

Public Hearing to Consider the Proposed Amendments to the Low Carbon Fuel Standard

Staff Report: Initial Statement of Reasons

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List of Acronyms and Abbreviations

2022 Scoping Plan Update	2022 Scoping Plan for Achieving Carbon Neutrality
AAM	Automatic Acceleration Mechanism
AB	Assembly Bill
ACC II	Advanced Clean Cars II
ACF	Advanced Clean Fleets
ACT	Advanced Clean Trucks
AFP	Alternative Fuels Portal
AFPR	Annual Fuel Pathway Report
AJF	Alternative Jet Fuel
Btu	British Thermal Units
CA-GREET	California Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation
CARB or Board	California Air Resources Board
CARBOB	California Reformulated Gasoline Blendstocks for Oxygenate Blending
CATS	California Transportation Supply Model
CCM	Credit Clearance Market
CCS	Carbon Capture and Sequestration
CEQA	California Environmental Quality Act
CHC	Commercial Harbor Craft
CI	Carbon Intensity
CH ₄	Methane
CNG	Compressed Natural Gas
CO ₂	Carbon Dioxide
Court	State of California Court of Appeal, Fifth Appellate District
DAC	Direct Air Capture
DC	Direct Current
EIA	Environmental Impact Analysis
EER	Energy Economy Ratio
eCHE	Electric Cargo Handling Equipment
ED	Emergency Department
EJ	Environmental Justice
EJAC	Environmental Justice Advisory Committee
eGRID	Emissions & Generation Resource Integrated Database
EMFAC	Emissions FACtor Model
eOGV	Electric Power for Ocean-going Vessel
eTRU	Electric Transport Refrigeration Units
EV	Electric Vehicle
FCI	Fast Charging Infrastructure
FCV	Fuel Cell Vehicle
FSE	Fuel Supply Equipment
gCO ₂ e/MJ	Grams of CO ₂ equivalent per megajoule
GHG	Greenhouse Gas
HEFA	Hydroprocessed Ester and Fatty Acid
HRI	Hydrogen Refueling Infrastructure
HyCAP	Hydrogen Capacity Model

HySCapE	Hydrogen Station Capacity Evaluation Model
ICT	Innovative Clean Transit
IRA	Inflation Reduction Act
ISOR	Initial Statement of Reasons
IWG	Interagency Working Group on the Social Cost of Greenhouse Gases
kW	Kilowatt
LCA	Life Cycle Analysis
LCFS	Low Carbon Fuel Standard
LC/LEU	Low-Complexity/Low-Energy-Use
L-CNG	Liquefied Compressed Natural Gas
LD	Light-Duty
LDV	Light-Duty Vehicle
LRT-CBTS	LCFS Reporting Tool and Credit Bank & Transfer System
LUT	Lookup Table
MFR	Multi-Family Residence
MHD	Medium- and Heavy-Duty
MHDV	Medium- and Heavy-Duty Vehicle
MW	Megawatt
MTCO _{2e}	Metric tons in carbon dioxide equivalent
NEVI	National Electric Vehicle Infrastructure Formula Program
N ₂ O	Nitrous Oxide
NO _x	Oxides of Nitrogen
NREL	National Renewable Energy Laboratory
OPGEE	Oil Production Greenhouse Gas Emission Estimator
PM _{2.5}	Fine Particulate Matter
RFS	Renewable Fuel Standard
RNG	Renewable Natural Gas
RPS	Renewable Portfolio Standard
SAF	Sustainable Aviation Fuel
SB	Senate Bill
SC-CO ₂	Social Cost of Carbon
SFAP	Sustainable Freight Action Plan
SLCP	Short-Lived Climate Pollutant
ULSD	Ultra Low Sulfur Diesel
U.S. EPA	United State Environmental Protection Agency
VMT	Vehicle Miles Traveled
ZEV	Zero-Emission Vehicle

Executive Summary

California is the midst of a rapid transition to cleaner fuels and carbon neutrality, with just over 20 years to transition from today's significant fossil fuel usage to a future of clean fuels and technology. In 2022, the California Air Resources Board (CARB) approved the 2022 Scoping Plan for Achieving Carbon Neutrality (2022 Scoping Plan Update), which charted a path to achieving carbon neutrality by 2045 and reducing greenhouse gas emissions 85% below 1990 levels by 2045. Meeting this goal will require the deployment of greenhouse gas (GHG) emission reduction strategies at an unprecedented scale and pace.

