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A Low Carbon Fuel Standard: In Brief

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SUMMARY

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A Low Carbon Fuel Standard: In Brief

As part of the congressional deliberations on addressing climate change, Congress may consider policy options for reducing greenhouse gas (GHG) emissions from the transportation sector. One of the leading contributors to the U.S. GHG emission profile in 2019 was carbon dioxide (CO_2) emitted from fossil fuel combustion by the transportation sector (e.g., gasoline and diesel consumption in automobiles, freight trucks, and aircraft). While Congress has acted to impact transportation sector GHG emissions (e.g., the Renewable Fuel Standard or RFS), some Members of Congress are evaluating taking additional action.

One policy option Congress may examine is a low carbon fuel standard (LCFS). An LCFS is a policy that requires transportation fuels to meet a certain energy-related GHG target (e.g., a specific carbon intensity) within a specified jurisdiction and timeframe. Some states have established an LCFS (e.g., California), and some states and regions are considering adopting an LCFS (e.g., Colorado). Generally, an LCFS is intended to be both fuel-neutral and technology-neutral. Eligible fuels for an LCFS could be required to meet certain requirements, such as a lifecycle assessment (LCA), which typically quantifies the environmental impact of a fuel from its extraction or feedstock production to its end use. Challenges to LCFS implementation include the determination of an appropriate energy-related GHG target, development of a robust LCA, and construction of a transparent compliance system.

Some in Congress are considering and have previously considered an LCFS. For instance, in the 117th Congress the Sustainable Aviation Fuel Act would establish a Low Carbon Aviation Fuel Standard that sets a carbon intensity benchmark for aviation fuel (S. 1608). Legislation that would have created an LCFS for motor vehicle fuel, non-road vehicle fuel, and aircraft fuel was introduced and at least one congressional hearing was held in the late 2000s. Some in Congress have opposed an LCFS, citing concerns about economic effects, including the potential for job losses, limited affordable lower carbon fuel options, and increasing fuel prices.

Some in Congress recommend that the existing RFS transition to an LCFS. The RFS requires renewable fuel be blended into the nation's transportation fuel supply. How a transition would happen is unclear given that the RFS is structured differently from existing state LCFS policies. For example, the RFS is a volume mandate that requires the use of renewable fuel volumes as specified in statute; the existing state and proposed LCFS programs are structured as a carbon intensity mandate that requires eligible transportation fuels to meet a certain carbon emission target. Further, the RFS only allows fuels made from renewable biomass; existing state LCFS programs have allowed a wide array of clean and renewable fuels. The statutory renewable fuel volume amounts for the RFS expire in 2022 with the U.S. Environmental Protection Agency (EPA) Administrator determining the volume amounts starting in 2023.

Congress would have the option to design a national LCFS according to congressional priorities. Discussions that Congress may have about a potential LCFS may or may not be influenced by state actions. Additionally, Congress would have many items to consider if it chooses to authorize a national LCFS. These items include policy certainty, a mechanism for the LCFS program to adapt to unforeseen circumstances, regional needs and ability, land use change, consumer choice, distributional effects, and equity, among others.

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Introduction

Congress continues to debate whether and how to address the greenhouse gas (GHG) impacts of transportation fuels.[1] The transportation sector was the leading contributor to U.S. GHG emissions in 2019—based on the most recent data available from the U.S. Environmental Protection Agency (EPA).[2] Passenger cars, light-duty trucks, and medium- and heavy-duty trucks constitute the bulk of transportation GHG emissions for 2019 (approximately 82%).[3] The majority of fuels used to operate those vehicles originate from fossil fuels (e.g., gasoline and diesel from crude oil).[4] The production and use of transportation fuels results in GHGs, which are typically emitted into the atmosphere or sometimes—though less frequently—sequestered.[5]

In 2005, Congress established a program—the Renewable Fuel Standard (RFS)—that was intended to, among other things, reduce the GHG emission impact of the U.S. transportation fuels portfolio.[6] The RFS mandates that U.S. transportation fuels contain a minimum volume of biofuel;[7] statutory annual volume requirements increased over time, but cease in 2022, with the EPA Administrator determining the volume amounts after 2022 with certain limitations.[8] There is

[1] For example, see the Build a Cleaner and More Resilient Transportation Sector section of the U.S. Congress, House Select Committee on Climate Crisis, *Solving the Climate Crisis—The Congressional Action Plan for a Clean Energy Economy*, 116th Cong., June 2020.

[2] U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2019*, EPA 430-R-21-005, April 14, 2021. From 2017 through 2019, the transportation sector has been the largest contributor of U.S. GHG emissions, followed closely by the electric power sector. For more information on greenhouse gases, see U.S. Environmental Protection Agency, *Greenhouse Gases—EPA's Report on the Environment*, https://www.epa.gov/report-environment/greenhouse-gases.

[3] U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2019*, Table 2-13: Transportation-Related Greenhouse Gas Emissions, April 14, 2021.

[4] For more information, see U.S. Energy Information Administration, *Oil and Petroleum Products Explained*, March 23, 2021. Petroleum—a type of fossil fuel—accounted for approximately 90% of the energy consumed in the transportation sector in the United States in 2020. U.S. Energy Information Administration, *Monthly Energy Review*, Table 2.5 "Transportation Sector Energy Consumption," June 2021. There are three primary petroleum transportation products: motor gasoline, diesel, and jet fuel. Motor gasoline accounted for approximately 65% of petroleum consumed in 2020; distillate fuel oil (i.e., diesel) accounted for approximately 24%; jet fuel accounted for approximately 9%. U.S. Energy Information Administration, *Monthly Energy Review*, Table 3.7c, "Petroleum Consumption: Transportation and Electric Power Sectors," June 2021.

