

An Overview and Next Steps for California's Low Carbon Fuel Standard

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Cassandra B. Drotman, Raymond H. Huff

SCS Engineers, Long Beach, California

Haley M. DeLong

SCS Engineers, Santa Rosa, California

INTRODUCTION

California's transportation sector is responsible for 50 percent (%) of greenhouse gas (GHG) emissions, 80% of nitrogen oxide (NO_x) emissions, and 95% of particulate matter (PM) emissions in the state. The Low Carbon Fuel Standards (LCFS) Regulation (Regulation) was developed by the California Air Resources Board (CARB) as one of the nine discrete early action measures that were implemented under the California Global Warming Solutions Act (AB 32, 2006) to reduce GHG emissions. CARB approved the LCFS in 2009 to reduce the carbon intensity (CI) of transportation fuel in California by ten percent by 2020 from a 2010 baseline. The Regulation was initially implemented in January 2011, and in December 2011, CARB amended the Regulation to clarify, streamline, and enhance certain provisions. The LCFS promotes the use and manufacturing of fuels with a low CI, as determined through a life cycle analysis (LCA) process. The LCA assesses the direct and indirect effects of producing, distributing, and consuming fuel used in California.

The LCFS was re-adopted by CARB in 2015 to address procedural issues and began implementation on January 1, 2016. Amendments were made to the LCFS most recently in 2018. These recent amendments set a more stringent benchmark of reducing the CI of the transportation fuel pool by at least 20% by 2030 compared to 2010 data, and provide additional opportunities to receive credits including promoting zero emissions vehicle adoption, alternative jet fuel, carbon capture and sequestration (CCS), and advanced technologies to achieve deep decarbonization in the transportation sector.

The LCFS is a key component of California's overall goal to become carbon neutral by 2045 and compliments other State GHG reduction programs. These programs include California's Cap and Trade Program, which sets a statewide limit on the largest emitting sources that are responsible for 85% of the State's GHG emissions, the Advance Clean Cars Program which requires more stringent emission limits on cars manufactured after 2015, and the Senate Bill (SB) 375, which requires regional land use and transportation planning with the end goal to provide communities with transportation alternatives so there are less single occupant vehicles on the road. In addition, the LCFS is necessary to meet the Governor's goal to reduce California's petroleum use by half by 2030 using 2015 as a baseline.

This paper provides an overview of the LCFS program, its applicability, reporting, and verification requirements, as well as CARB LCFS market and stability.

LCFS PROGRAM OVERVIEW

CARB establishes CI benchmarks for gasoline and diesel, and the fuels that replace them, which are reduced annually through 2030, and are compared against regulated entities reports. The CI is measured in grams of carbon dioxide equivalent (CO_{2e}) per megajoule (gCO_{2e}/MJ) and measures the GHG emissions associated with an LCA assessment. Fuels with a CI below the annual benchmark generate a credit while fuels with a CI above the annual benchmark generate a deficit. These credits and deficits are measured in units of Metric Tons of CO_{2e} (MTCO_{2e}). Credits must be obtained to match any deficits for the fuels that are above this CI benchmark, and a reporting entity’s annual compliance obligation is met once it has retired the credits from its credit account that is equal to its deficits. Only reporting entities are allowed to hold credits, and these credits never expire.

CI benchmarks are based on gasoline and diesel usage during the 2010 baseline year. There are separate CI benchmarks for gasoline/gasoline fuel substitutes, diesel/diesel fuel substitutes, and fuels used as a substitute for conventional jet fuel. Note that conventional jet fuel is considered an opt-in fuel under the LCFS and does not generate deficits, and the sole purpose of the CI benchmarks for conventional jet fuel substitutes are to calculate credits from alternative jet fuel. Figure 1 shows the CI benchmarks for gasoline and diesel and their fuel substitutes through 2030.

