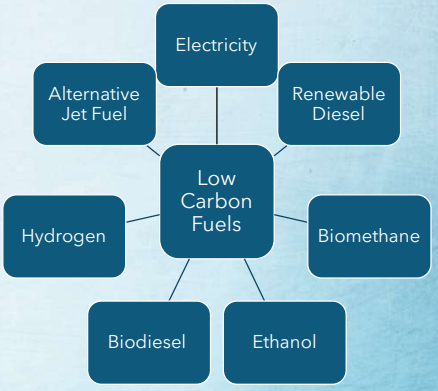
Overview of the Low Carbon Fuel Standard

Last Updated: November 2025

History and Background

LCFS History

- Originally adopted in 2009 and amended in 2011
  - Following brief pause, re-adopted in 2015
  - Amended again in 2018, and most recently in 2024
- Goal: reduce carbon intensity (CI) of transportation fuel pool by at least **30% by 2030** and **90% by 2045**
- Expected benefits:
  - Complement other AB 32 measures
  - Transform and diversify fuel pool
  - Reduce petroleum dependency
  - Reduce emissions of other air pollutants



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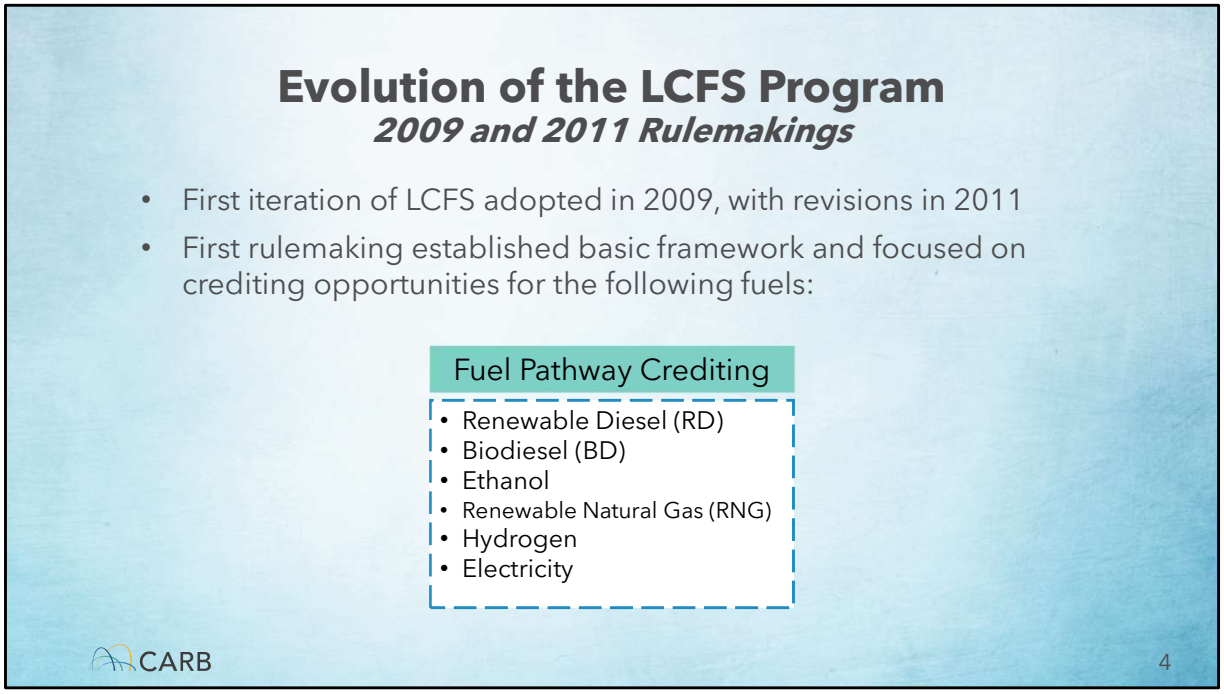
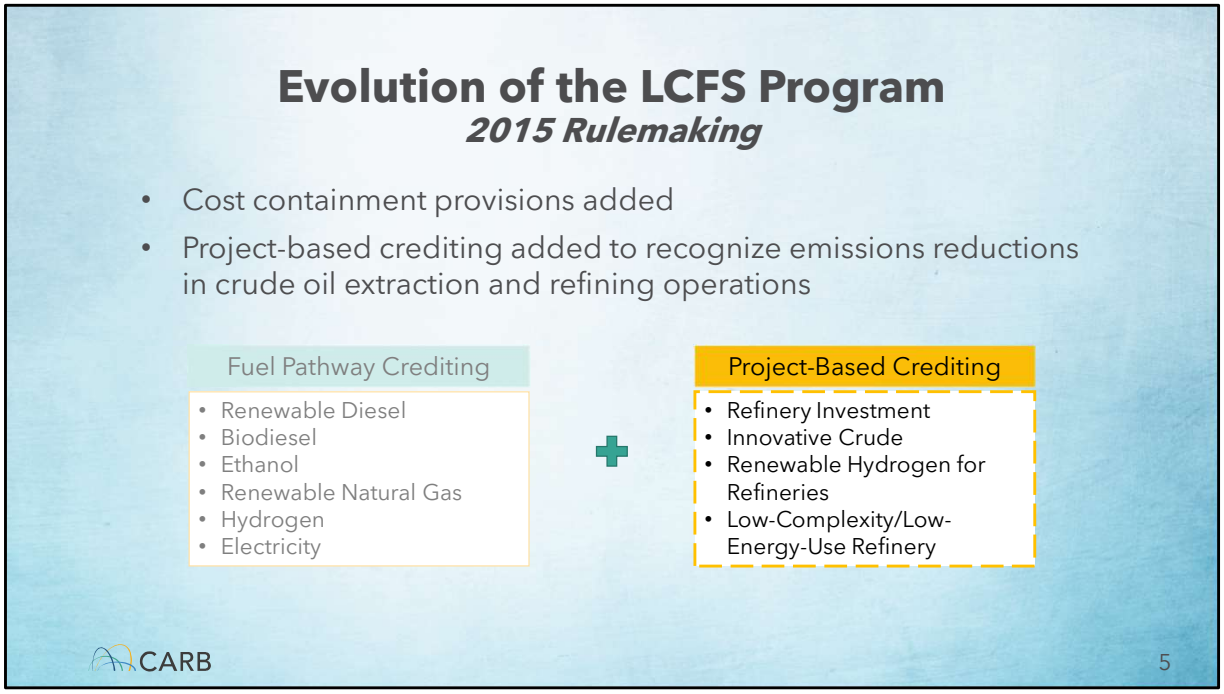
In 2009 the Board approved the LCFS regulation to reduce the carbon intensity (CI) of transportation fuel used in California by at least 10% by 2020 from a 2010 baseline. In 2011, the Board approved amendments to the regulation to clarify, streamline, and enhance certain provisions of the regulation. In 2015, the Board re-adopted the LCFS to address procedural issues, which began implementation on January 1, 2016. In 2018, the Board approved amendments to the regulation, which included strengthening and smoothing the CI benchmarks through 2030 in-line with California's 2030 GHG target enacted through SB32.

In 2024, the Board approved amendments to the regulation, including strengthening the CI benchmarks through 2045 in-line with the 2022 Scoping Plan Update, and added sustainability guardrails for crop-based fuels and updates to the infrastructure crediting programs.

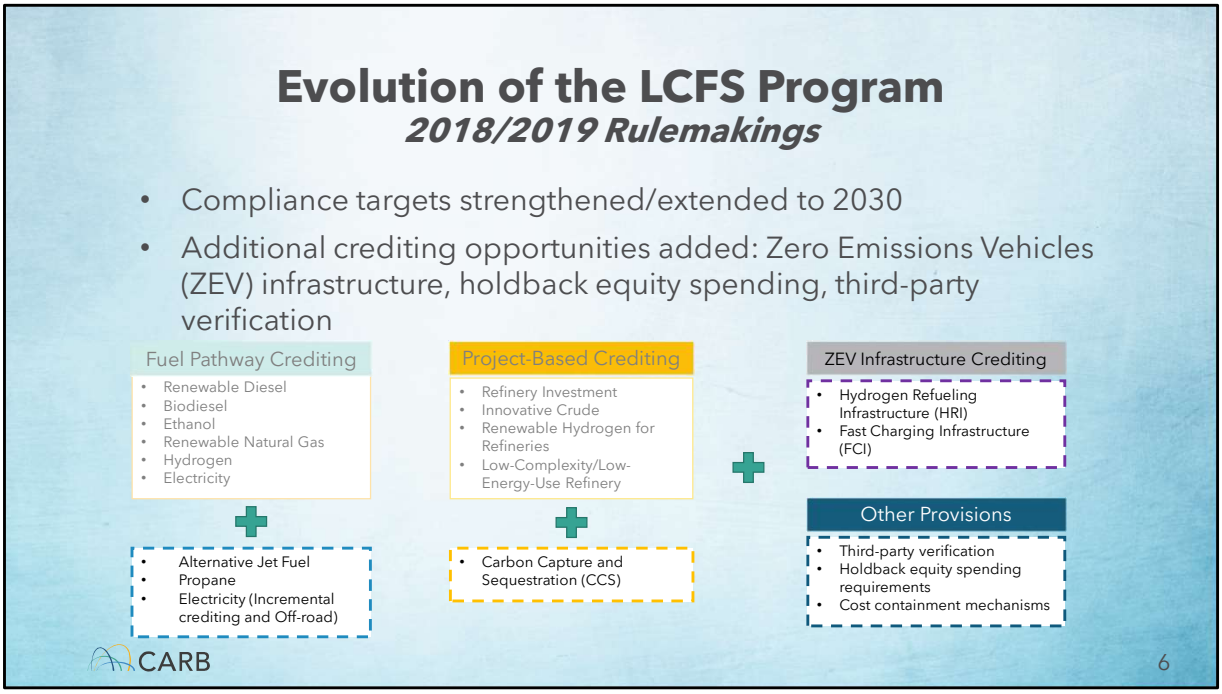
The LCFS is one of the key AB 32 measures to reduce greenhouse gas emissions in California but also has other significant benefits. It transforms and diversifies the fuel pool in California to reduce petroleum dependency and achieves air quality benefits, which are State priorities that preceded AB 32.



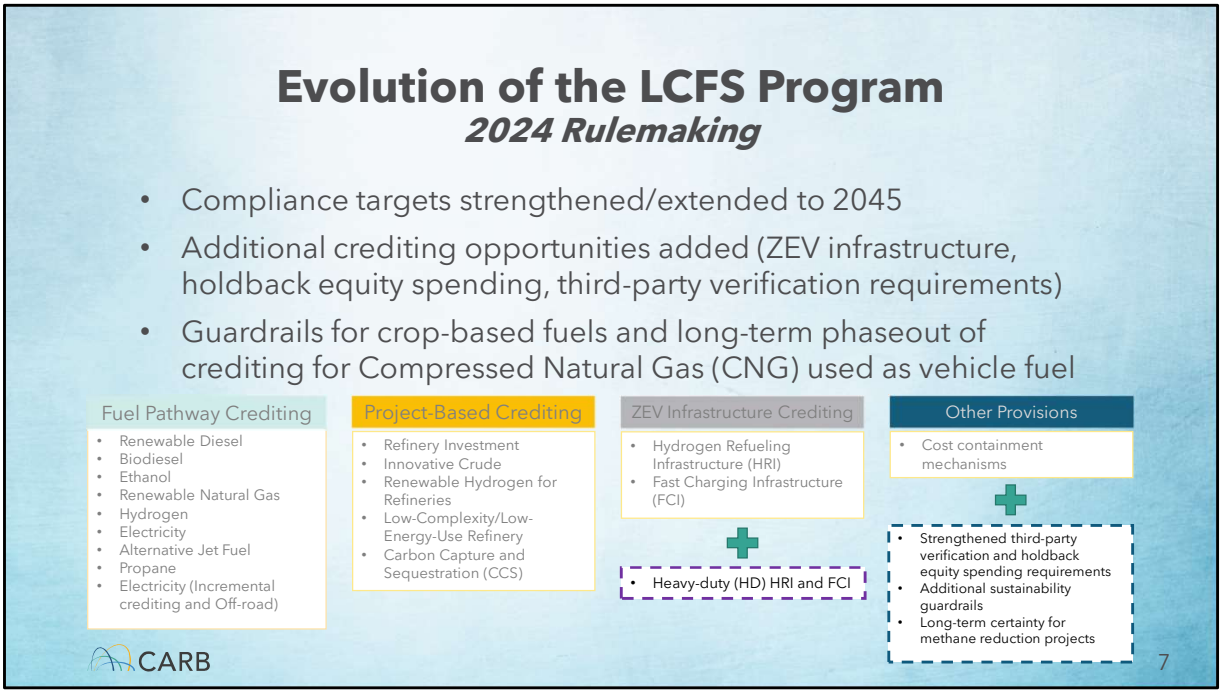
The original LCFS was created as an early action item under AB 32 and Governor Schwarzenegger's Executive Order S-01-07. The first iteration provided a number of ways that fuel suppliers can generate credits under the regulation. The most common credit generation pathways come from the low carbon fuels, like renewable diesel, ethanol, renewable nature gas, electricity, low-carbon hydrogen, and alternative jet fuel.