[5] A greenhouse gas is any gas that absorbs infrared radiation in the atmosphere (e.g., carbon dioxide, methane, nitrous oxide, ozone, hydrofluorocarbons). An emission is the release of a substance (usually a gas when referring to the subject of climate change) into the atmosphere. Sequestration can occur in two forms—biologic or geologic. Biologic carbon sequestration is the process by which trees and plants absorb carbon dioxide, release the oxygen, and store the carbon. Geologic sequestration involves injecting carbon dioxide deep underground. U.S. Environmental Protection Agency, *Glossary of Climate Change Terms*, September 29, 2016. For more information on carbon capture and sequestration, see CRS In Focus IF11501, *Carbon Capture Versus Direct Air Capture*, by Ashley J. Lawson and CRS In Focus IF11345, *Carbon Sequestration Legislation in the 116th Congress*, by Angela C. Jones.

[6] P.L. 109-58.

[7] For more information on the RFS, see CRS Report R43325, *The Renewable Fuel Standard (RFS): An Overview*, by Kelsi Bracmort.

[8] There is one exception. The statutory annual volume amounts for biomass-based diesel were prescribed only through 2012 (42 U.S.C. §7545(o)(2)(B)(i)(IV)). The EPA Administrator has other statutory authorities including the authority to waive the RFS requirements under certain conditions and the authority to "reset" the RFS given certain conditions. For more information on RFS waiver authority and a RFS reset, see CRS Report R44045, *The Renewable Fuel Standard (RFS): Waiver Authority and Modification of Volumes*, by Kelsi Bracmort.

interest amongst some Members of Congress about how EPA will administer the RFS post-2022 and if legislative action would be required to change how EPA administers the RFS post-2022.[9]

Some in Congress have discussed the option of implementing a national low carbon fuel standard (LCFS) to further address the transportation sector's contribution to GHG emissions, as well as to possibly transition the RFS away from its current biofuel volume requirements.[10] In short, an LCFS is a policy that requires transportation fuels to meet a certain energy-related GHG target. An LCFS is one of many options that could potentially curb GHGs from the transportation sector. Other options include vehicle GHG emission standards, more efficient engines and/or transportation modes, and less travel. Congress could consider these options—and their potential impacts—singularly or in tandem.[11]

A national LCFS presents both opportunities and challenges. Potential opportunities include a transportation fuel policy with an explicit directive to address carbon emissions and therefore climate change, and the possibility to spur development of emerging alternative transportation fuels that, while providing a range of environmental benefits (as well as some potential drawbacks), may initially be more cost-prohibitive to produce. Potential challenges include regulatory flexibility, long-term policy certainty, and technical expertise.

This report provides a brief overview of an LCFS, congressional interest in an LCFS, the connection between the RFS and an LCFS, and considerations for policymakers. The report also briefly discusses the California LCFS and some of the proposed regional programs. This report is not a comprehensive analysis of all components related to an LCFS.

A Low Carbon Fuel Standard

This section describes the key features of an LCFS as a potential starting point for a discussion. It discusses an LCFS as structured under some existing state policies and based on a review of selected sources which included federal documents, scientific literature, stakeholder perspectives, and more.[12] Although there is no federal LCFS, several states have enacted or proposed LCFS policies applied to transportation fuels.[13] A potential national LCFS may or may not be tethered to one of the aforementioned sources (e.g., existing state policy or stakeholder recommendations). Should Congress choose to enact an LCFS, Congress may design a program that satisfies congressional priorities. Should Congress want to construct an LCFS, Congress has multiple options to consider, including the ultimate policy objective, the policy metrics, and more.

An LCFS requires transportation fuels to meet a certain target—based on the average GHG emissions of the fuel—within a specified jurisdiction and timeframe.[14] In general, this target

[9] Marc Heller, "Grassley Says RFS Debate Could Explode Come 2022," *E&E Daily*, June 17, 2020; Jonathan H. Harsch, "Battle Brewing over Ethanol Program Post 2022," *Agri-Pulse*, March 1, 2017.

[10] See e.g., U.S. Congress, Senate, *The Case for Climate Action: Building a Clean Economy for the American People*, prepared by Senate Democrats' Special Committee on the Climate Crisis, 116th Cong., August 25, 2020, p. 57; and U.S. Congress, House Select Committee on Climate Crisis, *Solving the Climate Crisis: The Congressional Action Plan for a Clean Energy Economy and a Healthy, Resilient, and Just America*, 116th Cong., June 2020, p. 101.

[11] For more information on vehicle GHG standards, see CRS In Focus IF10871, *Vehicle Fuel Economy and Greenhouse Gas Standards*, by Richard K. Lattanzio, Linda Tsang, and Bill Canis.

[12] An exhaustive review of LCFS literature and perspectives is beyond the scope of this report.

[13] States with an existing LFS include California, Oregon, and Washington. States that have considered an LCFS include Colorado, New Mexico, and New York.

[14] Another name for an LCFS is a clean fuel standard (CFS).

becomes more stringent over time. An LCFS may be designed to address GHG emissions from one or multiple transportation fuel types (e.g., gasoline, aviation fuel, etc.). Each fuel receives a score based on its GHG emissions. Typically, a credit system is used to allow flexibility to show program compliance. The regulated parties—those that must demonstrate compliance—usually include transportation fuel producers, importers, and refiners.

The overall goal of existing nonfederal LCFS policy is to reduce the carbon intensity (CI) of transportation fuels (see text box). Existing nonfederal LCFS policy is intended to be fuel-neutral and technology-neutral.[15] Based on existing programs, an LCFS sets an annual CI target and then allows the regulated parties and/or the market to determine the best method to achieve the target.[16]

Under existing programs, compliance with the annual CI target is measured using a credit system. Credit system design can vary. In general, a regulated party obtains enough credits to demonstrate compliance at the end of the compliance period. A credit is generated for those transportation fuels with a CI score that is below the CI target. A deficit is generated for those transportation fuels with a CI score above the CI target. Typically, surplus credits can be traded or saved for future compliance. Based on existing programs, regulated parties ordinarily have two options to show LCFS compliance: (1) acquire eligible fuels with attached credits, and (2) acquire credits. Regulated parties typically will either produce eligible fuel themselves or purchase it from others. Regulated parties typically will purchase credits from producers who are selling their excess credits, or they may use credits remaining from their previous compliance periods, if such flexibilities are allowed.