Many of the strategies identified in the 2022 Scoping Plan Update to address climate change and achieve carbon neutrality are the same strategies needed to drastically improve air quality. As transportation emissions, primarily from the use of fossil fuels, are California's single biggest source of greenhouse gas emissions and contributor to poor air quality, the State is working to rapidly increase the numbers of zero-emission vehicles on the road and deploy cleaner fuels to power them. If California is successful in meeting the clean fuel and vehicle goals identified in the 2022 Scoping Plan Update, we will reduce fossil fuel demand by 94% by 2045. CARB has already taken significant steps to reducing transportation emissions by adopting regulations such as Advanced Clean Cars II, Advanced Clean Fleets, Advanced Clean Trucks, Innovative Clean Transit, and other rules that promote and accelerate the deployment of low and zero-emission technologies.

The Low Carbon Fuel Standard (LCFS) is a key part of California's transportation decarbonization strategy and a successful one thus far. The LCFS provides the economic incentives to produce cleaner fuels like electricity, hydrogen and biofuels that are needed to displace fossil fuels and reduce transportation sector emissions. The LCFS has supported the displacement of billions of gallons of petroleum fuels with lower carbon alternatives, and without these alternative fuels the State risks returning to higher levels of fossil fuel use and fewer climate and air quality benefits. With clear scientific consensus on the need to rapidly decarbonize and achieve carbon neutrality by mid-century, the significant health and economic benefits of phasing down fossil fuel use, and the introduction of federal funding for alternative fuels and clean energy, now is the time to update and strengthen the LCFS regulation. This regulatory update proposal, which is described in detail in this staff report, is focused on the following key concepts:

- Increasing the stringency of the program to reduce emissions and decarbonize the transportation fuel sector, which will also aggressively reduce our dependence on fossil fuels;
- Strengthening the program's equity provisions to promote investment in disadvantaged, low-income and rural communities;
- Supporting electric and hydrogen truck refueling;
- Incentivizing more production of clean fuels needed in the future, such as low-carbon hydrogen;
- Supporting methane emissions reductions and deploying biomethane for best uses across transportation; and
- Strengthening guardrails on crop-based fuels to prevent deforestation or other potential adverse impacts.

These proposed changes, if adopted, would result in significant GHG reductions as well as air quality, health, and economic benefits across the State. These benefits include:

GHG Reductions

- 90% reduction in carbon intensity of California's transportation fuels by 2045.
- 558 million metric tons of life cycle CO_{2e} reductions from the amendments.

Health Benefits

- Almost \$5 billion in total avoided health costs resulting from nearly 4,300 tons of PM_{2.5} reduction and more than 25,000 tons of NO_x reductions.

Economic Benefits

- \$128 billion in revenue estimated accruing to California businesses from credit generation/sales.
- Job growth in the electricity and biofuel sectors as demand for these fuels grows.
- Increases the diversity and competitiveness of transportation fueling options for California consumers, transitioning supply from just ten fossil fuel refiners to hundreds of individual biofuel, electricity, and hydrogen producers.

The changes would also help support implementation of California's world-leading zero-emission vehicle policies, align with the 2022 Scoping Plan Update, and provide a model for other jurisdictions looking to deploy clean fuel and climate policies. And finally, as Californians transition away from less-efficient fossil fuels and into more energy efficient zero-emission vehicles (ZEVs) and lower-carbon fuel alternatives, the fuel costs Californians pay to travel would also decrease, providing Californians billions of dollars in savings. CARB staff estimates the amount of money Californians spend on fueling costs across all vehicle class could be up to 42% lower in 2045 than compared to fuel costs in 2021. This translates into an annual savings of over \$20 billion in fuel expenditures in 2045 alone.