Figure 1. CI Benchmarks for Gasoline, Diesel Fuel, and their Fuel Substitutes

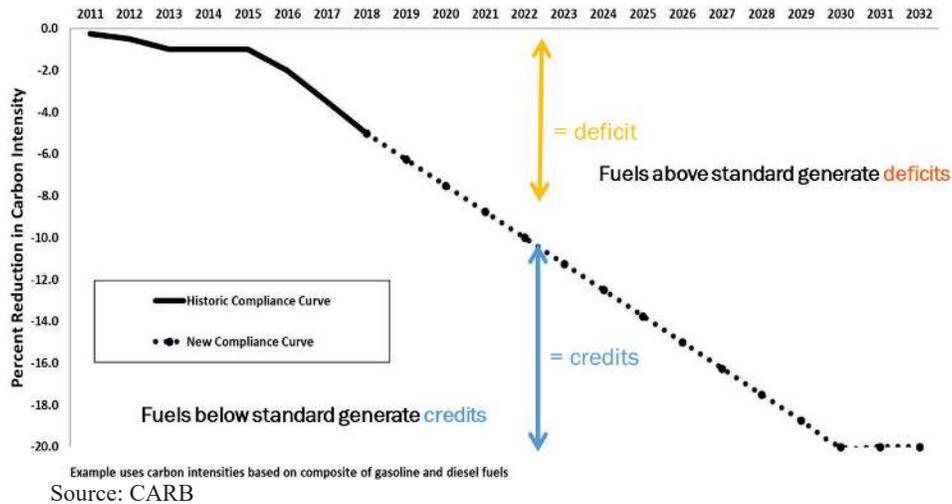
Compliance Year	Gasoline (gCO _{2e} /MJ)	Diesel (gCO _{2e} /MJ)
2019	93.23	94.17
2020	91.98	92.92
2021	90.74	91.66
2022	89.50	90.41
2023	88.25	89.15
2024	87.01	87.89
2025	85.77	86.64
2026	84.52	85.38
2027	83.28	84.13
2028	82.04	82.87
2029	80.80	81.62
2030	79.55	80.36

Source: CARB

When the LCFS was first adopted, the CI benchmark had a “back-loaded” trajectory for 2010 through 2020 to allow for the development of alternative fuels with low CIs and advanced vehicle technologies, while strengthening the longer term goals through 2030. This approach also allows excess credits to be generated early on in the program which are available for use in

the more stringent future years. Figure 2 shows the historic and current trajectory of the declining CI curve through 2030.

Figure 2. Declining CI Curve



LCFS REPORTING SECTOR REQUIREMENTS

Fuel Transaction Reporting – Sold, Supplied, or Offered for Sale in CA

Applicability

The current fuels subject to the LCFS, include the following fuels that are sold, supplied, or offered for sale in California, can be found in Section 95482(a) of the Regulation and are shown below:

- California reformulated gasoline (“gasoline” or “CaRFG”)
- California diesel fuel (“diesel fuel” or “ULSD”)
- Fossil compressed natural gas (CNG), liquified NG (LNG), or liquified compressed NG (L-CNG)
- Bio-CNG, bio-LNG, or bio-L-CNG
- Electricity
- Compressed or liquified hydrogen (“hydrogen”)
- Fuel blend with >10% ethanol by volume
- Fuel blend with biomass-based diesel
- Denatured fuel ethanol (E100)
- Neat biomass-based diesel (B100 or R100)
- Alternative jet fuel
- Propane
- Any other liquid or non-liquid fuel

The Regulation allows has an exemption for specific fuels under 95482(c) and (d), a summary is included below:

- Alternative fuel that is not biomass-based, and supplied in California by all providers for transportation use at an aggregated quantity less than 420 million MJ
- Conventional jet fuel or aviation gasoline
- Military tactical vehicles or support equipment
- Fossil CNG dispensed at a fueling station with total throughput of 150,000 gasoline-gallons equivalent or less till January 1, 2024
- Fossil propane dispensed at a fueling station with total throughput of 150,000 gasoline-gallons equivalent or less till January 1, 2021
- Locomotives and ocean-going vessels

Reporting

Petroleum importers, refiners, and wholesalers consist of the deficit generating regulated entities. Deficit-generating reports include the quarterly fuel transaction reports, crude oil quarterly and annual volumes reports. The quarterly fuel transaction reports require producers, importers, and exporters to report quarterly quantities (i.e. volume) of California Reformulated Gasoline Blendstock for Oxygenated Blending (CARBOB) and diesel. Deficits are generated by producers and importers which are calculated based on the volumes reported to CARB and the CIs for gasoline and diesel contained in the lookup table in the Regulation Section 95488.5(e) (Table 7-1).

The crude oil quarterly and annual volumes reports require petroleum refiners to report volumes of crude oil feedstock by marketable crude oil name (MCON) that is processed into CARBOB and diesel, and the county or state of origin for each crude supplied to the refinery during each quarter and calendar year. These reports are used by CARB to calculate the incremental deficits for CARBOB and diesel to mitigate increases in crude oil CI.