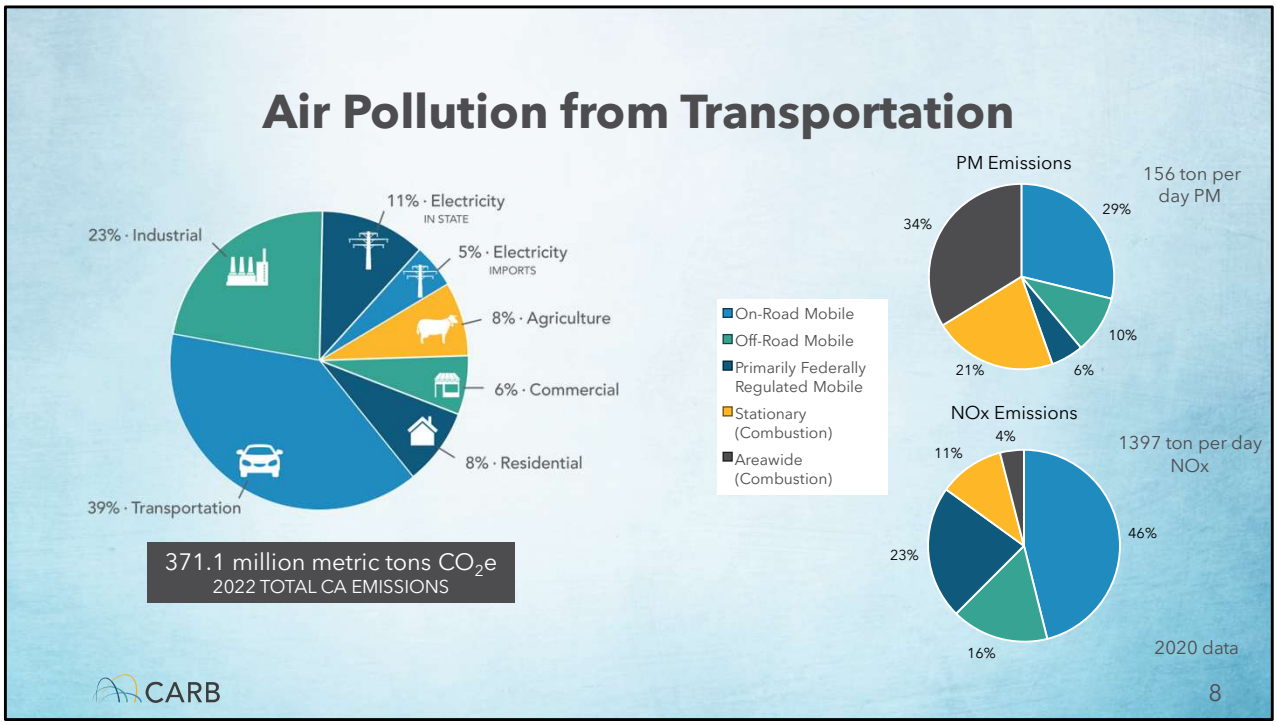
The 2015 rulemaking introduced provisions for the petroleum industry to generate credits and reduce their compliance obligation– project-based crediting – through investing in technologies that reduce crude extraction and refining GHG emissions. The 2015 rulemaking also included cost containment provisions, revised the annual CI benchmarks, and updated emissions calculations.



The 2018 and 2019 rulemakings extended the CI benchmarks through 2030 and created the ZEV Infrastructure Crediting programs, in addition to creating opportunities for more lower-carbon fuels and project types to earn credits. These rulemakings also introduced third-party verification requirements to ensure the integrity of the LCFS program and holdback equity spending requirements to ensure investment in disadvantaged communities.



The most recent rulemaking, which became effective on July 1, 2025, increased the 2030 decarbonization target to 30 percent and extended the CI benchmarks through 2045 with a target in that year of 90 percent. Additionally, the rulemaking included updates to the ZEV Infrastructure programs to include medium- and heavy-duty ZEVs, revisions to verification and holdback spending requirements, and introduced sustainability guardrails for crop-based fuels.

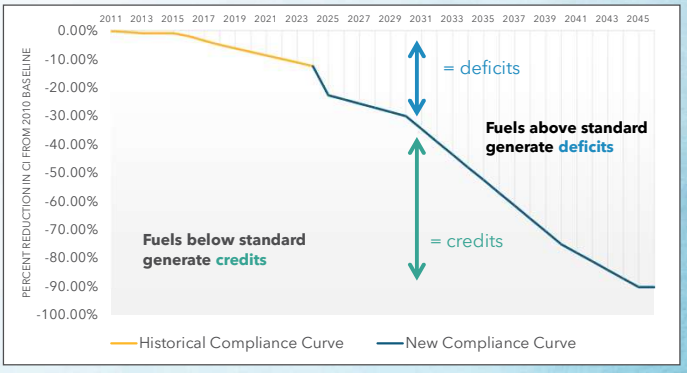


The transportation sector is the single largest source greenhouse gas emissions in California. It is also the main source of health-impacting air pollutants in California.

As we consider the future of California's transportation policies, we need to keep our air quality challenges in the forefront. About half of Californians breath unhealthy air, despite all the progress we've made over the past fifty years. Transportation accounts for roughly 50% of greenhouse gas emissions (GHG), 40% of particulate matter (PM), and 60% of oxides of nitrogen (NOx) in California. While the focus of the LCFS is to decarbonize transportation, it also provides meaningful air pollution reductions from the sector by incentivizing use of low carbon fuels, many of which substantially reduce PM and NOx as well.

Basic LCFS Requirements

- Sets annual CI benchmarks for gasoline, diesel, jet fuel, and the fuels that replace them
- CI is the measure of greenhouse gas emissions associated with producing, distributing, and consuming a fuel
  - Based on complete life cycle analysis
  - Measured in grams of carbon dioxide equivalent per megajoule (gCO_2e/MJ)



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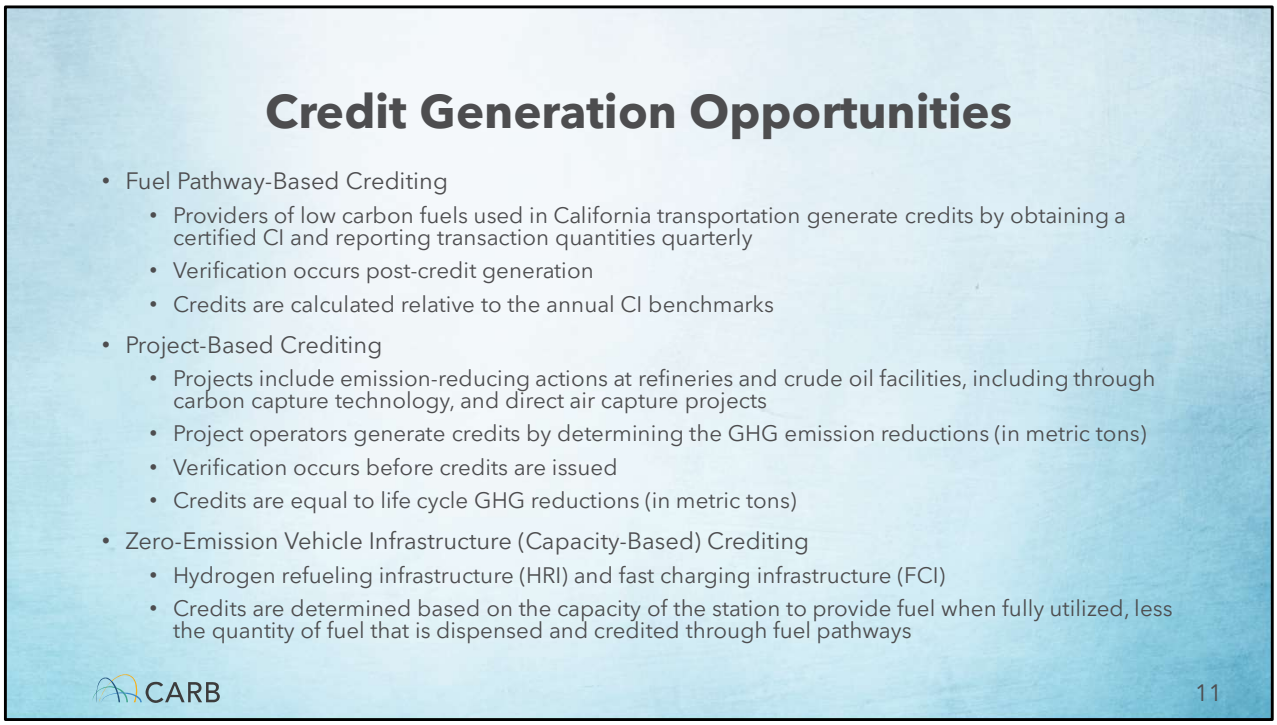
The LCFS sets annual carbon intensity standards, or benchmarks, which decline over time, for gasoline, diesel, and the fuels that replace them.

Carbon intensity (CI) is expressed in grams of carbon dioxide equivalent per megajoule of energy provided by that fuel. CI takes into account the GHG emissions associated with all the steps of producing, transporting, and consuming a fuel—also known as a complete life cycle of that fuel.

The LCFS lets the market determine which mix of fuels will be used to reach the program targets. CARB designed the LCFS to achieve cost-effective GHG reductions from the transportation sector. The LCFS that does not mandate a specific fuel or outcome, rather it sets a performance target in the form of carbon intensity (CI) reductions, which provides participating entities many compliance options and opportunities to find the most affordable way to advance clean, lower carbon intensity fuels. In this way, the LCFS is structured to create an economically efficient, least-cost pathway for diversifying the state's transportation fuels with lower carbon fuels, rather than pursuing more direct and potentially more costly measures.

Components of the LCFS

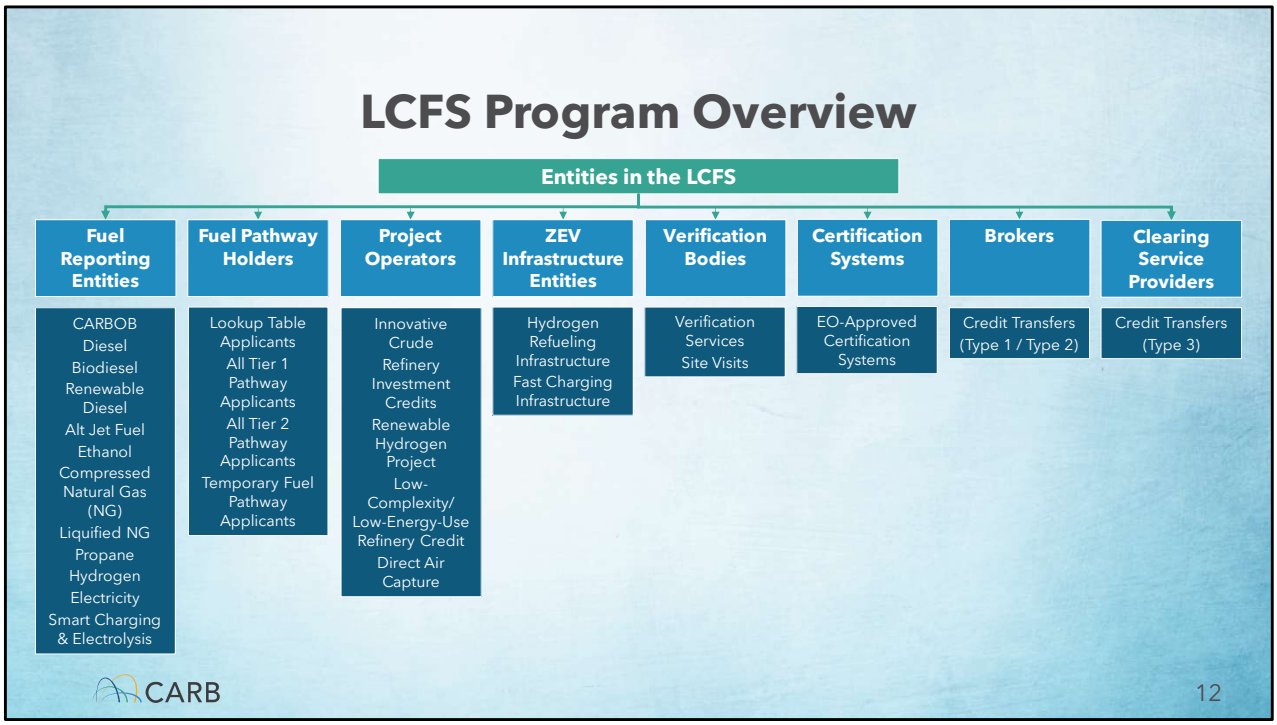


There are three ways to generate credits in the LCFS: fuel pathways, projects, and capacity-based crediting.

Under fuel pathway-based crediting, all transportation fuels need a carbon intensity score to participate in the LCFS, and the fuel type dictates which process is used to determine that CI. Providers of low carbon fuels used in California transportation generate credits by obtaining a certified CI and reporting transaction quantities on a quarterly basis. Credits are calculated relative to the annual CI benchmark and will undergo verification following credit generation.

Under project-based crediting, projects include actions to reduce GHG emissions in the petroleum supply chain, as well as carbon capture and sequestration using Direct Air Capture. Crediting for projects is based on life cycle emission reductions, and credits are issued after the reported reductions are verified.

Finally, the infrastructure crediting program is designed to support the deployment of zero emission vehicle (ZEV) infrastructure. Crediting for ZEV infrastructure is based on the capacity of the hydrogen station or EV fast charging site, and the actual fuel dispensed. The 2024 rulemaking created separate programs for heavy-duty hydrogen infrastructure (HD-HRI), heavy-duty DC fast charging infrastructure (HD-FCI), light- and medium-duty HRI (LMD-HRI), and light- and medium-duty FCI (LMD-FCI).



CARB's LCFS program applies to a range of entities, including fuel reporting entities, fuel pathway holders, verification bodies, and credit brokers. The Alternative Fuels Portal (AFP), LCFS Credit Banking and Transfer System (LRT-CBTS), and Verification On-Line Tool are the three modules that make up the LCFS database management system.