An LCFS has certain scientific and technical features. First, fuels are usually rated based on a lifecycle assessment (LCA) of their *pathway*. A pathway is how a fuel came to be—its source, its method of conversion to fuel, and its type.[17] The LCA quantifies, among other effects, the GHG emissions of a fuel throughout its entire lifecycle (e.g., for fossil fuels this may include from extraction through combustion, commonly referred to as "well to wheels)."[18] Under such an analysis, the same transportation fuel brought to market by different producers may have vastly different lifecycle emissions profiles. For example, different gasoline supplies can have different emissions profiles based upon their production pathways (e.g., mined and refined bitumen versus conventionally extracted and refined light, sweet crude oil). Second, there is usually a program

[15] Sonia Yeh et al., *National Low Carbon Fuel Standard: Technical Analysis Report*, Institute of Transportation Studies, University of California, Davis, Research Report UCD-ITS-RR-12-11, July 19, 2012. This is in contrast to the federal RFS, which mandates the use of fuels produced from renewable biomass.

[16] An LCFS may apply specific CI targets to different fuel types (i.e., gasoline, diesel, aviation fuel) and their substitutes (e.g., ethanol, renewable diesel, sustainable aviation fuel).

[17] Fuel sources include crude oil, natural gas, hydrogen, biomass, and more. Fuel conversion methods include distillation, compression, liquefaction, reformation, gasification, electrolysis, dry mill, and more. Fuel types include gasoline, diesel, jet fuel, compressed natural gas, liquefied natural gas, hydrogen, electricity, palm oil biodiesel, corn starch ethanol, and more.

[18] One of the more controversial aspects of an LCA for transportation fuels is emissions due to direct and indirect land use change. There is debate about which fuels should undergo land use change examination, whether to account for land use change emissions, and how to estimate such emissions. For this reason and others (e.g., the model used for the LCA, the assumptions made, etc.), it is possible for there to be disagreement on the estimated GHG impact of a transportation fuel. Further discussion about LCA is beyond the scope of this report. For more information on the variability and uncertainty associated with modeling the GHG impact, or carbon intensity, of transportation fuels see Sonia Yeh et al., "A Review of Low Carbon Fuel Policies: Principles, Program Status and Future Directions," *Energy Policy*, vol. 97 (2016). For more information on LCA for electric vehicles, see CRS Report R46420, *Environmental Effects of Battery Electric and Internal Combustion Engine Vehicles*, by Richard K. Lattanzio and Corrie E. Clark.

metric that signifies the carbon intensity of the eligible fuels.[19] Third, there is usually a baseline or benchmark to which the eligible fuels are compared. Fourth, there is usually a pricing mechanism by which credits are assigned a value relative to the eligible fuel.

The scientific and technical aspects of an LCFS may involve a range of implementation challenges. Challenges include the robustness of the LCA (e.g., which data are included in the assessment and how the data are collected and updated), construction of a transparent compliance system, and determination of an appropriate GHG reduction target and a corresponding pricing mechanism to provide for the specified policy goals. Also, policymakers may want to consider regional demands and resources when designing an LCFS (e.g., feedstock availability in certain regions of the country).

Carbon Intensity (CI)

Carbon intensity can have various interpretations and means of measurement in different contexts. In general, carbon intensity measures how much GHG, or in particular carbon dioxide (CO_2), is emitted relative to some metric (e.g., electricity produced, fuel consumed, or dollars generated). For example, the U.S. Energy Information Administration (EIA) defines CI as the "amount of carbon by weight emitted per unit of energy consumed."[20] EPA defines CI as the "relative amount of carbon emitted per unit of energy or fuels consumed."[21] The U.S. Department of Energy (DOE) has referred to CI as the "measure of CO_2 produced per dollar of GDP."[22]

There can be a range of CI scores for a single fuel type depending on the fuel pathway, which may take into account the feedstock, feedstock transportation to the conversion facility, the fuel produced, transportation of the fuel to its end-use location, and more.[23] CI may only account for carbon dioxide or it may account for multiple GHGs (with other GHGs weighted based on their warming potential relative to CO_2). Carbon intensity may only reflect one part of the activity (e.g., biomass growth and harvest), or it might reflect the entire activity cycle (e.g., biomass growth and harvest, biomass conversion to a liquid fuel, delivery of liquid fuel to pump).

For an LCFS, CI is typically defined as the amount of carbon by weight emitted per unit of energy consumed for a given transportation fuel. The California Air Resources Board (CARB) reports that a fuel pathway CI "consists of the sum of the greenhouse gases emitted throughout the production and use life cycle of the fuel, expressed on a per-unit-of-fuel-energy basis."[24] CARB expresses CI in grams of carbon dioxide equivalent per megajoule (gCO_2e/MJ).[25]

While there are public laws that include the term "carbon intensity" (see, for example, the Energy Policy Act of 2005, P.L. 109-58), carbon intensity is not defined in federal statute. Members introduced bills in the 116th Congress and the 117th Congress that would have defined carbon intensity. For instance, H.R. 8769 (116th Congress) and S. 1608 (117th Congress) would have defined carbon intensity for aviation fuel as the quantity of lifecycle GHG emissions per unit of fuel energy (similar to the CA-LCFS).

[19] Existing state programs use gCO_2e/MJ (see text box).

[20] U.S. Energy Information Administration, *Glossary*, July 6, 2021.