Entities use the LCFS Reporting Tool & Credit Bank and Transfer System (LRT-CBTS) to facilitate reporting, compliance demonstration, credit generation, banking, and transfers. All quarterly fuel transaction reports, crude oil quarterly and annual volume reports are submitted through the LRT-CBTS. The quarterly fuel transaction reports and crude oil quarterly reports are due three months after the end of each quarter (i.e. first quarter report due June 30, second quarter report due September 30, third quarter report due December 31, and fourth quarter report due March 31). The crude oil annual volume reports are due by April 30.

Alternative Fuels Pathways

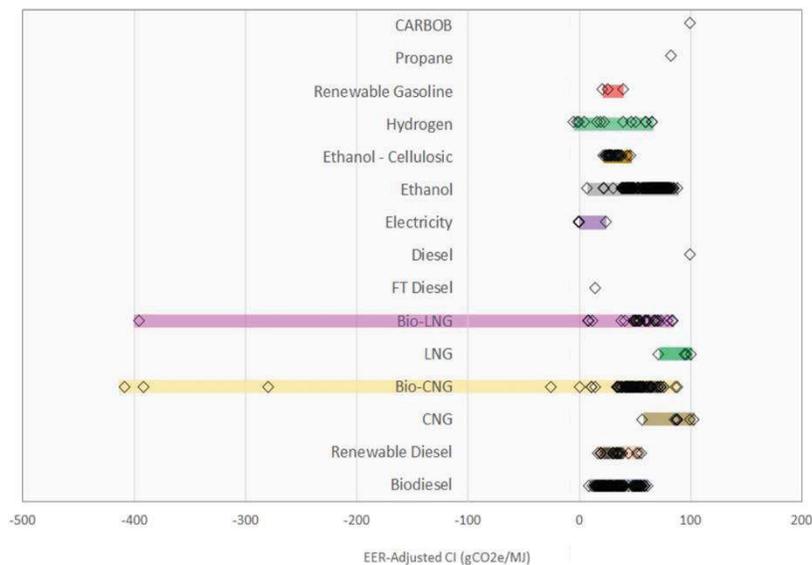
Applicability

There are also several alternative fuels/opt-in fuels that are eligible to generate credits, if a fuel supplier elects to become an opt-in fuel reporting entity, which can be found in Section 95482(b) of the Regulation and are shown below:

- Electricity
- Bio-CNG
- Bio-LNG
- Bio-L-CNG
- Alternative jet fuel
- Renewable propane

Fuel pathway-based crediting requires a pathway specific CI score for all alternative transportation fuels. In order to calculate the CI, fuel pathway applications are required to use the California modified Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation model (CA-GREET 3.0), including simplified CI calculators derived from this model and instruction manuals. Figure 3 shows the range in CARB certified CI values for various fuel pathways in 2019.

Figure 3. CI Values: Current Certified Pathways (2019)



¹The diamonds each represent a fuel pathway, and the bars show the range of the CIs.
Source: CARB

Pathway Types

There are three main methodologies to determine the CI of a fuel pathway.

1. **Lookup Table Pathway** – simplest pathway, and uses default CARB CIs from Section 95488.5 for fuels such as CARBOB, diesel, fossil CNG, fossil propane, and hydrogen. Note a fuel pathway application is not required unless they are using the default CI values for hydrogen fuel and zero-CI electricity.
2. **Tier 1 Pathway** – most common low carbon fuels and uses a simplified CI calculator which includes emission factors and life cycle inventory data derived from CA-GREET 3.0. There are eight simplified CI calculators for the following pathway types:
 - a. Starch and fiber ethanol

- b. Sugarcane-derived ethanol
 - c. Biodiesel and renewable diesel
 - d. LNG and L-CNG from North American natural gas
 - e. Biomethane from North American landfills
 - f. Biomethane from anaerobic digestion of wastewater sludge
 - g. Biomethane from anaerobic digestion of dairy and swine manure
 - h. Biomethane from anaerobic digestion of organic waste.
3. **Tier 2 Pathway** – applicable to innovative, next generation fuel pathways that cannot be accurately modeled using a simplified CI calculator, including fuel pathways with CCS.

Fuel pathways must use current operational data with a reporting period between three (3) and 24 months to determine the CI.