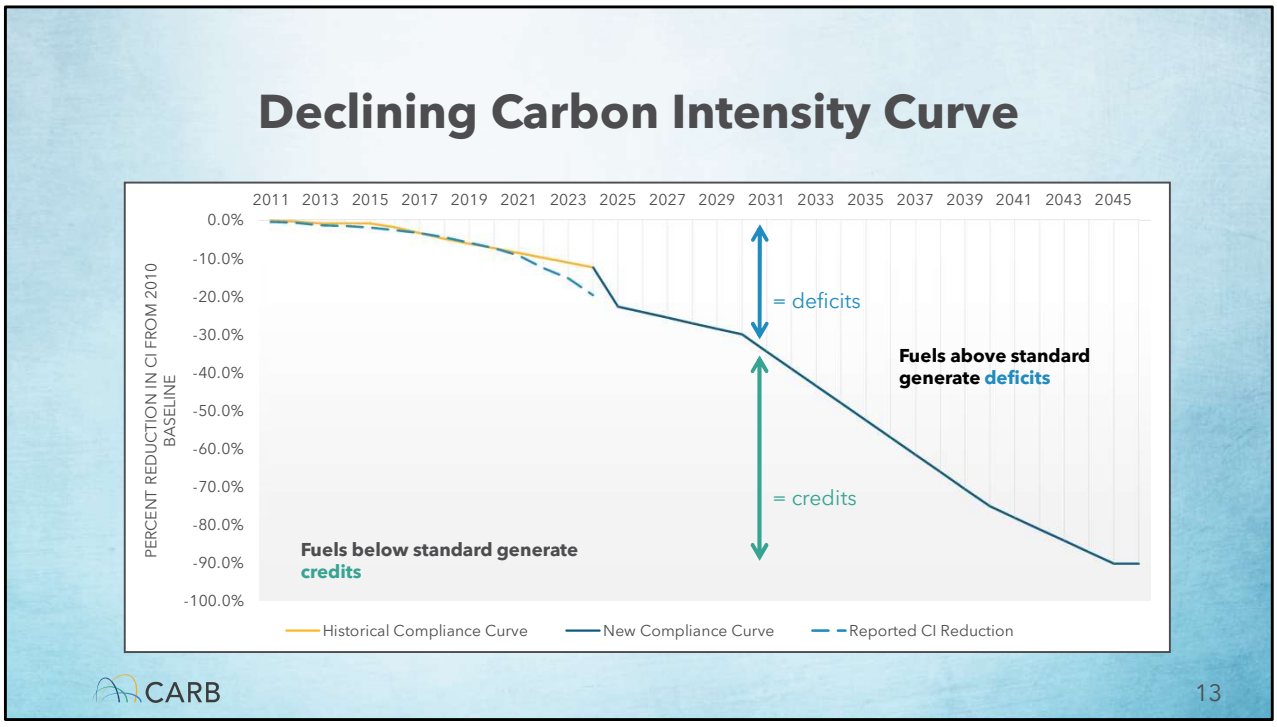
The AFP facilitates the application process to obtain a certified CI score. Applicants for Tier 1 and Tier 2 pathways, which rely on site-specific data, use this portal to submit their CI calculator and supplemental information. All applicants for Hydrogen Lookup Table pathways apply through the AFP, along with applicants for the Zero-CI Electricity Lookup Table pathway. Entities seeking any other Lookup Table pathway, including CARBOB, ULSD, California Average Grid Electricity, CNG, LPG, and Smart Charging or Smart Electrolysis, do not need to register in the AFP and continue to use the LRT-CBTS.

The LRT-CBTS is designed to facilitate reporting and credit banking and transfers. It is also able to process project-based crediting and ZEV infrastructure crediting applications.

The Verification On-Line module provides access to participant data for LCFS-accredited Verification Bodies and services.

Note that applications for carbon capture and sequestration may be approved through the:

- AFP (fuel pathway-based crediting) if the capture occurs within the process of an alternative fuel pathway, e.g., CO2 from ethanol fermentation
- LRT (project-based crediting) if the capture is associated with crude oil production (Innovative Crude provisions) or a petroleum refinery (Refinery Investment Credit provisions), or by direct air capture (not associated with any fuel; may be credited as a stand-alone project).



The program works this way: CARB sets an annual, declining carbon intensity target in the regulation for transportation fuels used in California. Fuels and fuel blendstocks introduced into the California fuel system that have CIs below the benchmark (shown by the blue line) generate credits, whereas those with a higher CI than the benchmark generate deficits, such as fossil gasoline and fossil diesel. Compliance is achieved when a regulated party uses or purchases credits to retire its deficits. Low carbon fuel producers can sell credits in the marketplace or use them for their own compliance obligations. Put simply, the program design rewards fuel producers who produce larger volumes of low carbon fuels.

Each year, the benchmark decreases: the same low carbon fuel will generate fewer credits by volume, while the same high carbon fuel will generate more deficits. Some fuels, depending on their CI score, may eventually flip from being a credit generator to a deficit generator as was recently the case for fossil natural gas. CARB anticipates that low-carbon fuels production will increase, generating more credits, while high-carbon fuels production will decrease, generating fewer deficits. As the number of available credits and deficits change, the price of credits can also change. In this way, the LCFS structure creates a strong financial incentive to deploy only the lowest carbon fuels to California and to continually innovate to reduce the carbon intensity of existing fuels.

Under the current LCFS regulation, CI benchmarks have been extended through 2045, with the 90% reduction applying to years after 2045.

The reported CI, shown by the dashed line, has been well below the benchmark for the past few years, which suggests support for faster decarbonization.

Carbon Intensity Benchmarks

Year	Gasoline Average CI (gCO_2e/MJ)	Diesel Average CI (gCO_2e/MJ)	Substitutes for Conventional Jet Fuel (gCO_2e/MJ)
2024	87.01	87.89	87.89
2025	76.60	81.70	81.70
2026	75.16	80.17	80.17
2027	73.72	78.63	78.63
2028	72.28	77.10	77.10
2029	70.84	75.57	75.57
2030	69.40	74.03	74.03
2031	64.94	69.27	69.27
2032	60.48	64.51	64.51
2033	56.02	59.75	59.75
2034	51.55	54.99	54.99
2035	47.09	50.23	50.23
2036	42.63	45.47	45.47
2037	38.17	40.71	40.71
2038	33.71	35.95	35.95
2039	29.24	31.19	31.19
2040	24.78	26.44	26.44
2041	21.81	23.26	23.26
2042	18.83	20.09	20.09
2043	15.86	16.92	16.92
2044	12.88	13.74	13.74
2045 and onward	9.91	10.57	10.57

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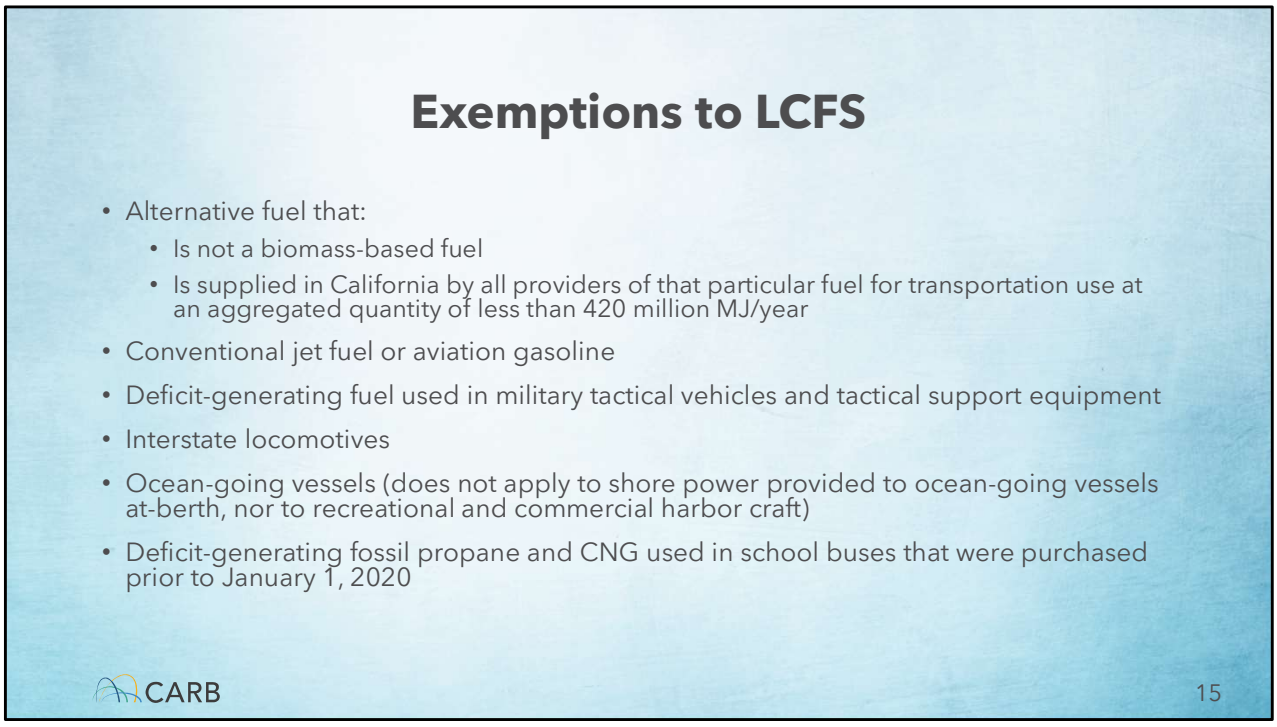
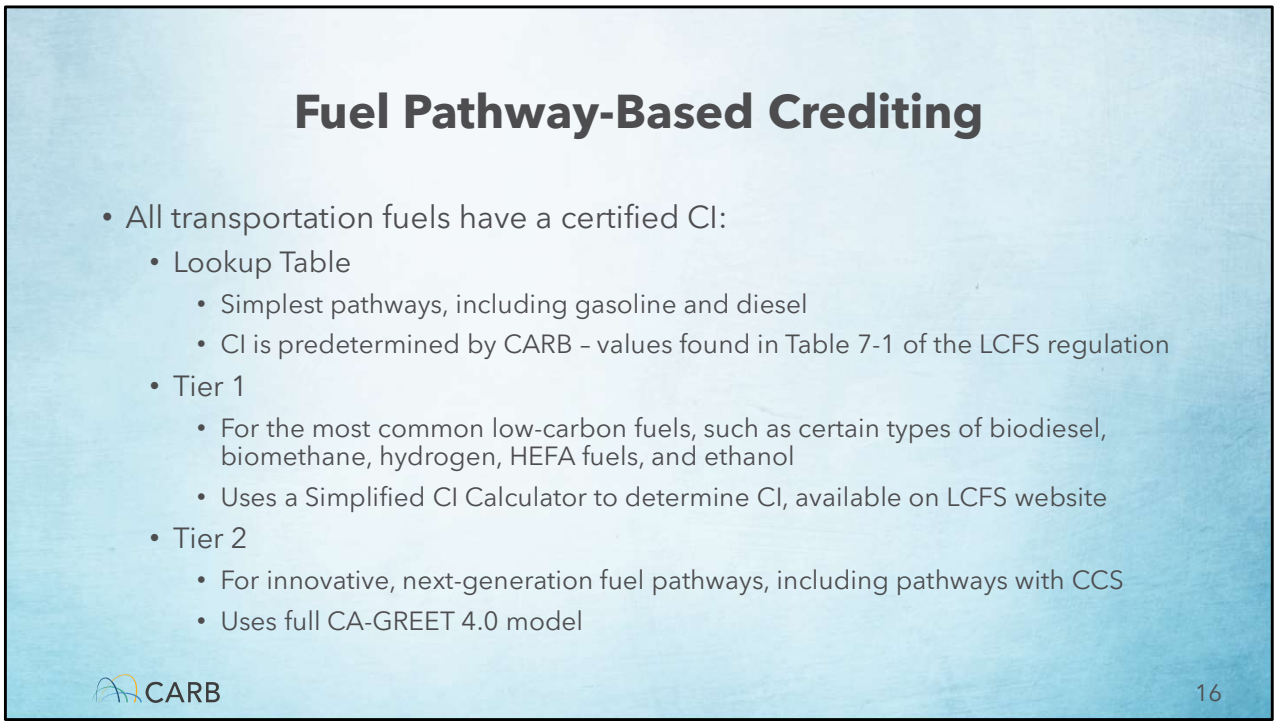
Credits and deficits are calculated using the carbon intensity benchmarks for gasoline and diesel fuel in each calendar year. These benchmarks equate to a 12.5 percent reduction in carbon intensity relative to 2010 in the 2024 compliance year, a 9% step-down in 2025, and from there, they increase to a 30 percent reduction in 2030 and a 90 percent reduction by 2045.

Since conventional jet fuel is not subject to the LCFS regulation and does not generate deficits, these carbon intensity benchmarks are used specifically to calculate credits from alternative jet fuel. The jet fuel benchmarks mirror the benchmarks for diesel.



The LCFS regulation does not apply to an alternative fuel that is not a biomass-based fuel or is supplied in California with an aggregated quantity of less than 420 million MJ/year, conventional jet fuel, aviation gasoline, and deficit-generating fuel used in military tactical vehicles. The LCFS regulation also does not apply to locomotives, ocean-going vessels, and deficit-generating fossil propane and CNG used in school buses purchased prior to January 1, 2020.



Lookup Table pathways are the simplest pathways, with the CI predetermined by CARB staff and incorporated into the regulation. These include gasoline, diesel, fossil jet fuel, compressed natural gas, propane, and electricity.

Tier 1 pathways are used for many of the most common low-carbon fuels, such as biodiesel, biomethane, hydrogen, and ethanol. We can determine the CI of these fuels using a simplified calculator, which takes in different inputs, such as the feedstock for biodiesel, or the treatment method for dairy methane, to calculate the life cycle emissions associated with the fuel.

Tier 2 pathways are designed for innovative, next-generation fuel pathways, including those using carbon capture and sequestration. This uses the full CA-GREET model to determine the CI of a fuel on an applicant-by-applicant basis.

Pathways that are submitted with less than 24 months of data are considered provisional until an Annual Fuel Pathway Report covering at least 24 months of operational data receives a positive or qualified positive verification statements.