[21] U.S. Environmental Protection Agency, *Terminology Services*, July 6, 2021, https://iaspub.epa.gov/sor_internet/registry/termreg/searchandretrieve/termsandacronyms/search.do?search=&term=carbon%20intensity&matchCriteria=Contains&checkedAcronym=true&checkedTerm=true&hasDefinitions=false.

[22] U.S. Department of Energy, *Interactive: Energy Intensity and Carbon Intensity by the Numbers*, February 19, 2016.

[23] For an example of carbon intensity scores for various fuel types, see California Air Resources Board, *LCFS Pathway Certified Carbon Intensities*, July 6, 2021.

[24] California Environmental Protection Agency, Air Resources Board, *Staff Report: Calculating Life Cycle Carbon Intensity Values of Transportation Fuels in California*, March 2015.

[25] California Code of Regulations, 17 CCR §95481(a)(26).

Congressional Interest in a Low Carbon Fuel Standard

For over a decade, some Members of Congress have expressed an interest in a national LCFS.[26] In 2009, a Member remarked "Establishing a low carbon fuel standard is one method that can be used to reduce greenhouse gas emissions and to encourage the development of less carbon-intense fuels."[27] More recently, some Members have again expressed support for an LCFS. For example, in 2020, a group of Members stated that an LCFS may "be an effective policy to reduce the carbon intensity of the fuel supply."[28] Others have called for the Renewable Fuel Standard (RFS) to transition to an LCFS.[29] In 2018, one Member stated "This performance-based standard [the California LCFS] clearly has greater climate benefits, but it seems to me that its flexibility is also better for the advanced biofuels industry."[30] In 2021, the Sustainable Aviation Fuel Act (S. 1608) was introduced; the bill would establish a Low Carbon Aviation Fuel Standard that sets a carbon intensity benchmark for aviation fuel.

Alternatively, some Members of Congress have opposed an LCFS. For instance, in 2013, some in Congress expressed that "affordable and reliable lower carbon fuel options do not exist," and that a nationwide LCFS set to reduce the carbon intensity of transportation fuels by 10 percent over 10 years could "increase gasoline and diesel prices by as much as 170 percent" and "destroy up to 4.5 million jobs."[31]

State and Regional Low Carbon Fuel Standards

Congress may want to consider low carbon transportation fuel action taken by some states. Three states have established an LCFS: California, Oregon, and Washington, with the latter two being recently established.[32] Some states have considered an LCFS, including Colorado, Minnesota, New Mexico, and New York.[33] Additionally, some states are considering the creation of a regional

[26] In the 110th Congress, Members introduced several bills, that would have established an LCFS. For more information on the bills introduced during the 110th Congress, see archived CRS Report R40078, *A Low Carbon Fuel Standard: State and Federal Legislation and Regulations*, by Brent D. Yacobucci (out of print; available from the author). Also, one bill was introduced during the 111th Congress (S. 1095).

[27] U.S. Congress, House Committee on Agriculture, *Hearing to Review Low Carbon Fuel Standard Proposals*, 111th Cong., 1st sess., May 21, 2009.

[28] U.S. Congress, Senate, *The Case for Climate Action: Building a Clean Economy for the American People*, prepared by Senate Democrats' Special Committee on the Climate Crisis, 116th Cong., August 25, 2020, p. 57.

[29] U.S. Congress, House Select Committee on Climate Crisis, *Solving the Climate Crisis: The Congressional Action Plan for a Clean Energy Economy and a Healthy, Resilient, and Just America*, 116th Cong., June 2020, p. 101. For more information on the RFS, see CRS Report R43325, *The Renewable Fuel Standard (RFS): An Overview*, by Kelsi Bracmort.

[30] U.S. Congress, House Committee on Energy and Commerce, Subcommittee on Environment, *Advanced Biofuels Under the Renewable Fuel Standard: Current Status and Future Prospects*, 115th Cong., 2nd sess., June 22, 2018.

[31] *Americans Can't Afford Democrats' National Energy Tax*, prepared by Senate Republican Policy Committee, June 25, 2013.

[32] Governor Arnold Schwarzenegger, *Executive Order S-01-07*, Office of the Governor of California, Sacramento, CA, January 18, 2007; Oregon House Bill 2186 (2009); Oregon Senate Bill 324 (2016); Oregon Governor Kate Brown, *Carbon Policy Executive Order N. 20-04*, March 10, 2020; State of Washington, *House Bill 1091* – 2021-22, May 17, 2021.

[33] Colorado Energy Office, *Low Carbon Fuel Standard Feasibility Study Final Report*, September 2020; State of Colorado, *Colorado Greenhouse Gas Pollution Reduction Roadmap*, January 14, 2021; Minnesota Department of

LCFS (e.g., the Midwestern Clean Fuels Policy Initiative). This section provides some key aspects for the California LCFS (CA-LCFS) and some of the proposed regional LCFS programs.[34] Some foreign countries and regions also have implemented or proposed LCFSs; these foreign programs are not reviewed in this report.[35]

California Low Carbon Fuel Standard

- **Program Goal:** To reduce the carbon intensity of California's transportation fuels by at least 20% by 2030.[36]
- **Base year:** 2010.[37]
- **Applicable Fuels:** Any transportation fuel that is sold, supplied, or offered for sale in California.[38]
- **Program Measurement:** A carbon intensity (CI) benchmark.[39] The CI benchmark is reduced over time (i.e., the benchmark becomes more stringent over time).[40]
- **Compliance System:** Credit; credits are expressed in metric tons of CO_2e.[41]
- **Credit Price:** The average credit price was $199/credit for calendar year 2020, $192/credit for 2019, $160/credit for 2018, $89/credit for 2017, and $101/credit for 2016 as set by the market.[42]
- **Administering Agency:** The California Air Resources Board (CARB).