Pathway Crediting and Reporting

Credits for alternative fuels that meet one of the three pathways discussed above, are calculated based on the CI of the fuel compared to the annual benchmark and the quantity of fuel that is transacted in each quarter as reported in the quarterly transaction reports submitted by the entity whom sold, supplied, or offered for sale the fuel in California. Reporting requirements for Tier 1 and 2 pathways require a fuel-pathway application, which is required to be validated by a third-party verification body, and an annual fuel pathway report to demonstrate that actual operations data is meeting the certified CI, which requires annual verification by a third-party verification body. If a lookup table pathway is used, the verification requirements do not apply.

Fuel pathway applicants, including lookup table pathway applicants for hydrogen and zero-CI electricity, and all Tier 1 and 2 pathway applicants, utilize the Alternative Fuels Portal (AFP) to report to CARB. Entities seeking a lookup table fuel pathway for the other fuels such as CARBOB, ULSD, California average grid electricity, CNG, LPG, and smart charging or smart electrolysis do not need to register with AFP, as an application is not required. The annual fuel pathway reports are due by March 31 and these reports are also submitted through the AFP.

Project-Based Reporters

Applicability

Project-based crediting allows project operators to generate credits for eligible project types that reduce GHG emissions in the petroleum supply chain, and also by using CCS. Project operators and joint applicants submit applications to CARB for consideration. Specific projects may include but are not limited to use of renewable energy sources, conversion of combustion power sources to electricity, use of CCS, and process improvement projects.

Refineries may also generate credits for being a low complexity and low-energy-use (LC/LEU) refinery and must use less energy compared to standard refineries and report under an average deficit-generating CI. To meet this criteria, the refinery must have a modified Nelson Complexity Score less than or equal to five (5), and the total annual energy use must be less than or equal to 5 million MMBTU. There are currently two small refineries in California that meet

this criteria. LC/LEU refineries must submit an application proving they meet the eligibility criteria.

Reporting

Project-based crediting entity may elect to do quarterly or annual reporting. If the project is generating a significant number of credits, entities may decide to do quarterly reporting to obtain generated credits more frequently, note once reporting frequency is selected, it must be used for entire calendar year.

LC/LEU reports are required on an annual basis and must include the CARBOB and diesel volumes sold, supplied, or offered for sale in California.

All LC/LEU annual reports and quarterly or annual project reports are submitted through the LRT-CBTS. LC/LEU annual reports, and project reports are due by March 31. The quarterly project reports are due three months after the end of each quarter (i.e. first quarter report due June 30, second quarter report due September 30, third quarter report due December 31, and fourth quarter report due March 31).

Zero-Emissions Vehicle Infrastructure Pathways

Applicability

The 2018 LCFS amendments added a third credit generating opportunity that involves capacity-based crediting for zero-emissions vehicle (ZEV) infrastructure. This credit generating opportunity incentivizes the construction of ZEV infrastructures such as hydrogen fueling stations or electric vehicle (EV) fast charging stations. These ZEV infrastructures will allow more consumers to purchase zero-emission vehicles.

Credits are generated based on the capacity of the stations to deliver fuel once the station is fully utilized. Credits then decrease as a fueling or charging station reaches full utilization until the point it is only generating credits for its dispensed fuel.

Reporting

An application for a ZEV infrastructure must be submitted to CARB in LRT-CBTS. Once the application is approved by CARB, quarterly reports must be submitted in LRT-CBTS before credits will be issued. Hydrogen refueling infrastructure (HRI) quarterly reports must include cost and revenue data, company-wide weighted average renewal content for dispensed hydrogen, and the station availability (i.e. percentage of hours the station is available for fueling compared to the permitted operating hours). DC fast charging infrastructure (FCI) quarterly reports must include cost and revenue data as well as station availability. These reports are due within 45 days after the end of the quarter and are not subject to the third-party verification requirements.

VERIFICATION REQUIREMENTS

The 2018 Regulation amendments also implemented a third-party verification requirement to ensure the accuracy of the reported GHG data and that it conforms to the regulatory requirements prior to the issuance of credits. Adding these third-party verification requirements helps prevent fraudulent reported data and provides additional public, market, and stakeholder confidence in the reported data. The third-party verification requirements are also consistent with the verification programs under California’s Cap-and-Trade system as well as international best practices.