Temporary Pathways

- Available for selected feedstock and fuel combinations:
  - Fuels associated with facilities that have produced a finished fuel for less than 3 consecutive months
  - Fuels associated with facilities that have processed a new feedstock that cannot be reported under a certified pathway
- Petitions to use a temporary pathway must be submitted through the AFP
- Allows entities to earn credits while their Tier 1 or Tier 2 applications are being evaluated
  - Temporary pathways may be approved for up to two consecutive quarters at a time

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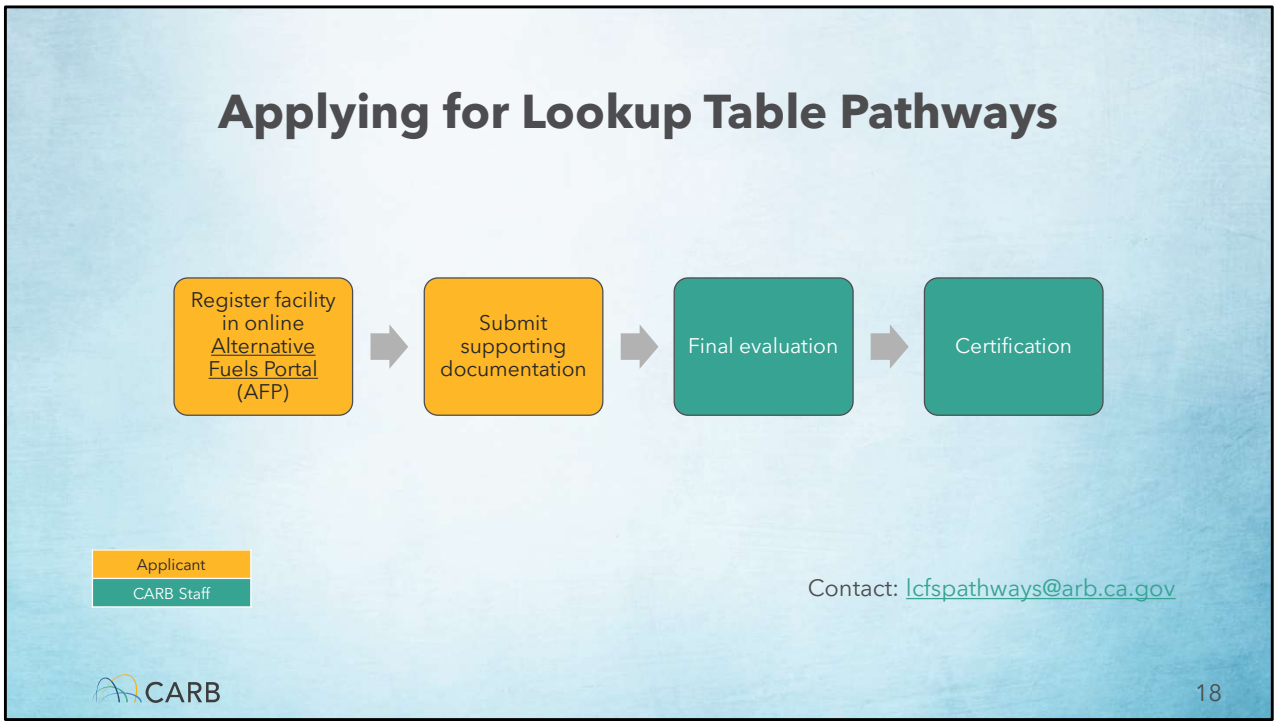
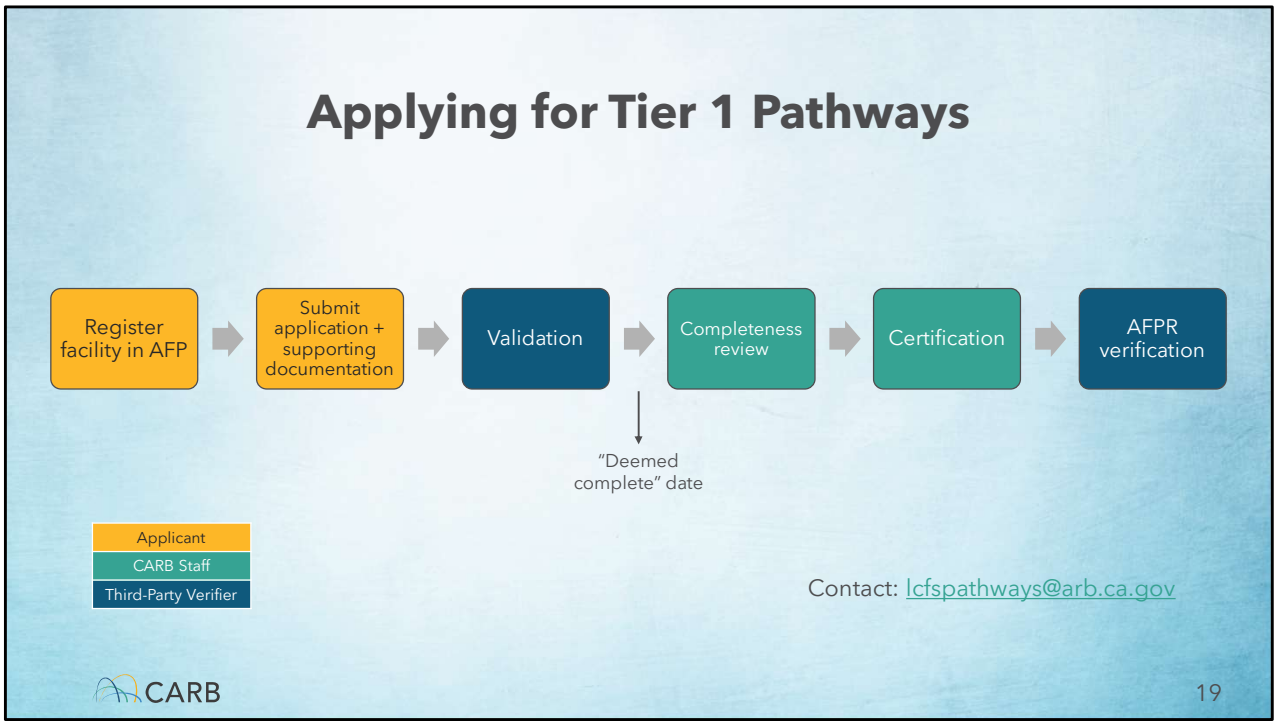
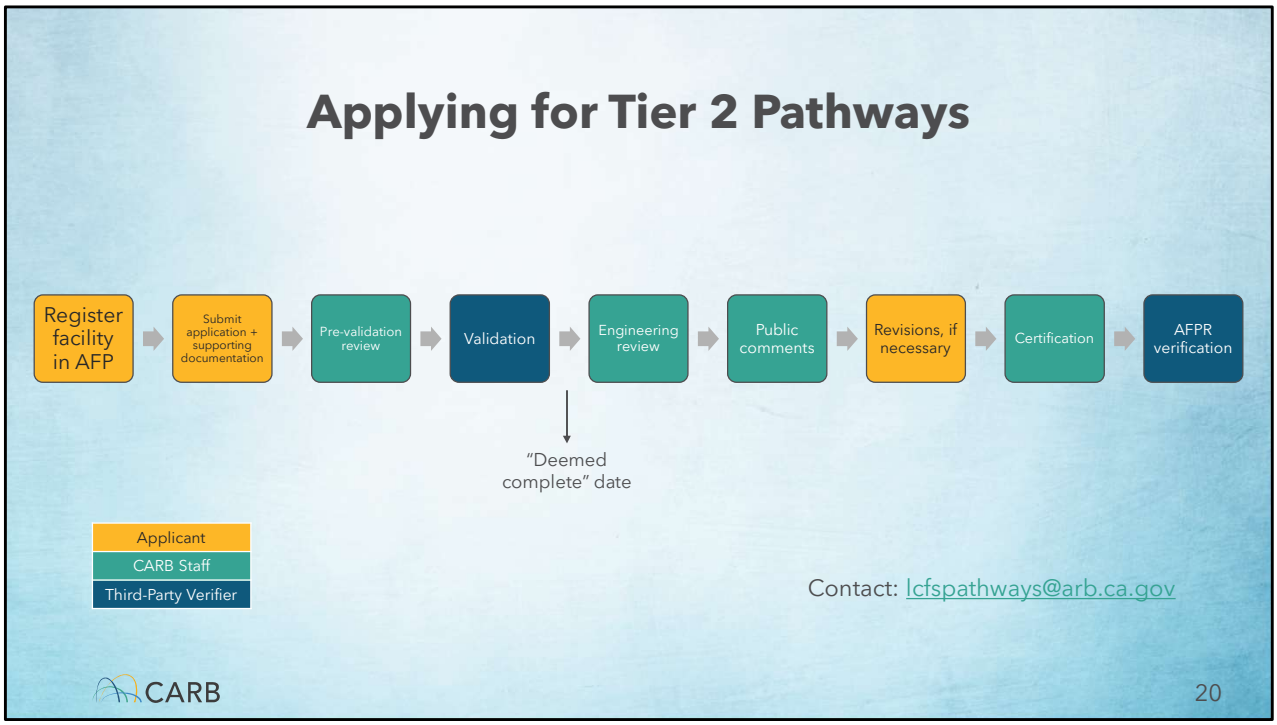
Certain limited fuels have the opportunity to earn a temporary pathway, which allows entities to earn credits using a temporary conservative CI score while their Tier 1 or Tier 2 applications are pending certification. The current temporary pathways can be found in Table 8 of the LCFS regulation.



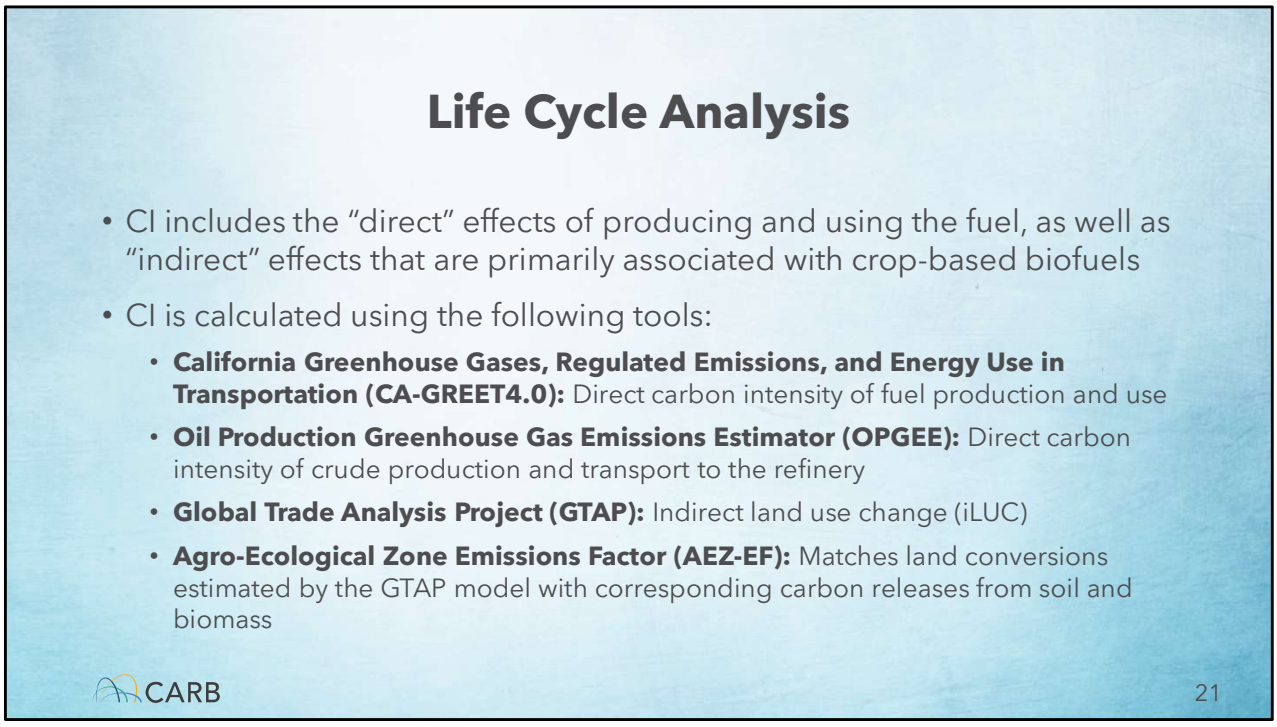
Lookup Table pathways are the simplest and most straightforward pathways. Entities must first register in the Alternative Fuels Portal, which is the online hub for fuel pathways and distinct from the LRT. Once registered, entities can select their pathway, some of which may require extra documentation. This documentation is evaluated and certified by CARB staff, and entities may start earning fuel pathway credits following certification.



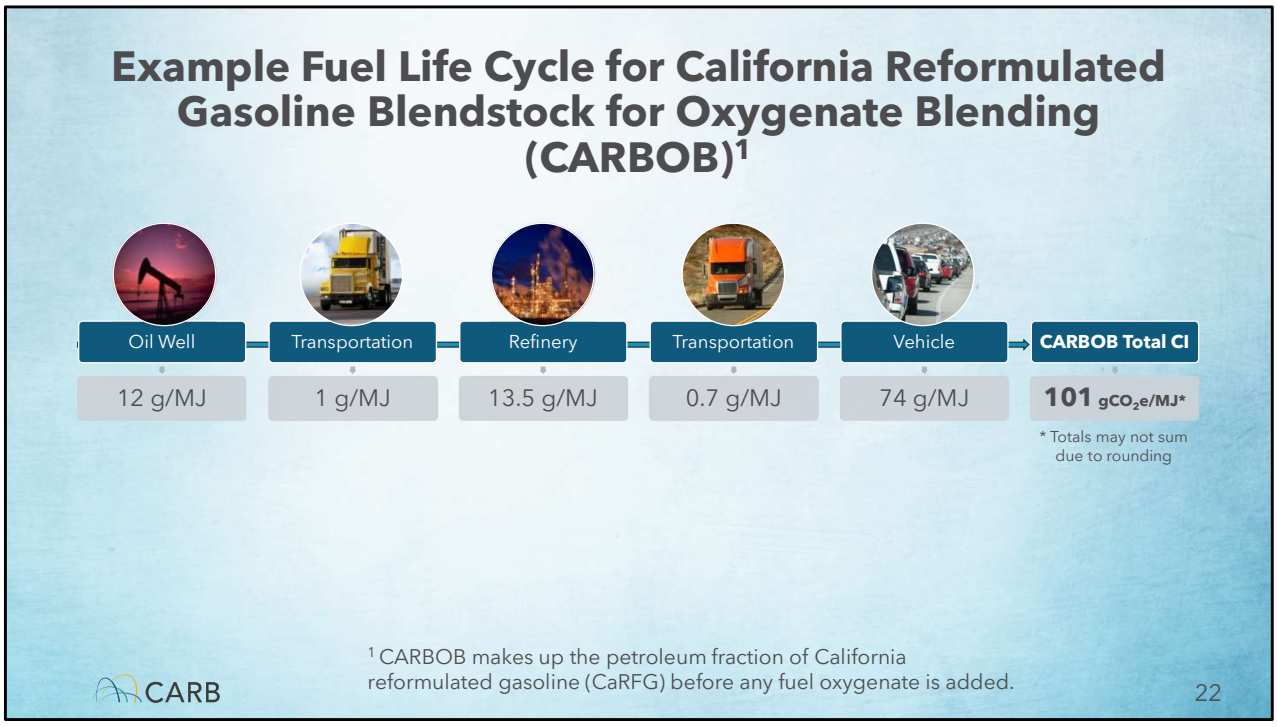
To apply for Tier 1 pathways, after registering in the AFP, entities have to submit complete applications and supporting documentation, which will then be validated by a third-party verifier. At that point, the application is "deemed complete", and CARB staff can continue with the completeness review and certification process. Following certification, entities will be able to start reporting fuel transactions starting with the quarter in which the pathway was deemed complete. Each year, annual fuel pathway reports should be submitted and verified.



