a turn in 2017, with quarterly deficits mostly outweighing the credits. That resulted in a gradual decline in banked credits.

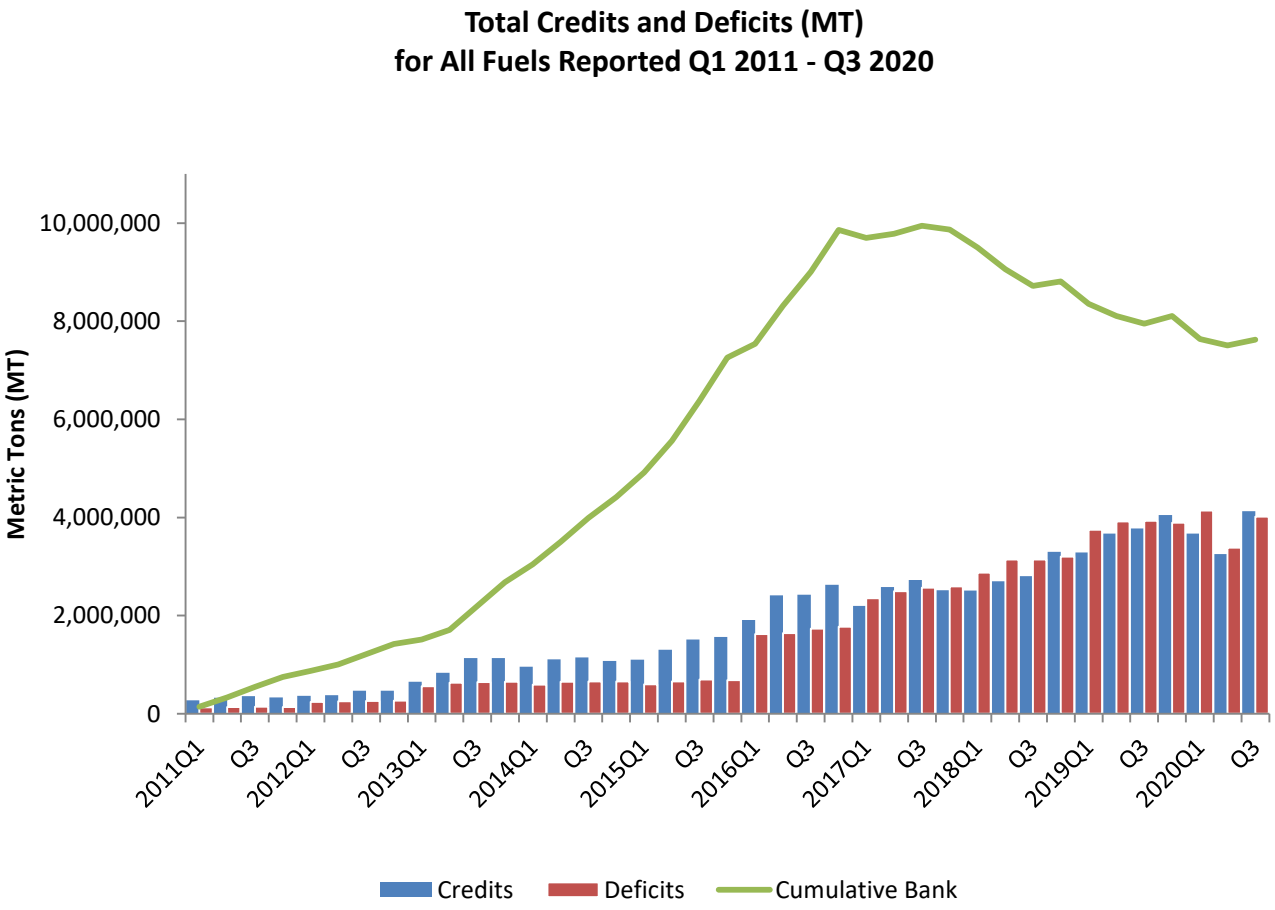

Figure 5. Credits, Deficits, and the Credit Bank. Source: LCFS Quarterly Summaries

With the more stringent CI reduction targets and the flip to a declining credit bank, credit prices have increased significantly. In an attempt to limit price spikes, CARB placed a cap of $200/metric ton (MT) (in 2016 dollars), on LCFS prices that is allowed to escalate at the consumer price index (CPI) every year. In 2020, we essentially hit the $200/MT cap. If one assumes that these prices are passed on to the consumer, it's a hefty charge on each gallon of gasoline and diesel sold in the state that, by our calculations, averages about $0.20/gal.