Note CARB uses the term “validation” for verification of a fuel pathway application and “verification” for the other report types. Regulated entities that are required to contract independent CARB accredited verifiers, beginning with 2020 fuels pathway applications and in 2021 (for the 2020 reporting year) for LCFS data reports and thereafter for LCFS are included in Section 95500 of the Regulation. The verification deadlines for the various LCFS’ applications and reports are as follows:

Application/ Report Type	Verification Deadline
Fuel Pathway Applications	Validated within 6 months of submission to CARB
Annual Fuel Pathway Reports	August 31
Quarterly Fuel Transaction Reports	August 31
Crude Oil Quarterly and Annual Volume Reports	August 31
LC/LEU Reports	August 31
Project Reports	Annual (August 31) or Quarterly (within 5 months of each quarterly project report deadline)

The Regulation does allow for quarterly review in the context of annual verification which allows the verification body to review the quarterly reports once submitted and identify issues sooner compared to reviewing all of the quarterly reports the following year. However, for quarterly review, there is only one verification statement which is still due by August 31 of the following year.

Verification requirements are included in Section 95501 of the Regulation. CARB requires an initial submittal of a conflict of interest (COI) form and notification of verification services (NOVS) form for their approval prior to starting verification services. Once approved, verification services include the following:

- Development of a validation or verification plan
- Developing a sampling plan/conducting a risk assessment
- Site visit
- Reviewing a reporting entity’s submitted report(s) and the associated data that went into preparing the report(s), focusing on the data with the highest risk based on the risk assessment
- Prepare a findings log of issues
- Ensuring the report’s accuracy according to the standards specified in the Regulation

- Assessing the reporting entity’s compliance with the Regulation
- Preparing a validation or verification report
- Material misstatement assessment
- Submitting a validation or verification statement to the CARB.

Verifiers are required to establish reasonable assurance that the reported data is free of a material misstatement, which are any discrepancies, omissions, or misreporting, or aggregation of the three, that leads the verification team to believe that the reported operational CI contains errors that result in an overstatement or understatement of 5 percent of the reported CI, or 2 gCO₂e/MJ, whichever absolute value expressed in gCO₂e/MJ is greater. Verifiers also must confirm that the reporting entity is in conformance with the Regulation.

At the end of verification services, the verification body will issue one of three types of verification statements that can be submitted: positive, qualified positive, or adverse. Positive verification statements means the verifier has reasonable assurance that the reported CI value is free of material misstatement and conforms to the Regulation. A qualified positive statement means the verifier has reasonable assurance that the reported CI value is free of material misstatement and the reported data does not contain any correctable errors; however, the data includes one or more non-conformances with the Regulation. An adverse statement means the reported CI contains a material misstatement or there were correctable errors in the data that the reporting entity did not address. An adverse validation statement would result in CARB denial of the application without prejudice. An adverse verification statement would result in no credit generation, investigation by CARB, and possible enforcement action.

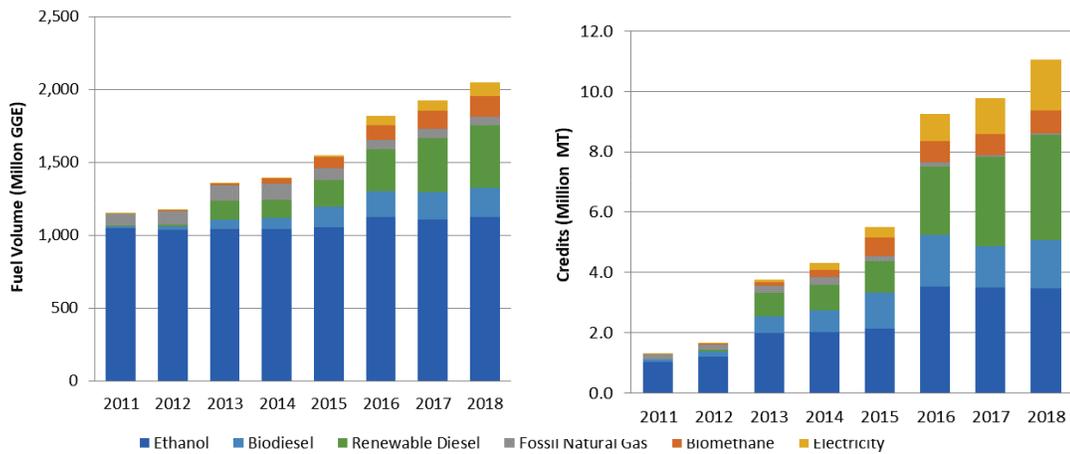
CARB LCFS MARKET AND STABILITY

According to CARB, low carbon fuel usage has increased, and during 2018, the total value of credit transactions exceeded \$2 billion. In addition, during 2018, there was a total of 317 reporting entities, and out of this total, 52 entities reported deficits. These entities generated 12,366,497 deficits while 11,182,369 credits were generated during 2018. However, this amount does not include the credits generated for the LC/LEU refineries. The program attained 100% compliance during the 2018 reporting year.