To apply for Tier 2 pathways, entities should first register in the AFP and submit an application using the full CA-GREET 4.0 model. CARB staff will do a preliminary review to make sure the life cycle analysis and submitted documentation are complete, accurate, and appropriate. Following the prevalidation review, entities should use a third-party verifier for validation, after which the application is "deemed complete." CARB staff will then do an engineering review to ensure the replicability of CI calculations and proper inputs. The pathway summary will then be published online for public review. The public comment period will be open for 14 days, and if there are any factual or methodological errors identified in that time, the applying entity will have the opportunity to revise the application package. CARB will then issue the final certification and entities can start reporting for the quarter in which the pathway was deemed complete.

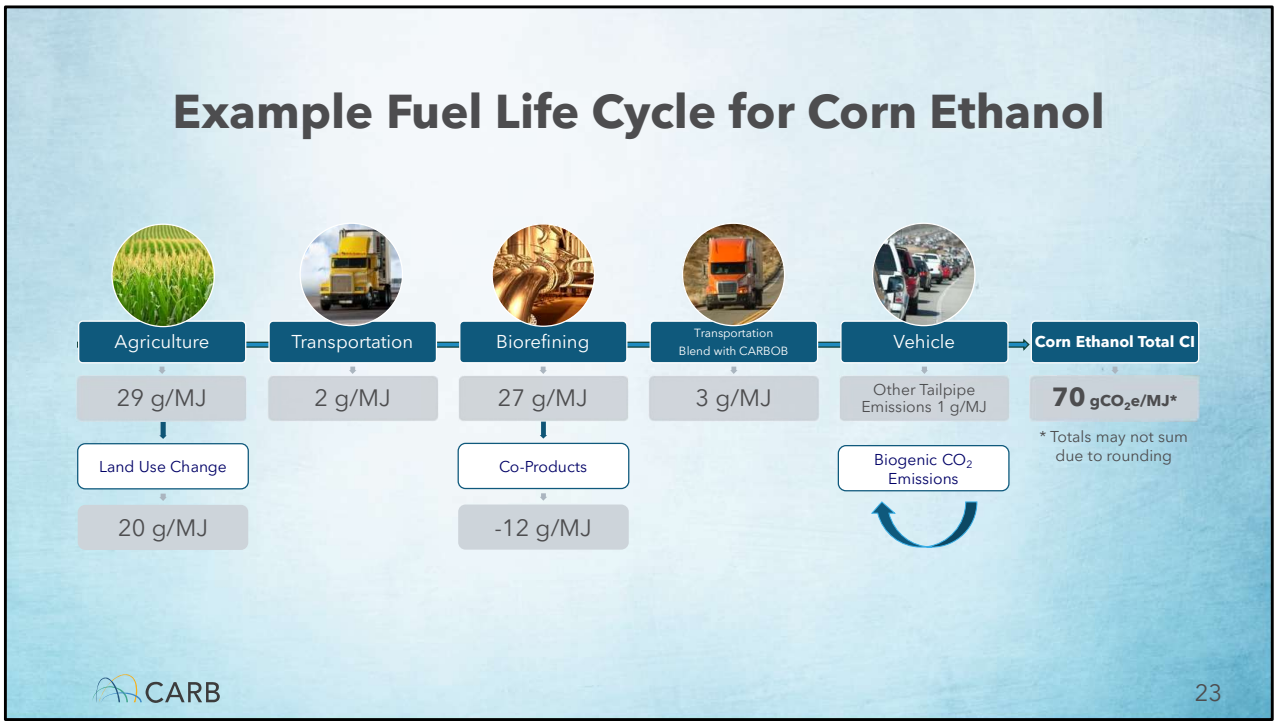


The CI includes the "direct" effects of producing and using the fuel, as well as "indirect" effects that are primarily associated with crop-based biofuels. Two models are used to calculate the direct effects, which are the California Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (CA-GREET) and Oil Production Greenhouse gas Emissions Estimator (OPGEE) models. To calculate the indirect effects of land use change associated with biofuels, staff used the Global Trade Analysis Project (GTAP) model and fed the outputs into the Agro-Ecological Zone Emissions Factor (AEZ-EF) model to estimate greenhouse gas emissions from various types of land conversions.



This is an illustration of the life cycle assessment of California Reformulated Gasoline Blendstock for Oxygenate Blending (CARBOB). CARBOB makes up the petroleum fraction of California reformulated gasoline (CaRFG) before any fuel oxygenate is added; CaRFG is essentially 90% petroleum blended with 10% ethanol by volume.

CARBOB CI is based on the 2010 average crude oil supplied to California refineries and average California refinery efficiencies. Crude oil is evaluated using the OPGEE model; the crude supplied to California refineries in 2010 was found to have an average CI of 12.61 gCO_2e/MJ, with some crudes ranging from as low as 2 to as high as 67 gCO_2e/MJ. Production of CARBOB at all California refineries adds 13.45 g/MJ to the fuel cycle CI. About 75% of the GHG emissions from the life cycle of CARBOB occur during combustion in vehicles (tailpipe emissions).



This is an illustration of the life cycle assessment of corn ethanol. Emissions associated with agriculture contribute 29 gCO_2e/MJ; of that, 11 g result from the production of fertilizer and soil amendments, and the soil emissions resulting from synthetic and organic additions contribute an additional 14 g/MJ, and on-farm emissions from energy use in tractors during activities such as planting, cultivation and harvest, make up the remainder.

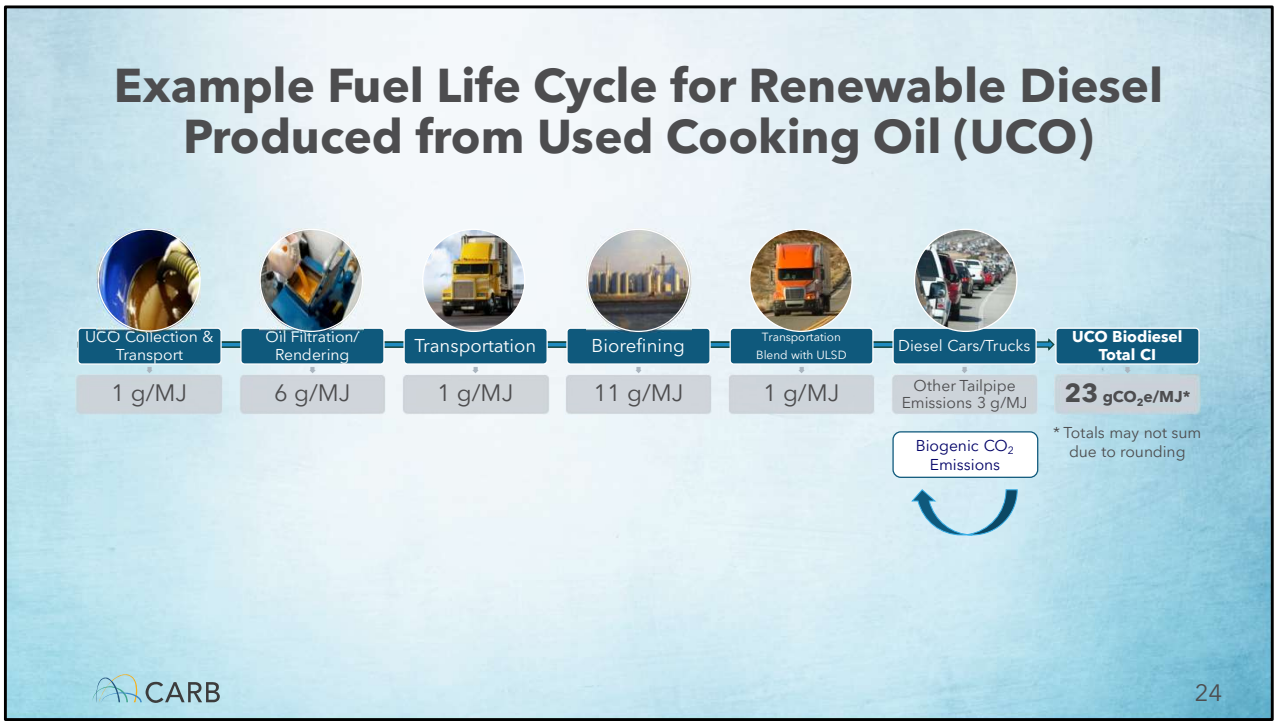
Emissions from production at the ethanol facilities vary widely depending on their process fuels, their efficiencies, and any processing of co-products, such as drying distiller's grains and solubles (DGS). Please note that this slide contains numerical values for illustrative purposes only.

DGS is the remnants of the corn after fermentation and is sold and used as livestock feed. A credit of -12 g/MJ is assessed for the production of DGS at a typical rate of 5.31 dry pounds per gallon of ethanol; this credit reflects market displacement of corn and other feed ingredients.

Contributing to the impacts associated with corn (and other crops) used to produce biofuels is the phenomenon called indirect land use change, or ILUC. ILUC occurs when demand for biofuels like ethanol, for instance, increases the demand for corn thereby raising its market price. Someone, somewhere, reacting to this price signal, will convert land to corn production, either directly or through a series of daisy-chain events, which will result in carbon emissions from that land. Those emissions are determined using the GTAP and AEZ-EF models and are added to the CI of corn ethanol. All crop-based feedstocks have ILUC values.

Finally, the CO_2 emitted from vehicles during biofuel combustion is considered carbon neutral, in

accordance with IPCC and U.S. EPA GHG inventory guidelines, as the carbon released was uptaken from the atmosphere by the corn within a short timeframe. Additionally, ethanol is required to be denatured in order to render it unfit for human consumption. A small amount of gasoline blendstock is added, typically 2.5%v/v, for this purpose, adding 1 g/MJ to the CI of denatured ethanol.



This is an illustration of the life cycle assessment of renewable diesel made from used cooking oil (UCO). UCO, also known as waste grease, is collected from sites like industrial food processors and restaurants. The UCO is transported to a rendering facility where it is filtered and purified to remove any water, solids, contaminants, to reduce the level of free fatty acids (FFA) and ensure the oil has the correct properties required for fuel production.

The rendered oil is then transported to a biorefinery where it is converted to renewable diesel by hydrotreating UCO with hydrogen. The process also co-produces renewable propane along other co-products, which can include alternative jet fuel, renewable light hydrocarbon, and renewable naphtha. An accounting method known as energy-based allocation is used to divide the total emissions from the facility among the co-products. A displacement method is used to credit light hydrocarbon if it is used to displace natural gas.

About 3 g/MJ of tailpipe GHG emissions result from the GHGs (methane and nitrous oxide) that form during renewable diesel combustion.

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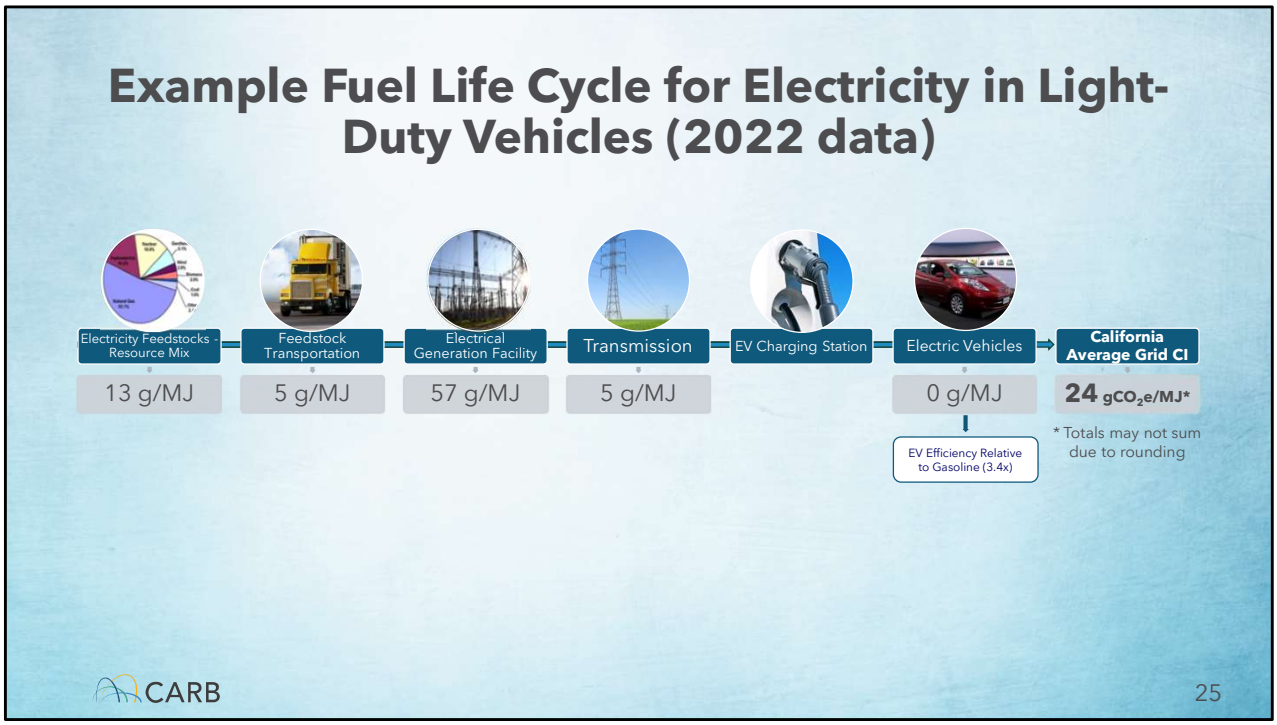


This is an illustration of the life cycle assessment of California's average grid electricity when it is used to charge electric vehicle (EV) batteries.