Agriculture, *Report in Fulfillment of Executive Order 19-35 Establishing the Governor's Council on Biofuels*, November 2, 2020; New Mexico Legislature, *SB 11 Clean Fuel Standard Act*, January 19, 2021; New York State Assembly Bill A5262A §2 (§19-0329(1)).

[34] Others have reviewed the various LCFS approaches. For more information, see Sonia Yeh et al., "A review of low carbon fuel policies: Principles, program status and future directions," *Energy Policy*, vol. 97 (October 2016) and Jacob Lipson, *Clean Fuels Program Comparison Chart: California, Oregon, and Proposed Washington Programs*, Washington State Legislature, House Environment & Energy Committee, February 11, 2019.

[35] For example, the Canadian province British Columbia has a low carbon fuel standard.

[36] For more information, see California Air Resources Board, "CARB Amends Low Carbon Fuel Standard for Wider Impact," press release, September 27, 2018.

[37] California Code of Regulations, 17 CCR §95484. "Annual Carbon Intensity Benchmarks."

[38] California Code of Regulations, 17 CCR §95482 "Fuels Subject to Regulation."

[39] CI is defined as the quantity of life cycle greenhouse gas (GHG) emissions, per unit of fuel energy, expressed in grams of carbon dioxide equivalent per megajoule (gCO_2e/MJ). California Code of Regulations, 17 CCR §95481(a)(26).

[40] California Code of Regulations, 17 CCR §95484. "Annual Carbon Intensity Benchmarks." For example, the average CI for gasoline and fuels used as a substitute for gasoline is set at 95.61 gCO_2e/MJ for 2011, 90.74 gCO_2e/MJ for 2021, and 79.55 for 2030. The CA-LCFS CI benchmarks for 2010 through 2030 are provided in tables for gasoline, diesel, and fuels used as a substitute for gasoline or diesel, as well as fuels used as a substitute for conventional jet fuel.

[41] California Code of Regulations, 17 CCR §95485, "Demonstrating Compliance."; California Code of Regulations, 17 CCR §95481, "Definitions and Acronyms."

[42] California Air Resources Board, *Monthly LCFS Credit Transfer Activity Report for December 2020*, January 12, 2021; California Air Resources Board, Monthly LCFS Credit Transfer Activity Report for December 2019, January 14, 2020 https://ww3.arb.ca.gov/fuels/lcfs/credit/July 2020 - Monthly Credit Transfer Activity.pdf; California Air Resources Board, *Monthly LCFS Credit Transfer Activity Report for December 2018*, January 8, 2019. For credit prices from January 2014 to the present, see California Air Resources Board, *LCFS Credit Transfer Activity Reports*.

Program performance:[43] In a 2019 press release,[44] CARB reported that "[from 2011 to 2018] almost 3.3 billion gallons of petroleum diesel have been displaced by clean, low-carbon alternatives," that "fuel producers are in 100 percent compliance with the LCFS," that "[Since 2011] … the program has generated credits representing a total reduction of 47.1 million metric tons of climate-changing gases"[45] and that "greenhouse gas reductions under this program have been occurring ahead of schedule."

Regions with a Proposed Low Carbon Fuel Standard[46]

Regional LCFS programs have been proposed by some entities.[47] The proposed regional programs include multiple states, and at least one proposed program included a region within one state.[48] The key difference between a regional LCFS and a state LCFS is the geographic boundary for the policy. The expansion of the program boundaries across state lines could be viewed as an opportunity for some (e.g., collaboration amongst various state agencies to reach transportation and climate goals) and a challenge for others (e.g., fuel providers may have to modify their business practices to satisfy the LCFS requirements for one region of their market). Additionally, regional programs may be designed to suit the needs and activities of that region. It is not clear whether multiple regional programs—assuming they are adopted—would affect what could be done at a national level (i.e., a national LCFS). Provided below is a brief overview for two proposed regional programs, one for the Northeast region and one for the Midwest region.

Massachusetts Clean Energy and Climate Plan / Transportation and Climate Initiative:

- Massachusetts reports it will "pursue the development and implementation of a regional Low Carbon Fuel Standard (LCFS) designed to substantially reduce the carbon intensity of transportation fuels by 2030 through a market-based crediting program that supports deployment of low carbon substitutes for petroleum-based

[43] There are other analysis of CA-LCFS program performance. For instance, see Julie Witcover, *Status Review of California's Low Carbon Fuel Standard, 2011–2018 Q1 September 2018 Issue* , UC Davis Institute of Transportation Studies, September 24, 2018 and Julie Witcover and Colin Murphy, *Status Review of California's Low Carbon Fuel Standard, Draft*, UC Davis Policy Institute for Energy, Environment, and the Economy, July 6, 2019.

[44] California Air Resources Board, "Cleaner fuels have now replaced more than 3 billion gallons of diesel fuel under the Low Carbon Fuel Standard," press release, May 16, 2019.

[45] EPA has a GHG equivalencies calculator that converts both energy data and emissions data into concrete everyday examples for the public to better understand what emission reduction looks like. EPA reports that 1 metric ton of CO_2e is equivalent to CO_2 emissions from 113 gallons of gasoline consumed. U.S. Environmental Protection Agency, *Greenhouse Gas Equivalencies Calculator*, March 2021, https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator. It is not clear how CARB defines "climate-changing gases." However, if one were to presume that "climate-changing gases" equates to CO_2e, then the EPA GHG equivalency calculator estimates that 47.1 million metric tons of CO_2e is equivalent to CO_2 emissions from 5.3 billion gallons of gasoline consumed.

[46] This section does not provide all of the actions pertaining to a potential LCFS that may occur at a regional level.

[47] Regional LCFS discussions have occurred since at least 2008. For example, see *Northeast and Mid-Atlantic Low Carbon Fuel Standard Memorandum of Understanding*, December 30, 2009, and Northeast States Center for a Clean Air Future, *Introducing a Low Carbon Fuel Standard in the Northeast Technical and Policy Considerations*, July 2009.