Credit pricing from 2016 to 2019 has ranged from \$65 to \$200 per credit. As of March 1, 2020, credit prices have been trading at an all-time high with an average price of \$208 per MT/per credit. CARB maintains a LCFS Data Dashboard web page, which displays the current and historical LCFS program data. This information includes volumes of alternative fuels and the associated numbers of credits generated, the average credit prices per month, the volume of credits transacted, and the percent reduction in CI to date.

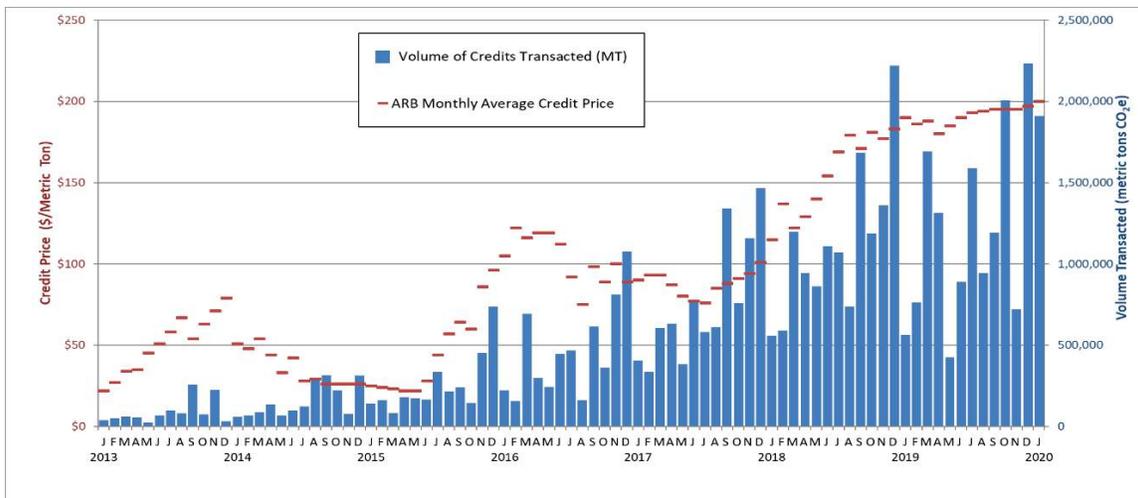
Figure 4 shows the alternative fuel volumes and associated credits generated through 2018. Figure 5 presents the monthly LCFS credit price and transaction volumes through January 2020.

Figure 4. Alternative Fuel Volumes and Credit Generation



Source: CARB

Figure 5. Monthly LCFS Credit Price and Transaction Volume



Source: CARB

SUMMARY

California’s LCFS program has undergone various amendments since it was first approved in 2009. The most recent 2018 amendments provided additional opportunities to generate LCFS credits, including promoting zero emissions vehicle adoption, alternative jet fuel, CCS, and advance technologies to achieve a deep decarbonization in the transportation sector. These 2018 amendments also implemented a third-party verification requirement to ensure the accuracy of reported GHG data and helps prevent fraudulent data which in return increases the confidence of the reported data and LCFS market.

In addition, the recent amendments set a more stringent benchmark of reducing the CI of the transportation fuel pool by at least 20% by 2030, compared to 2010 data. As the transportation sector is responsible for 50% of California's overall GHG emissions, the LCFS is an essential component to ensure California's overall goal to become carbon neutral by 2045.

REFERENCES

- California Code of Regulation (CCR), Title 17, Subchapter 10, Article 4, Subarticle 7, Sections 95480 to 95503, Low Carbon Fuel Standard Regulation, amended January 4, 2019.
- CARB's Low Carbon Fuel Standards Website and Associated Resources (<https://ww2.arb.ca.gov/our-work/programs/low-carbon-fuel-standard>)
- California Air Resources Board. Data Dashboard. (<https://ww3.arb.ca.gov/fuels/lcfs/dashboard/dashboard.htm>)
- CARB's Low Carbon Fuel Standard Verification Accreditation Training and Training Material. (December 2019).