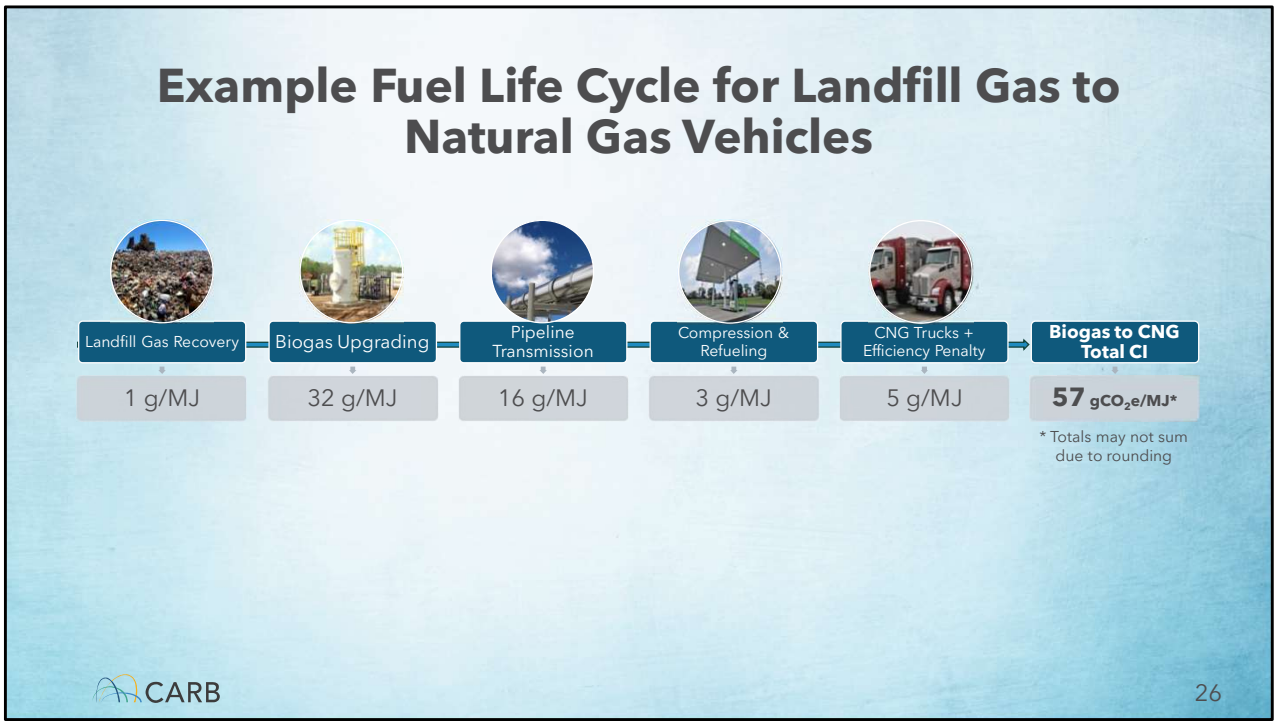
The carbon intensity of California electricity is calculated in CA-GREET 3.0 using the 2022 average California generation resource mix from the CEC database,[1] slightly modified to match CA-GREET resource categories[2] in order to calculate the emissions associated with each resource.

The GHG emissions for this pathway consist of the upstream emissions associated with producing and transporting each fuel to the power plant, the emissions associated with generating electricity (combustion of fossil-based resources like natural gas), and transmission line losses (translated to emissions from the excess electricity that must be supplied to meet demand).

Finally, EVs are over three times more efficient than the internal combustion engines (ICE) they replace. The life cycle emissions from electricity generation sum up to 80 gCO_2/MJ of electricity, but the final CI is shown here adjusted based on the vehicle's energy economy ratio as compared to a conventional fuel vehicle. The energy economy ratio translates to an emission savings representing the smaller amount of energy an EV needs to travel the same distance as an ICE.

1 2022 California Total System Electric Generation data from California Energy Commission (CEC). Accessed 12/2023. https://www.energy.ca.gov/data-reports/energy-almanac/california-electricity-data/2022-total-system-electric-generation

2 California Air Resources Board, CA-GREET 3.0 Supplemental Document, Update: 13-AUG-2018: https://ww2.arb.ca.gov/sites/default/files/classic/fuels/lcfs/ca-greet/cagreet_supp_doc_clean.pdf



This illustration shows the stages that are analyzed while performing life cycle assessment of compressed natural gas (CNG) from landfill gas (LFG). LFG is also known as biogas as it originates from organic materials which decompose without oxygen in landfills, resulting in generation of methane. Biogas is typically 50-60% methane and the remainder is made up of CO_2 and trace gases.

Recovery of biogas is accomplished using electrical fans to draw gas up through wells inserted throughout a landfill. Most landfills are required to capture LFG and oxidize methane to CO_2 by the use of a flare or thermal oxidizer. By capturing and using this gas as a transportation fuel rather than flaring, CO_2 emissions are avoided.

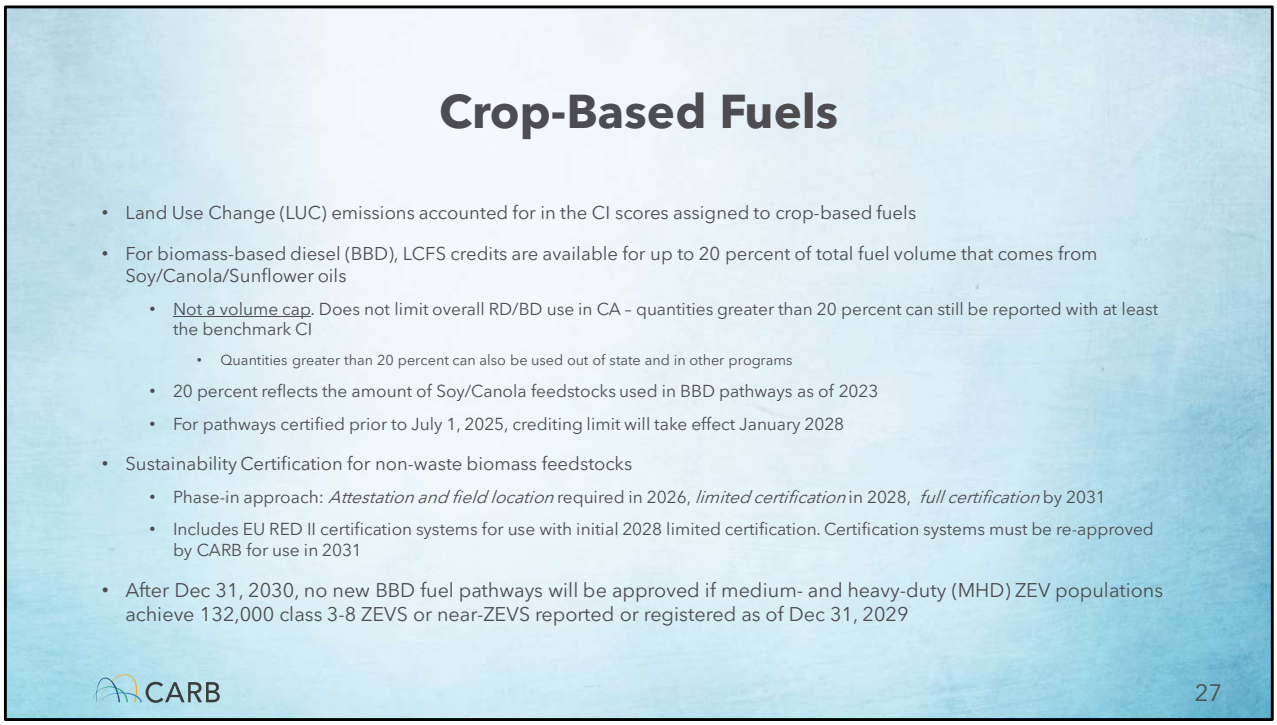
Capture mechanisms are imperfect, resulting in an estimated 25% of LFG that escapes the flare; this emission is considered outside of the LCA system boundary, as it occurs whether a landfill is capturing gas for use as a fuel, or for flaring. This is a principle of life cycle assessment, which seeks to determine what emissions would occur in a reference or baseline scenario, and compares the project case to determine the net change caused by a process or product.

Biogas upgrading is where the majority of the emissions associated with LFG to CNG occur. The objective is to remove CO_2, water, and to scrub unwanted components such as hydrogen sulfide in order to bring the biogas to pipeline-quality and motor vehicle standards. At this stage the gas is referred to as biomethane.

Transmission via the system of natural gas pipelines that span the U.S. can also result in a

significant quantity of emissions, for a conservative distance from a landfill to CA, 3,600 miles pipeline is chosen. Compressors require energy to move gas through pipelines, and methane has opportunities to escape during gas transmission; the magnitude of emissions is dependent on the distance gas travels from its source to its end use.

When pipeline gas is withdrawn at a refueling station, it is compressed to CNG before it is injected into a vehicle. The tailpipe emissions that occur during combustion of CNG in a natural gas engine for methane and nitrous oxide only; CO2 is cancelled with the avoidance of the combustion of a flare. Please note that this slide contains numerical values for illustrative purposes only.

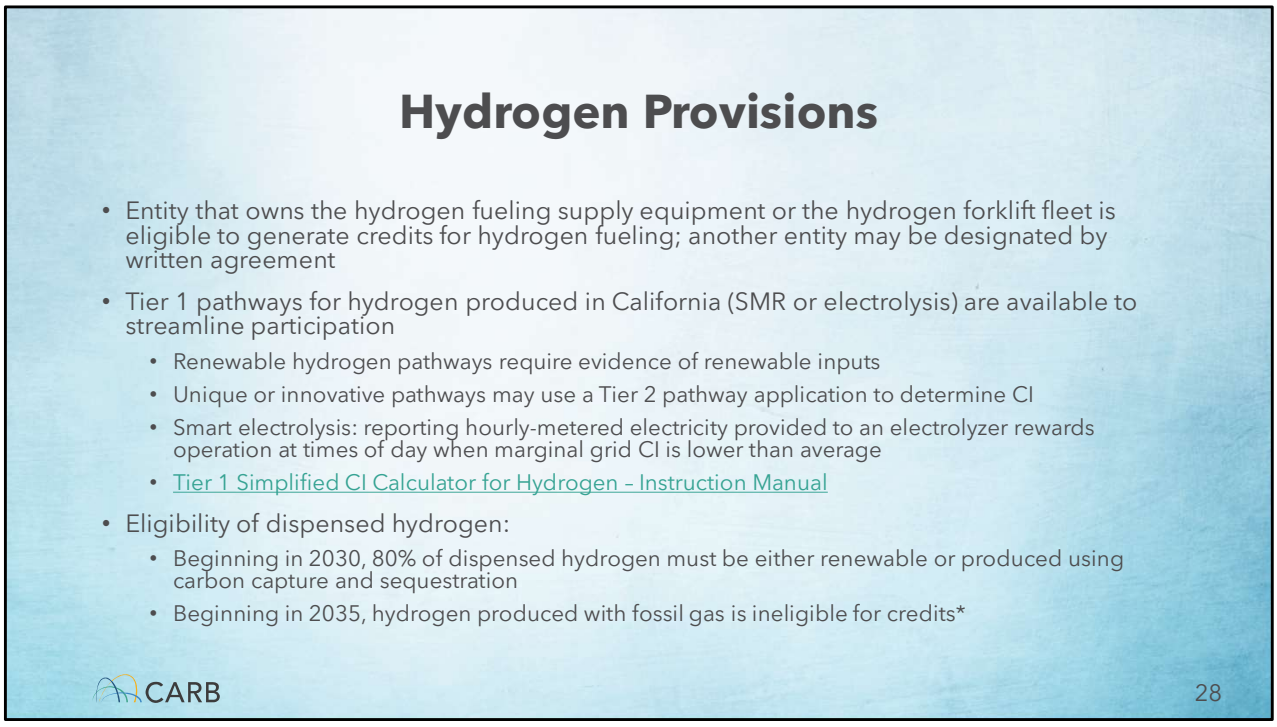


While the majority of biomass-based diesel (BBD) is still derived from waste oil, since 2020, the use of crop-derived, biomass-based diesel has increased over the course of the LCFS. A rapid increase in vegetable oil demand for biofuel production, without appropriate guardrails, could potentially introduce a feedstock supply and land use problem.

Based on public feedback and Board direction, staff reviewed existing strategies and stakeholder suggestions for creating transparency and guardrails to promote the use of sustainable feedstocks. The LCFS now includes a limit on crediting for biomass-based diesel produced from soy, canola, and sunflower feedstocks, taking effect immediately for new pathways and in 2028 for existing pathways. This is not a volumetric cap and therefore doesn't limit biodiesel nor renewable diesel use in California. Instead, it limits crediting for these feedstocks to 20% of each producer's total production. If a producer uses these feedstocks in excess of 20% biobased diesel production, those additional fuel quantities will not earn credits.

Additionally, the program includes new sustainability requirements for independent feedstock certification by a certification body approved by the Executive Officer, with a phase-in approach.

Lastly, if the state meets its 2030 target for medium-heavy duty ZEV deployment, no additional BBD fuel pathways will be approved. CARB will continue monitoring feedstocks entering the market to inform future changes to these provisions.



The LCFS also contains hydrogen provisions. The entity who owns the hydrogen fueling supply equipment or the hydrogen forklift fleet is eligible to generate credits for hydrogen fueling. Tier 1 pathways for hydrogen produced in California are available to streamline participation of renewable hydrogen production and smart electrolysis.

*Hydrogen produced with fossil gas will be ineligible for credits in 2035, unless biomethane attributes are matched to 100% of the hydrogen production OR 100% of the hydrogen is producing using CCS technology.

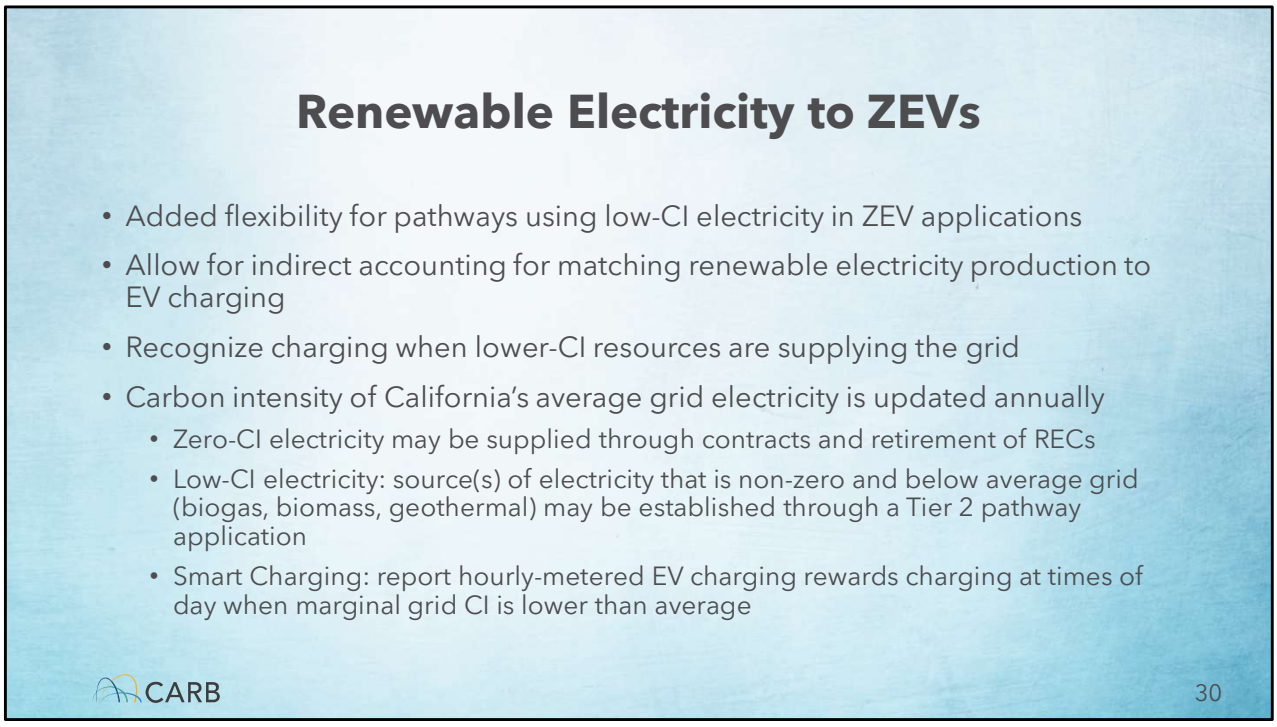
To learn more about the LCFS electricity and hydrogen provisions, please see http://www.arb.ca.gov/fuels/lcfs/electricity/electricityh2.htm.