I. Introduction and Background

In this chapter, the California Air Resources Board (CARB or Board) staff provides a brief overview of the Low Carbon Fuel Standard (LCFS) regulation (California Code of Regulations, title 17, sections 95480-95503), information on the history and status of the LCFS program, and an overview of the proposed revisions to the program.

The purpose of the LCFS regulation is to reduce the carbon intensity (CI) of transportation fuels used in California, thereby reducing GHG emissions, and to incentivize the production of low-carbon and renewable alternatives, such as low-CI electricity and renewable hydrogen, and biofuels to displace fossil fuels and allow more energy security in the transportation sector. It is the most direct tool being deployed to reduce dependence on fossil fuels in the transportation sector.

The Board approved the LCFS regulation in 2009 as a discrete early action measure under the California Global Warming Solutions Act of 2006 (Assembly Bill [AB] 32, Núñez and Pavley, Chapter 488, Statutes of 2006; Healthy and Safety Code sections 38500 et seq.). Since the passage of AB 32, California has developed bold, creative, and durable policy solutions to protect our environment and public health. In fact, California met the target established in AB 32—a return of GHG emissions to 1990 levels by 2020—six years ahead of schedule.

Recognizing California's early successes in achieving GHG emissions reductions and the need to accelerate climate mitigation efforts, California has continued to enact ambitious goals and take concrete steps to achieve them. There have been several major new climate statutes enacted and executive orders issued since the last major LCFS rulemaking in 2018. In 2022, Governor Gavin Newsom signed several climate bills, including AB 1279 (Muratsuchi, Chapter 337, Statutes of 2022), Senate Bill (SB) 905 (Caballero, Chapter 359, Statutes of 2022), and SB 1020 (Laird, Chapter 361, Statutes of 2022). AB 1279 requires an 85% reduction in anthropogenic GHG emissions below 1990 levels by 2045. SB 905 requires CARB to adopt regulations creating a framework for the development of carbon capture, removal, and storage projects by 2025. And SB 1020 includes new benchmarks of 90% clean electricity by 2035 and 95% by 2040 ahead of the 100% goal by 2045. A particular focus on the transportation sector was established through Executive Order N-79-20.¹ Signed in 2020, Executive Order N-79-20 established a State goal that sales of all new passenger vehicles be zero emission by 2035 and that 100% of medium- and heavy-duty vehicles in the State be zero emission by 2045 for all operations where feasible and by 2035 for drayage trucks. The 2022 Scoping Plan Update,² approved by the Board in December 2022, lays out a cost-effective and technologically feasible path to achieve these targets and achieve carbon neutrality by 2045.

The 2022 Scoping Plan Update signals the need for an aggressive reduction of fossil fuel use, building on and accelerating greenhouse gas reduction programs that have been in place for a decade and a half, including the LCFS program. This means rapidly moving to zero-emission

¹ State of California Executive Department, Executive Order N-79-20. September 23, 2020. <https://www.gov.ca.gov/wp-content/uploads/2020/09/9.23.20-EO-N-79-20-Climate.pdf>

² California Air Resources Board, 2022 *Scoping Plan for Achieving Carbon Neutrality*. November 16, 2022. https://ww2.arb.ca.gov/sites/default/files/2022-12/2022-sp_1.pdf