[48] The Puget Sound Clean Air Agency had considered an LCFS for the Puget Sound area, which encompasses four counties in the State of Washington and the city of Seattle. In April 2020, the Agency announced it was suspending any action on the Agency's draft Clean Fuel Standard. For more information, see Puget Sound Clean Air Agency, *Clean Fuel Standard: Proposed Draft Rule Background Technical Analysis*, October 2019 and TJ Martinell, "Air agency drops regional fuel standard proposal," *TheLens.News*, April 6, 2020https://pscleanair.gov/528/Clean-Fuel-Standard.

liquid transportation fuels" following the implementation of the Transportation and Climate Initiative Program (TCI-P).[49] Massachusetts also reports it will "work with its neighbors to develop and implement a regional LCFS no later than 2026."[50]

Midwestern Clean Fuels Policy Initiative:

- The Midwestern Clean Fuels Policy Initiative "aims to create a market specifically for regional clean fuel producers that simultaneously delivers environmental and economic benefits."[51] The Initiative highlights several features for a potential clean fuels policy that it thinks should receive consideration, including a fair lifecycle assessment, point of regulation, a consistent approach for all clean fuels, and fueling infrastructure.[52] The Initiative reports that developing a clean fuels policy is complicated, and provides three areas where additional work is needed: farm-level carbon accounting, biofuel credit value distribution, and electricity credit distribution.

The RFS and a National LCFS

The RFS and an LCFS both address the environmental impact of transportation fuels. Some have argued that a national LCFS could replace or complement the RFS, particularly in light of the fact that, starting in 2023, the EPA Administrator will determine the annual volume requirements.[53] If

[49] Massachusetts reports it is leading the implementation of the TCI-P. The TCI-P is a multijurisdictional cap-and-invest program. The Commonwealth of Massachusetts, *Interim Clean Energy and Climate Plan for 2030*, December 30, 2020. For more information on the TCI-P, see Transportation and Climate Initiative of the Northeast and Mid-Atlantic States, *Transportation and Climate Initiative Program Memorandum of Understanding*, December 21, 2020. The Transportation and Climate Initiative (TCI) is a regional collaboration of 12 Northeast and Mid-Atlantic states and the District of Columbia that seeks to improve transportation, develop the clean energy economy and reduce carbon emissions from the transportation sector. For more information, see *The Transportation and Climate Initiative: An Agenda for Progress Declaration of Intent*, 2010, which states "The TCI will build upon ongoing federal, state and regional collaborations, including the Regional Greenhouse Gas Initiative and the recently announced initiative to develop a framework for a Low Carbon Fuel Standard."

[50] The Commonwealth of Massachusetts, *Interim Clean Energy and Climate Plan for 2030*, December 30, 2020. It is not clear how many members of the TCI may join a regional LCFS.

[51] Great Plains Institute, *A Clean Fuels Policy for the Midwest: A White Paper from the Midwestern Clean Fuels Policy Initiative*, January 7, 2020. The Midwestern Clean Fuels Initiative reports it is a broad coalition of fuels producers and marketers, nonprofit and research organizations, scientists and engineers, and agriculture and industry stakeholders.

[52] Ibid. The initiative uses the term "clean fuels policy" instead of "low carbon fuel standard." The initiative reports that "A clean fuels policy, also known in some jurisdictions as a low carbon fuel standard or clean fuel standard, is a performance-based incentive program that supports the commercial deployment of fuels with lower lifecycle carbon intensity. A clean fuels policy evaluates all fuels used in the relevant jurisdiction based on lifecycle carbon accounting and assigns each fuel production method a unique carbon intensity (CI) score that is the complete well-to-wheels carbon equivalent emissions normalized for the energy content of the fuel."

[53] Stakeholders and others have studied and/or commented on the potential impacts of layering an LCFS on top of a RFS or replacing the RFS with an LCFS. For example, see Environmental Protection Network, *Resetting the Course of EPA: Reducing Air Emissions from Mobile Sources*, August 2020; U.S. Congress, House Committee on Energy and Commerce, Subcommittee on Environment, *Advanced Biofuels Under the Renewable Fuel Standard: Current Status and Future Prospects*, 115th Cong., June 22, 2018; U.S. Congress, House Committee on Agriculture, *Hearing to Review Low Carbon Fuel Standard Proposals*, 111th Cong., May 21, 2009; Haixiao Huang et al., "Stacking Low Carbon Policies on the Renewable Fuels Standard: Economic and Greenhouse Gas Implications," *Energy Policy*, vol. 56 (May 2013), pp. 5-15 and Institute of Transportation Studies, University of California, Davis, "National Low Carbon Fuel Standard: Technical Analysis Report," Research Report UCD-ITS-RR-12-11, 2012.

Congress considers creating a national LCFS to complement or replace the RFS, several factors about the RFS may be instructive. This section briefly explores three of those factors.[54]

First, the RFS involves at least four sectors of the economy: energy, the environment, agriculture, and transportation. In general, the RFS involves the production of fuels (energy) made from renewable biomass (agriculture) used in vehicles (transportation) that must meet a GHG emission threshold (the environment).[55] Thus, different Members of Congress, federal agencies, and stakeholders may view the RFS from different perspectives. These differences in perspectives have, at times, led to challenges with proposals to amend the program, program implementation, and program compliance.[56] It is not clear if a national LCFS would generate the same differences in perspectives since LCFSs generally are structured differently than the RFS as described below.

Second, the RFS is a volume mandate. The statute for the RFS dictates how much renewable fuel is to be blended into the nation's transportation fuel supply each year.[57] The foundation of the RFS is the total annual renewable fuel volume required (in gallons). The foundation of existing LCFS programs has been the annual carbon intensity target (in gCO_2e/MJ). Existing models of LCFS programs do not dictate how much of a certain low-carbon fuel must be used; the LCFS program's primary focus is whether the average of all fuel supplied meets the CI target.