Electricity Provisions

- Electric vehicles, trucks, electric transit systems (fixed guideway, buses), electric forklifts, electric cargo-handling equipment, shore power to ocean-going vessels at-berth, and many other off-road electric equipment types are eligible to generate credits
  - Energy economy ratios (EER) are determined by CARB for specific vehicle/fuel combinations
  - New equipment types can apply for an EER
- Proceeds from electricity credits must be used to promote transportation electrification

CARB 29

Electric vehicles, trucks, electric transit systems (fixed guideway, buses), electric forklifts, electric cargo-handling equipment, electric transportation refrigeration units, and shore power to ocean-going vessels at-berth are eligible to generate credits. Table 5 of the LCFS regulation contains EER values for fuels used in both light- and medium-duty and heavy-duty applications, which, in conjunction with the electricity CI, determines the number of credits awarded to different electric vehicles and equipment. All electricity credit generators must use credit proceeds to promote transportation electrification, provide benefits to their EV customers, and educate them about the benefits of EV transportation.



The combination of zero-carbon electricity and zero-emission vehicles offers significant opportunity for reductions that have not been fully recognized by the program to date. To address this issue, the 2018 amendments allowed renewable power generated off-site to be used in EV charging and hydrogen production by electrolysis. The amendments also recognized the benefits of shifting EV charging and electrolyzer loads to periods of time when excess renewable electricity might otherwise be wasted. These provisions are intended to help make these vehicles fully "zero emission" on a life cycle basis.

The load-serving entity, auto manufacturer, or another entity may also generate "incremental" credits for supplying metered, low-CI electricity, or smart charging to those residences. In the event that multiple entities claim incremental credits for a given residence, the LCFS provides the following order of priority: the Load-Serving Entity (LSE), including a Community Choice Aggregator (CCA); the automobile manufacturer who provides metered charging data through on-vehicle telematics; and any other entity who can provide the metered data has the third priority, which could include a charging service provider or an aggregator.

The LCFS streamlines and facilitates the credit generation and reporting for public, workplace and fleet charging. Utilities will receive those credits unless electrical vehicle service providers, site hosts, or fleet owners opt in.

Base Crediting

- Base credits are awarded to Electrical Distribution Utilities (EDUs) for residential EV charging
- EDUs are required to direct a portion of base credits to a Clean Fuel Reward (CFR) program
  - Starting in 2025, CFR will provide an EV price reduction incentive for purchase of battery-electric medium- and heavy-duty vehicles
- Credits not directed towards the CFR are considered "holdback credits"
  - The majority of holdback credits must be used to support transportation electrification primarily in disadvantaged communities

CARB 31

Because there is not yet widespread installation of separate metering in residences of EV owners, CARB calculates the credits for non-metered residential charging of EVs, to maintain the quality and accuracy of the credit generations. The LCFS streamlines and facilitates the credit generation and reporting for public, workplace, and fleet charging. Utilities receive those credits, known as base credits, unless electrical vehicle service providers, site hosts, or fleet owners opt in. Depending on the size and ownership of the utility, an EDU is required to direct a certain portion of its base credits to a Clean Fuel Reward. The remainder of its base credits are largely directed towards holdback equity spending, which supports transportation electrification projects primarily in disadvantaged communities, including low-income, rural, and tribal communities.

Project-Based Crediting Opportunities

- Renewable Hydrogen Used at Refineries
  - Credit for renewable hydrogen used at a refinery to make transportation fuels
  - Usage limited to 10% of annual deficits
- Refinery Investment
  - Incentivizes GHG-reduction projects at refineries
- Innovative Crude Production Methods
  - Solar steam or heat generation
  - Solar- or wind-based electricity
  - Carbon capture and sequestration
  - Renewable natural gas or biogas energy
- Low-Complexity/Low-Energy-Use Refinery
- Carbon Capture and Sequestration by Direct Air Capture

CARB 32

Fuel producers may qualify for project-based crediting through a variety of different methods to reduce greenhouse gas emissions in the petroleum supply chain. This is not an exhaustive list of eligible projects.

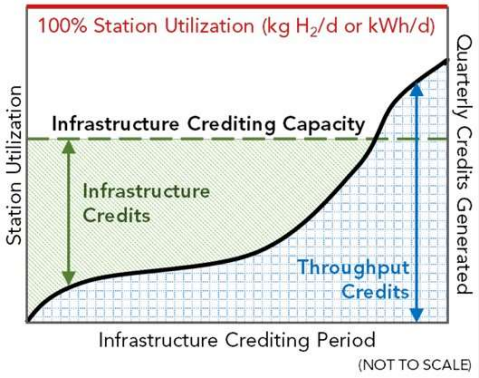
The renewable hydrogen refinery credit provision allows refineries to generate credits through the use of renewable hydrogen at the refinery to produce gasoline and diesel. In order to qualify for the credit, a refinery must replace a minimum of 1 percent of the fossil hydrogen used in the production of gasoline and diesel. The credits generated from this provision can be used to offset up to 10 percent of annual deficits generated.

The refinery investment credit provision allows refineries to generate credits for GHG reduction projects undertaken at a refinery. The GHG reduction projects must achieve a carbon intensity reduction of 0.1 gCO_2e/MJ and can include renewable energy sources, conversion of combustion power sources to electricity, use of carbon capture and sequestration, and process improvement projects.

The innovative crude credit provision support innovative technologies for solar steam or heat generation, solar- or wind-based electricity, renewable natural gas or biogas energy, and carbon capture and sequestration. The low-complexity/low-energy-use refinery provision supports facilities for being low-complexity and low-energy-use refineries.

ZEV Infrastructure Crediting

- Infrastructure crediting is available for:
  - Hydrogen Refueling Infrastructure
  - DC Fast Charging Infrastructure
- Available to public, shared, and private heavy-duty (HD) and light- and medium-duty (LMD) fueling facilities
- Credits calculated based on station capacity and utilization
- Crediting overview available on the LCFS ZEV Infrastructure Crediting webpage



CARB

33

ZEV Fueling Infrastructure Crediting is available for Hydrogen Refueling Infrastructure (HRI) and DC Fast Charging Infrastructure (FCI). Generally, the station must be located in California, with different requirements for shared/public and private stations. Applications must be received on or before December 31, 2030, for light- and medium-duty stations, and on or before December 31, 2035, for heavy-duty stations.

Credits will be calculated on the basis of station capacity and utilization. Infrastructure credits will decrease as a station/charger's dispensed fuel volumes approaches the defined credited capacity, until it is only generating credits for its dispensed fuel. In this way, the provision is designed to be "self-sunsetting." This provision is designed to address the "chicken & egg" problem, in which demand for zero emission vehicles is low because consumers can't refuel them, and refueling station developers won't build stations until more vehicles are sold.

For more information on LCFS infrastructure crediting, please visit:
https://ww2.arb.ca.gov/resources/documents/lcfs-zev-infrastructure-crediting

Carbon Capture and Sequestration (CCS)

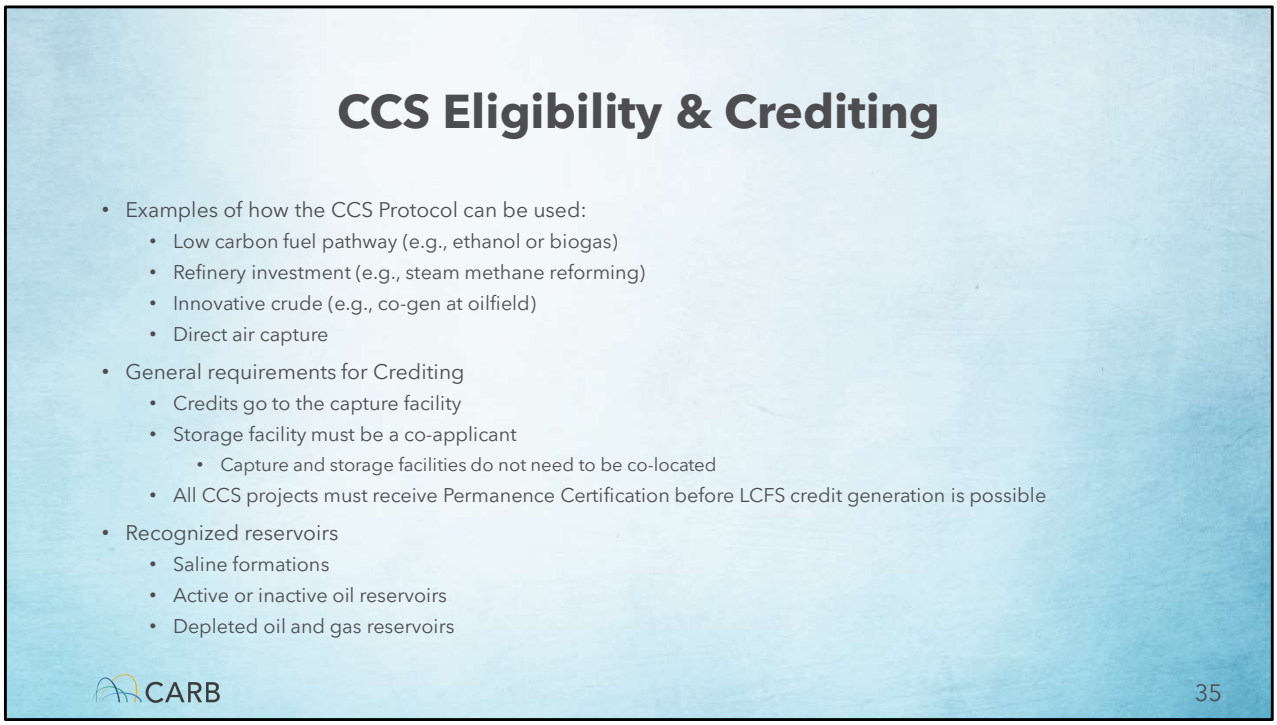
- Projects claiming CCS credits must comply with the CCS Protocol
- Credits must be prorated based on the volumes delivered to California (except for direct air capture projects)
- Amount of net CO_2 sequestered by alternative fuel producers can be used to adjust the carbon intensities of the associated fuel pathways
- Must undergo verification

CARB 34

Projects claiming CCS credits must comply with the CCS Protocol. Credits must be prorated based on the volumes delivered to California, except for direct air capture projects.

The amount of net CO_2 sequestered by alternative fuel producers can be used to adjust the carbon intensities of the associated fuel pathways.

All CCS projects must undergo verification.



Entities must follow certain guidelines in order to earn credits for projects using CCS. Examples of how the CCS Protocol can be used in the LCFS include low carbon fuel pathway, refinery investment, innovative crude, or direct air capture. To generate credits for CCS projects, credits go to the capture facility. The storage facility must also be a co-applicant, but capture and storage facilities do not need to be co-located. All CCS projects must receive a Permanence Certification before LCFS credit generation is possible. Recognized reservoirs under the LCFS include saline formations, CO2 enhanced oil recovery, and depleted oil and gas reservoirs.

Demonstrating Compliance and Reporting

- Compliance period: January 1st through December 31st
- A deficit generator's annual compliance obligation is met when it has retired a number of credits from its credit account that is equal to its deficits
- Fuel transactions from each calendar quarter are reported during the next calendar quarter
  - After each deadline, no credits can be generated for an activity that took place in the prior quarter (e.g., no credits will be issued for a transaction in the 1st quarter that is reported after June 30th)
  - Transactions involving business partners must be reconciled by the "Deadline" dates shown in the following table:

Report	Period Covered	Deadline
1st quarter	January – March	June 30th
2nd quarter	April – June	September 30th
3rd quarter	July – September	December 31st
4th quarter	October – December	March 31st
Annual	The prior calendar year	April 30th

- LCFS Registratio

CARB

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A regulated entity's annual compliance obligation is met when the regulated entity demonstrates via its annual report that it possessed and has retired a number of credits from its credit account that is equal to its compliance obligation. The annual compliance period is January 1st through December 31st of each calendar year.

Fuel transactions from each calendar quarter are reported during the next calendar quarter. After each deadline, no credits can be generated for an activity that took place in the prior quarter. Transactions involving business partners must be reconciled by the "Deadline" dates shown in the LCFS Reporting Schedule table. The quarterly reporting schedule is as follows:

- June 30th: For the first calendar quarter covering January through March
- September 30th: For the second calendar quarter covering April through June
- December 31st: For the third calendar quarter covering July through September
- March 31st: For the fourth calendar quarter covering October through December

The annual compliance reports must be submitted by April 30th of each year.