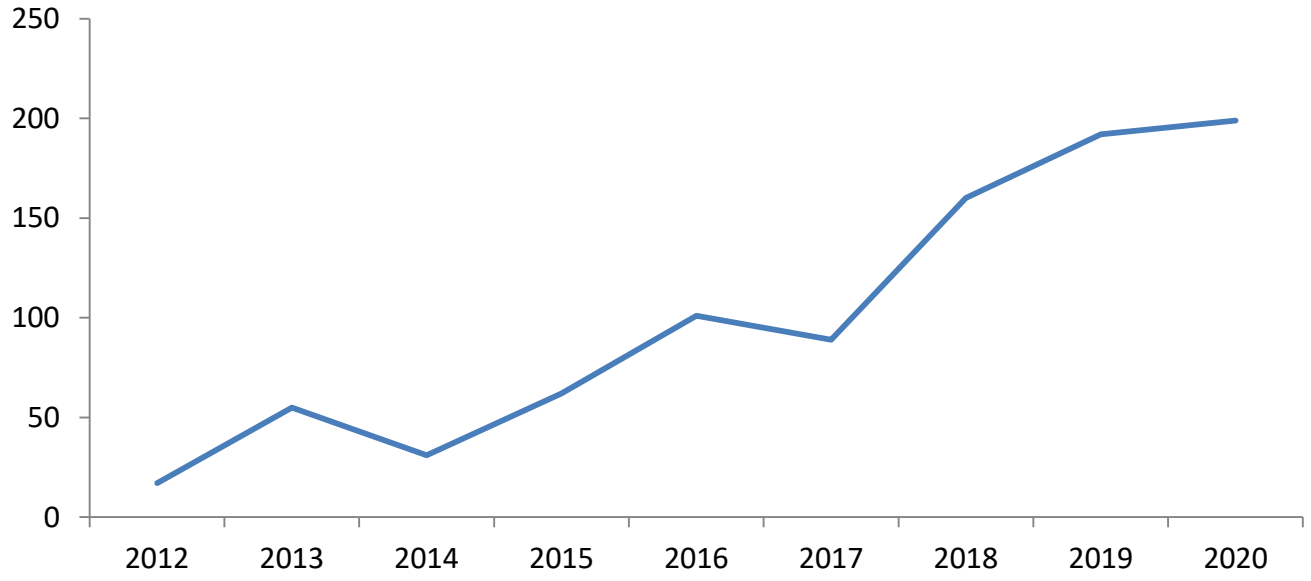

Figure 6. LCFS Credit Price. Source: LCFS Quarterly Summaries

Ultimately, the California LCFS program has shown that market-based incentive programs can be implemented to reduce calculated CIs. The recent surge in the use of renewable diesel and reduction in the CI of diesel fuels used in the state demonstrates that the program is meeting its objective. For this reason, we expect that similar incentive programs will be implemented beyond California. The robustness of this program was recently evidenced by the fact that ExxonMobil just doubled down on its commitment to purchase renewable diesel from the Bakersfield Renewable Fuels biorefinery scheduled for startup in 2022, which will provide lifecycle GHG emissions reductions of 40-80%, as well as, of course, LCFS credits. We'll be tracking that deal in our U.S. Refinery Billboard report and comment on it in our upcoming renewable diesel blog.

Now that we've looked at the carbon policies on the transportation sector in general and discussed California's landmark LCFS policy in detail, we'll turn our attention in the next blogs in this series to the alternative fuels being utilized to comply with lower-carbon policies.

Note: The article was authored by Amy Kalt of Baker & O'Brien and published on RBN Energy's Daily Energy Post on April 27, 2021.

"Come Clean" was written by Kara DioGuardi and John Shanks and in January 2004 was the second single released from Hilary Duff's second studio album, Metamorphosis. Produced by John Shanks, the song peaked at #35 on the Billboard Hot 100 Singles chart in the U.S., but broke into the Top 20 in the UK and Australia.