Third, in order to be eligible for the RFS, the fuels must be produced from renewable biomass.[58] The RFS does not incorporate fuels produced from other sources that may be considered "clean" by some stakeholders (e.g., natural gas, hydrogen, nuclear, wind, or solar). Additionally, the majority of the annual RFS mandate is met with liquid transportation fuel. Some might contend that other renewable sources or fuel types are not feasible for the present time or in the near-term as most vehicles use liquid fuels. Others might counter that the RFS excludes certain sources of clean energy (e.g., hydrogen) and limits the adoption of alternative vehicles (e.g., electric vehicles). An LCFS typically accepts eligible fuels from any source that meets the annual CI target.

The RFS and the CA-LCFS

The CA-LCFS and the RFS share a common goal: to reduce the GHG impact of transportation fuels. The programs have similarities and differences in how they achieve this goal. Provided below is a list of selected similarities and differences.[59]

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[54] The RFS is a complex policy framework. This section presents high-level information for certain aspects of the RFS that are immediately relevant to discussions about potentially adopting a national LCFS. This section does not discuss the interaction between the RFS and the CA-LCFS. For an example of one analysis that studies the interaction between the RFS and the LCFS, see Jarrett Whistance and Wyatt Thompson, "Chapter 10—The Impact of Key US Biofuel Policies: An Example of the US RFS and California's LCFS," in *Biofuels, Bioenergy and Food Security: Technology, Institutions and Policies*, ed. Deepayan Debnath and Suresh Chandra Babu (Academic Press, 2019).

[55] Eligible fuel for the RFS includes transportation fuel used in motor vehicles as well as jet fuel and home heating oil. However, the majority of the annual mandates thus far has been met with liquid transportation fuel used in cars and light-duty trucks.

[56] For example, there were several years early on in the program when EPA did not meet the statutory deadlines to announce the annual mandates and, more recently, EPA's issuance of small refinery exemptions have been a concern for some. Over the years, bills have been introduced in Congress that would have modified or repealed the RFS.

[57] The volume outlined in statute can be waived (i.e., reduced) by the EPA Administrator given certain conditions.

[58] 42 U.S.C. §7545(o)(1)(J).

[59] This section identifies some of the key features to consider if one wanted to compare the CA-LCFS and the RFS. CRS does not posit that the comparison of the two programs is an easy task. Indeed some researchers report that "By themselves, each policy [CA-CFS and RFS] has garnered quite a bit of attention in the academic literature, with most

Selected Differences

- **Primary goal of program.** The primary focus of the CA-LCFS thus far has been the reduction in the carbon intensity of California transportation fuels. It could be argued that discussions about the RFS have focused on multiple program goals, among them economic development of rural communities and reduced dependence on oil, and not solely the GHG impact of transportation fuels.
- **Program metric.** The CA-LCFS uses a CI benchmark (i.e., gCO_2e/MJ) as its program metric. The RFS uses volume (i.e., billion gallons) as its metric.
- **Program structure.** The CA-LCFS is concerned with whether a transportation fuel meets the CI benchmark.[60] The RFS is concerned with meeting the volumes set in statute and then finalized by EPA.
- **Transportation fuel resource.** The CA-LCFS applies to transportation fuels from fossil, alternative, and renewable resources. The RFS applies to transportation fuel made from one renewable resource: renewable biomass.
- **Transportation fuels.** The CA-LCFS is only applicable to transportation fuels. The RFS includes transportation fuels as well as home heating oil.
- **Geographic jurisdiction.** The CA-LCFS is a state program, applicable to fuel supplied in California. The RFS is a national program, that, in general, is applicable nationwide.[61]
- **Compliance program structure.** There are differences between the CA-LCFS and the RFS compliance programs. For instance, the CA-LCFS has a Credit Clearance Market (CCM) with a price cap. CARB reports that this price cap in the CCM "prevents extreme market volatility."[62] Further, under the CA-LCFS,

studies focusing the individual structure of the policies and perhaps their effects on related agricultural and energy markets or on their ability to meet certain climate or GHG reduction goals. Fewer studies have investigated the interaction between the two policies, and at least some of those that have done so use a hypothetical federal-level LCFS representation instead of a state-level representation." Jarrett Whistance and Wyatt Thompson, "Chapter 10 - The impact of Key US Biofuel Policies: An example of the US RFS and California's LCFS," in *Biofuels, Bioenergy and Food Security*, pp. 179-192. This CRS report does not cover how the CA-LCFS and the RFS may interact with each other. For more information on interactions between the programs, see Jarrett Whistance, Wyatt Thompson, and Seth Meyer, "Interactions between California's Low Carbon Fuel Standard and the National Renewable Fuel Standard," *Energy Policy*, vol. 101 (2017), pp. 447-455. CRS presents this information as a starting point for congressional staff engaged in policy discussions about the different approaches to address the greenhouse gas impact of transportation fuels.

[60] Some researchers report this LCFS program "flexibility gives obligated parties the option to blend whichever optimal mix of fuels satisfies their CI reduction obligations." Jarrett Whistance and Wyatt Thompson, "Chapter 10 - The impact of Key US Biofuel Policies: An example of the US RFS and California's LCFS," in Biofuels, Bioenergy and Food Security, pp. 179-192. Additionally, the researchers report "the LCFS does not require specific volumes of renewable fuel to meet the GHG reduction targets each year. The average CI of the motor fuel pool just has to equal the target level, and it is up to the obligated parties (i.e. fuel producers and importers) to determine the mix of fuels that will meet that goal." Jarrett Whistance, Wyatt Thompson, and Seth Meyer, "Interactions between California's Low Carbon Fuel Standard and the National Renewable Fuel Standard," Energy Policy, vol. 101 (2017), pp. 447-455.

[61] The RFS statute exempts noncontiguous states and territories, but allows them to opt in. 42 U.S.C. §7545(o)(2)(A)(ii).