For more information on the LRT-CBTS and AFP, or to submit quarterly or annual reports, please visit the Data Management System web page:
http://www.arb.ca.gov/fuels/lcfs/reportingtool/datamanagementsystem.htm

Third-Party Verification

- LCFS requires annual third-party verification for fuel pathways and reported fuels transactions:
  - Annual Fuel Pathway Reports
  - Quarterly Fuel Transaction Reports
  - Crude Oil Quarterly and Annual Volumes Reports
  - Project Reports
  - Low-Complexity/Low-Energy-Use Refinery Reports
  - Electric Vehicle Charging and Hydrogen Refueling
- Verifiers are required to take robust training program and pass exams to become accredited for LCFS verification
- Fuel pathway inputs (energy use, feedstock source, transport distance, etc.) checked by verifiers and include site-visits
- Program includes robust data accuracy and meter calibration requirements

CARB 37

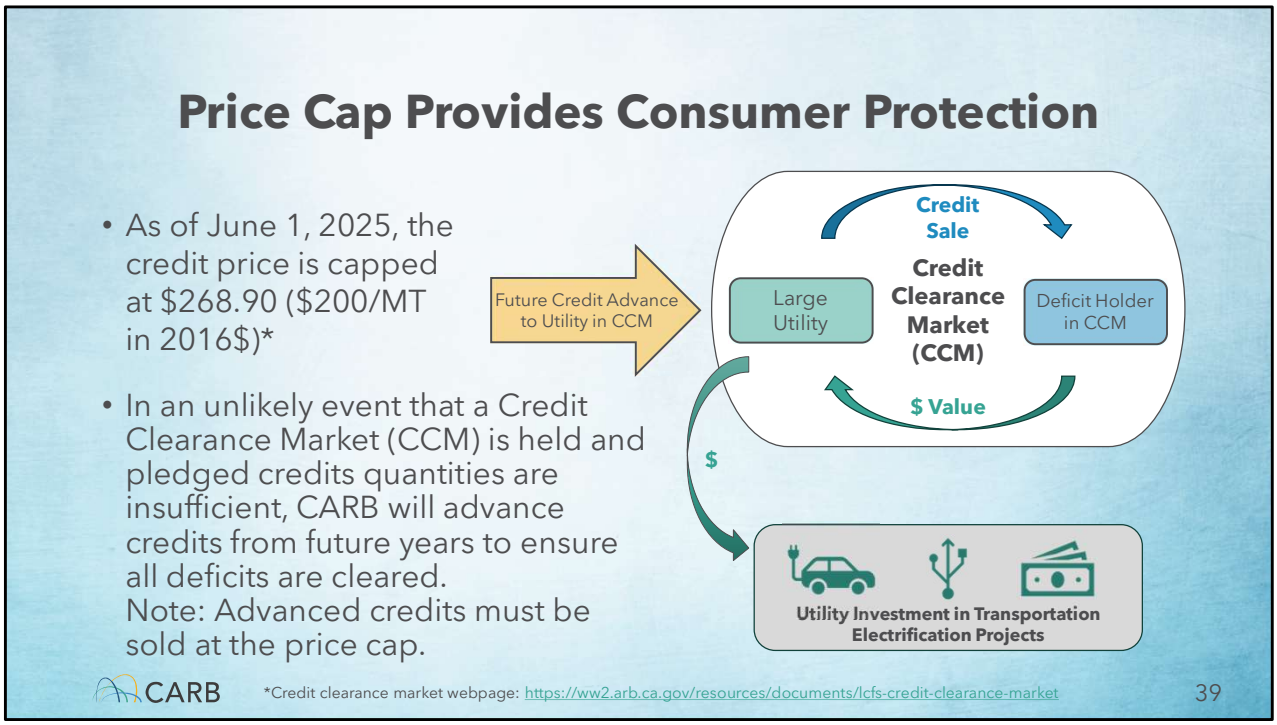
Many of these crediting opportunities are also subject to third-party verification requirements, which help maintain the integrity of the program. Participating verifiers undergo a robust accreditation process, and the actual verification procedure can vary based on the fuel pathway. Fuel pathway holders with less than 6,000 credits/deficits may defer verification for up to two years (does not apply to entities with book-and-claim biomethane or hydrogen). The program also includes stringent data accuracy and meter calibration requirements.

Automatic Acceleration Mechanism

- The Automatic Acceleration Mechanism (AAM) advances all annual CI benchmarks by one year when the following conditions are met, based on a rolling four quarter average:
  - the ratio of the accumulated credit bank to the average quarterly deficits is greater than 3 **and**
  - credit generation exceeds deficit generation based on the prior four quarters' reporting **and**
  - the AAM has not been triggered in any of the immediately prior four quarters
- The AAM may be triggered as early as 2027, based on 2026 data, with the benchmark schedule pulled forward for 2028

CARB 38

The program has successfully incentivized the rapid growth in the development of low carbon fuels and the overall CI of California's transportation fuel pool has been well below the benchmark for the past few years. This trend shows support for faster decarbonization. To help increase the stringency of targets if the credit market continues to significantly overperform, the LCFS now includes an Automatic Acceleration Mechanism (AAM) that will advance all annual CI benchmarks by one year when the specified conditions are met. The AAM is counterbalanced by a cost-containment mechanism which prevents the credit cost exceeding a maximum price.

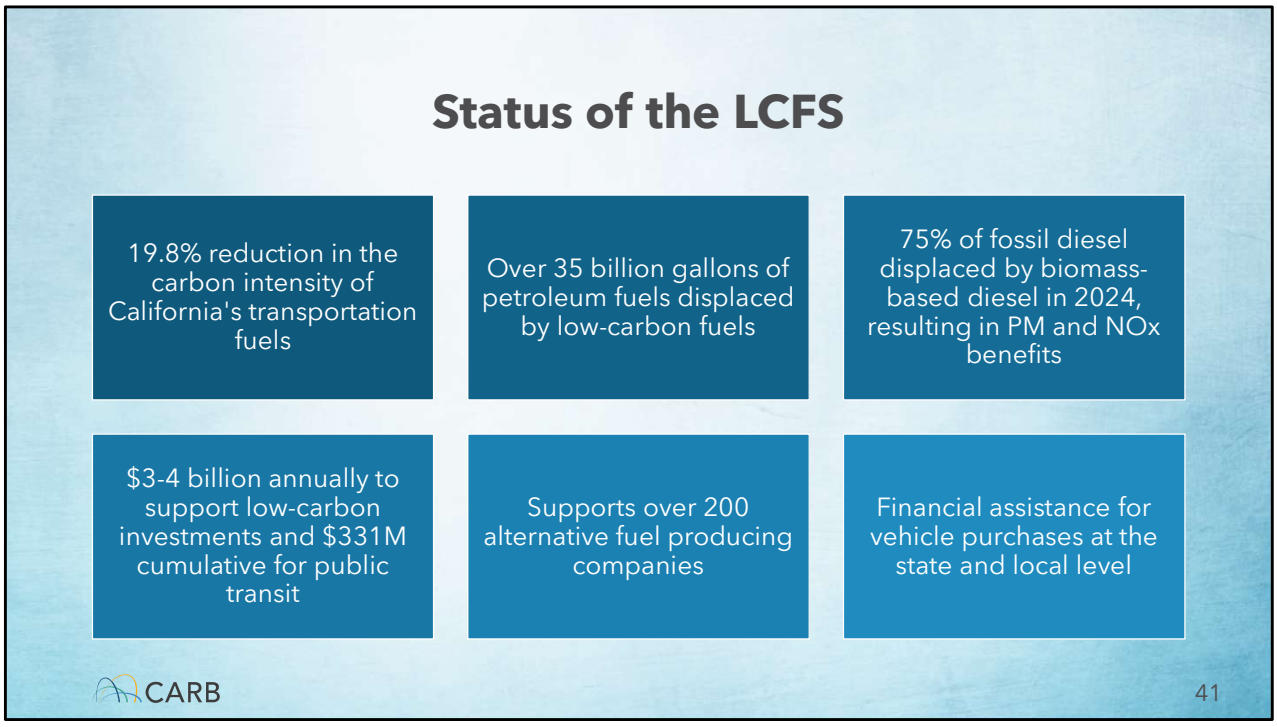


The cost containment mechanism works through the Credit Clearance Market, which can occur if there are regulated parties who have not met their previous year-end compliance obligations. If a regulated party does not have sufficient credits to retire its generated deficits, that party must purchase its pro-rata share of credits in the Credit Clearance Market, if one occurs. The Credit Clearance Market includes a price cap that provides consumer protection. The price cap is adjusted for inflation annually, and is announced on the first Monday in April of each year.

In the event that a CCM occurs, all fuel reporting entities will first be issued a call to pledge credits for sale in the CCM. If too few credits are pledged to meet demand, then CARB will issue advanced credits from eligible large utilities to be pledged for sale in the CCM. Entities with deficit obligations will then be able to purchase the advanced credits from the utilities at that year's maximum LCFS price, and the utilities are then required to use the proceeds to invest in electrification projects.

The price cap thereby strengthens incentives to invest in low-CI fuels, increases certainty regarding the maximum cost of compliance, prevents extreme market volatility, and ensures that willing credit generators can sell available credits.

LCFS Progress



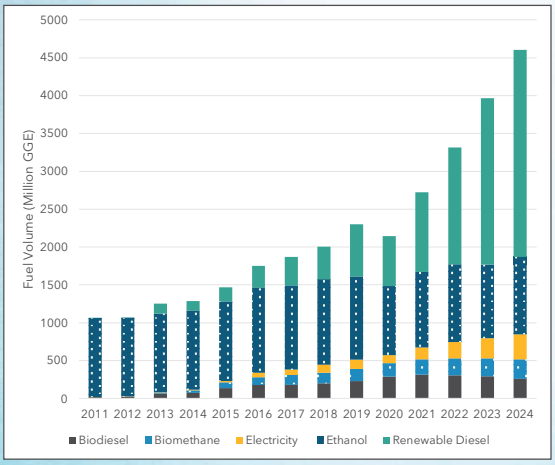
The LCFS has been one of California's most effective policy tools to speed up the transition away from fossil fuels without relying on any public sector funding. The program has generated approximately three to four billion dollars annually in private sector investment in cleaner transportation fuels and options. That private sector investment ultimately keeps money in Californians' pockets through:

- Increasing consumer choices, which drives transportation fuel price competition
- Growing new industries and attracting investments that support jobs and strengthen communities
- Reducing dependence on petroleum, the oil industry, thereby protecting consumers from its associated supply and cost volatility
- Making electric vehicles more affordable
- Expanding access to electric vehicle charging and hydrogen refueling infrastructure
- Reducing health care costs associated with air pollution from fossil fuels

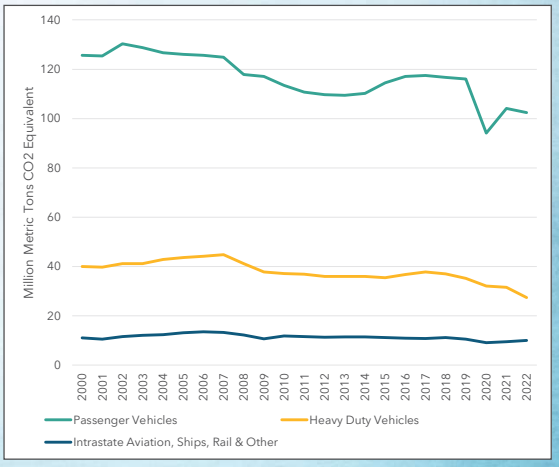
Underlying the stats on this slide are stories of how the LCFS has helped spur investment in clean energy here in California. The success of the LCFS can be seen in refineries' transition from fossil fuel production to renewable fuel production, utilities using LCFS revenue to invest in EV infrastructure and support communities with rebates for ZEVs and other incentives to reduce transportation electrification costs, dairies using the program incentives to capture methane and even produce hydrogen and electricity for use in transit buses, EV charging companies utilizing the LCFS to build more fast chargers, transit agencies using LCFS revenue to support ongoing operations of zero-emission buses and electrified rail, and trucking companies receiving upwards of $1000 per truck each month in LCFS revenue for battery-electric trucks to help close the gap between diesel and battery electric truck costs.

A Successful LCFS Provides Climate Benefits

Alt. Fuel Volumes Supported by LCFS



Transportation Sector GHG Emission Reductions



CARB

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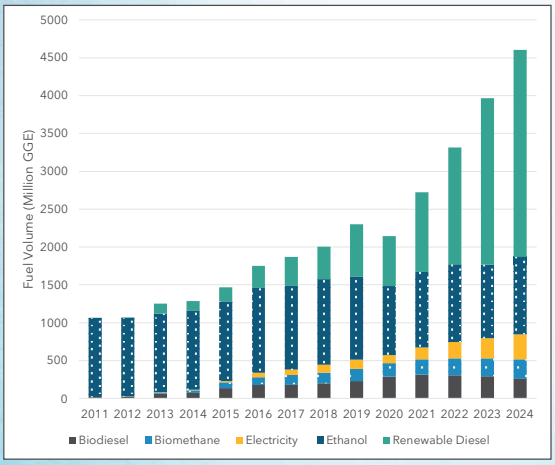
As of 2022, compared to 2010 when the LCFS took effect, the greenhouse gas emissions associated with California's transportation sector have decreased by over 14%, with the greatest reductions observed in the light-duty sector.

A Successful LCFS Rewards Clean Energy Investment

Alt. Fuel Volumes Supported by LCFS



Approximate Total LCFS Credit Value*

- Biodiesel - $2.2B
- Biomethane - $2.8B
- Electricity - $4.0B
- Ethanol - $4.5B
- Renewable Diesel - $6.9B

**Value ($) uses avg. 2013-24 credit price of $110 and total credits generated from Q1 2011 – Q4 2024*

CARB

43

Since 2010, the LCFS has helped to generate tens of billions of dollars for lower-carbon fuels. These investments have multiple benefits: diversifying the transportation fuel market, providing more options to consumers; reducing reliance on fossil fuels; and improving public health outcomes.

Other jurisdictions are following California's footsteps, which is evident in the Pacific Coast Collaborative, a regional agreement between California, Oregon, Washington, and British Columbia to strategically align policies to reduce greenhouse gases and promote clean energy.

One of the provisions of this Collaborative explicitly addresses Low Carbon Fuel Standard programs. California, Oregon, Washington, and British Columbia have existing LCFS programs in place, while New Mexico is currently developing its own LCFS program.

Staff has been routinely working with these jurisdictions, providing assistance where we can. Over time, these LCFS programs will build an integrated West Coast market for low-carbon fuels that will create greater market pull, increased confidence for investors of low carbon alternative fuels, and synergistic implementation and enforcement programs.

Other regions are also noticing California's success and considering LCFS-like performance standards for transportation fuels, with at least eight other states across the country having pending legislation related to a clean fuel standard.