[62] California Air Resources Board (CARB), "LCFS Basics," https://ww2.arb.ca.gov/sites/default/files/2020-09/basics-notes.pdf. CARB reports "The CCM increases market certainty regarding maximum compliance costs, strengthens incentives to invest in and produce low-CI fuels, and reduces the probability of credit shortfalls and price spikes." CARB "LCFS Credit Clearance Market," https://ww2.arb.ca.gov/resources/documents/lcfs-credit-clearance-market.

credits do not expire.[63] In general, under the RFS, Renewable Identification Numbers (RINs) may be used to demonstrate compliance in the year they are generated and the following year.[64] The RFS has no price cap on RINs.[65]

Selected Similarities

- **GHG emission reduction.** Both the CA-LCFS and the RFS are designed to reduce GHG emissions from fuels. The CA-LCFS attains this by incorporating a GHG component into its metric (i.e. gCO_2e/MJ). The RFS attains this by including a GHG emission reduction threshold for each fuel category.[66]
- **Annual program.** The CA-LCFS and the RFS are both annual programs with an annual target and an annual compliance period.[67]
- **Multiple sector involvement.** Both the CA-LCFS and the RFS involve multiple sectors (e.g., energy, transportation, agriculture, and the environment) that may view each program from a different perspective.
- **Compliance system.** The CA-LCFS and the RFS both have a compliance system that requires regulated parties to demonstrate compliance using a credit system.
- **Market-based trading.** Both programs allow trading of credits in a financial market. Thus, obligated parties facing a deficit may be able to purchase credits from parties with a surplus.
- **Legal challenges.** Both programs have undergone numerous legal challenges.[68]

LCFS Considerations for Policymakers

An LCFS can potentially have a range of effects. The design, implementation, and enforcement of an LCFS will determine the quantity and magnitude of those effects. Should Congress choose to establish an LCFS, there are several items to consider. Some of those items include[69]

- Ability of the policy to respond to unknown events or unforeseen consequences (e.g., Will there be a scientific breakthrough or change in consumer demand for transportation fuel?),

[63] California Code of Regulations, 17 CCR §95487 "Credit Transactions." Some researchers report "Unlike the RFS, of which 20% can be met by RINs generated in the previous year, LCFS credits can be banked indefinitely and can be used to meet any of the future GHG reduction targets." Jarrett Whistance, Wyatt Thompson, and Seth Meyer, "Interactions between California's Low Carbon Fuel Standard and the National Renewable Fuel Standard," Energy Policy, vol. 101 (2017), pp. 447-455.

[64] 40 C.F.R. §80.1427(6)(i).

[65] Some in Congress have proposed a RIN price cap; see Jarrett Renshaw, "Exclusive: Senator Cruz wants to cap renewable fuel credits at 10 cents - document," *Reuters*, December 15, 2017. Others in Congress oppose a RIN cap; see Growth Energy, "Growth Energy Thanks Senate Biofuels Champions for Defeating Cruz's Midnight-Hour RIN Cap Amendment," press release, February 5, 2021.

[66] For instance, under the RFS, advanced biofuel must have lifecycle greenhouse gas emissions of at least 50% less than lifecycle greenhouse gas emissions from its gasoline or diesel counterpart. 42 U.S.C. §7545(o)(1)(B).

[67] Some researchers report the "RFS mandates are finalized annually, introducing considerable uncertainty into the market." Sonia Yeh et al., "A review of low carbon fuel policies: Principles, program status and future directions," Energy Policy, vol. 97 (October 2016).

[68] For a timeline of major court decisions on CA-LCFS cases from 2011 - 2015, see Sonia Yeh et al., "A review of low carbon fuel policies: Principles, program status and future directions," Energy Policy, vol. 97 (October 2016).

[69] The items are not listed in any order of priority and this list is not exhaustive.

- Connections between the LCFS and other incentives or programs (e.g., Will there be procurement mandates, tax incentives, or carbon capture and storage efforts that impact the LCFS?),
- Consumer choice (e.g., Will consumers prefer a certain type of fuel or vehicle?),
- Distributional effects (e.g., Who receives the environmental and monetary benefits? Who pays any costs for fuel transition?),
- Economic development (e.g., Will an LCFS create jobs?),
- Eligible fuel types (e.g., Will clean fuel or renewable fuel be eligible?),
- Equity (e.g., Will there be a transportation fuel equity analysis for the program? Who will have access and opportunity to participate in fuel production, credit trading, etc.?),
- Existing state programs (e.g., Will state programs fold into a national LCFS?),
- Global leadership and competitiveness (e.g., Can the United States serve as the world leader for developing clean fuel technologies and infrastructure?),
- Land use change (e.g., Is there a robust and reliable methodology to measure direct and indirect land use change?),
- Litigation (e.g., Are there potential legal challenges that may forestall program implementation and, thus, prevent program goals from being met?),
- Periodic program evaluation (e.g., Will there be scheduled time periods to review and modify the policy if needed?),
- Policy certainty (e.g., Will there be mid- to long-term regulatory certainty for producers, obligated parties, and others?),
- Potential dominance of one fuel type over other fuel types (e.g., Will there be a sudden transition to electric bus fleets by municipal and state governments or electric delivery vehicles by ecommerce businesses?),
- Program administrator and regulator (e.g., Should the same entity implement the program and regulate compliance?),
- Program compliance (e.g., Will program compliance consist of a credit system or a pass-fail system?)
- Program flexibility (e.g., How flexible or prescriptive will the policy be?),
- Program transparency (e.g., Will there be enough transparency to ensure confidence in credit transactions for compliance),
- Regional needs and ability (e.g., Which regions have the capacity to produce low-carbon fuel?), and
- Scientific and technical expertise (e.g., What science and technical experts are available to routinely and independently analyze the policy?).

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