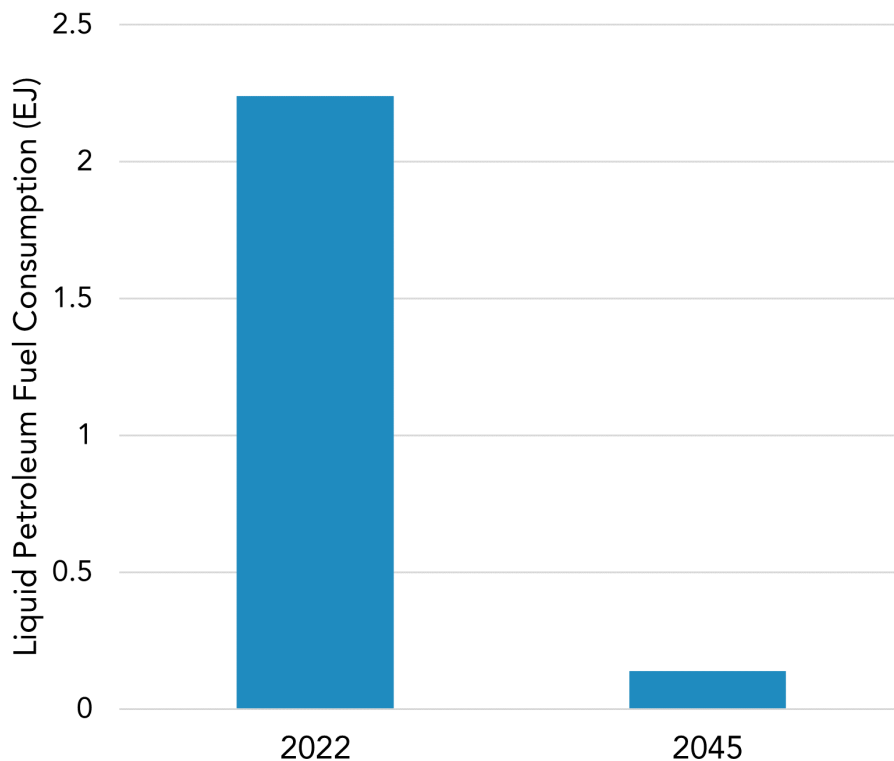
transportation; transitioning the cars, buses, trains, and trucks that now constitute California's single largest source of planet-warming pollution to zero-emission technology. In the transportation sector, the transition to complete zero-emission vehicle (ZEV) technology will not happen overnight.

Achieving GHG emissions of 85% below 1990 levels by 2045 will require significant investment and use of lower carbon opportunities while zero-emission technologies gain market penetration and achieve interim climate goals. Conventional internal combustion engine vehicles from legacy fleets will remain on the road for some time, even after all new vehicle sales have transitioned to ZEV technology. Therefore, it is necessary to ensure there are reliable and adequate low-carbon fuel supplies available and continue expansion of low-carbon fuel production in ways that use existing infrastructure where possible, such as transitioning refineries to clean fuel production.³

Meeting this demand requires building out significant new low-carbon energy supply capacity, which the LCFS incentivizes in the transportation sector. Specifically, a greater demand for electricity and renewable hydrogen is expected, necessitating the expansion of renewable electricity and hydrogen production; the transition of low-carbon liquid biofuels from end-uses from on-road vehicles with many zero-emission options into sectors that are more difficult to decarbonize like aviation, marine, and other off-road uses; and transition of biomethane used as compressed natural gas (CNG) in vehicles to a feedstock for hydrogen or an energy source to decarbonize the broader natural gas system. Successful implementation of the technology and fuel switching called for in the 2022 Scoping Plan Update results in a 94% reduction in liquid petroleum demand by 2045 compared to 2022, as shown in Figure 1. For these outcomes to happen, California must accelerate the pace of clean energy and technology deployment. Private investments, policy signals such as a more stringent LCFS, and federal incentives will all need to be leveraged to realize the outcomes in the 2022 Scoping Plan Update.

³ State of California Executive Department, *Executive Order N-79-20*. September 23, 2020. <https://www.gov.ca.gov/wp-content/uploads/2020/09/9.23.20-EO-N-79-20-Climate.pdf>

Figure 1: Fossil Fuel Demand Projections in 2045 relative to 2022 (from 2022 Scoping Plan Update)

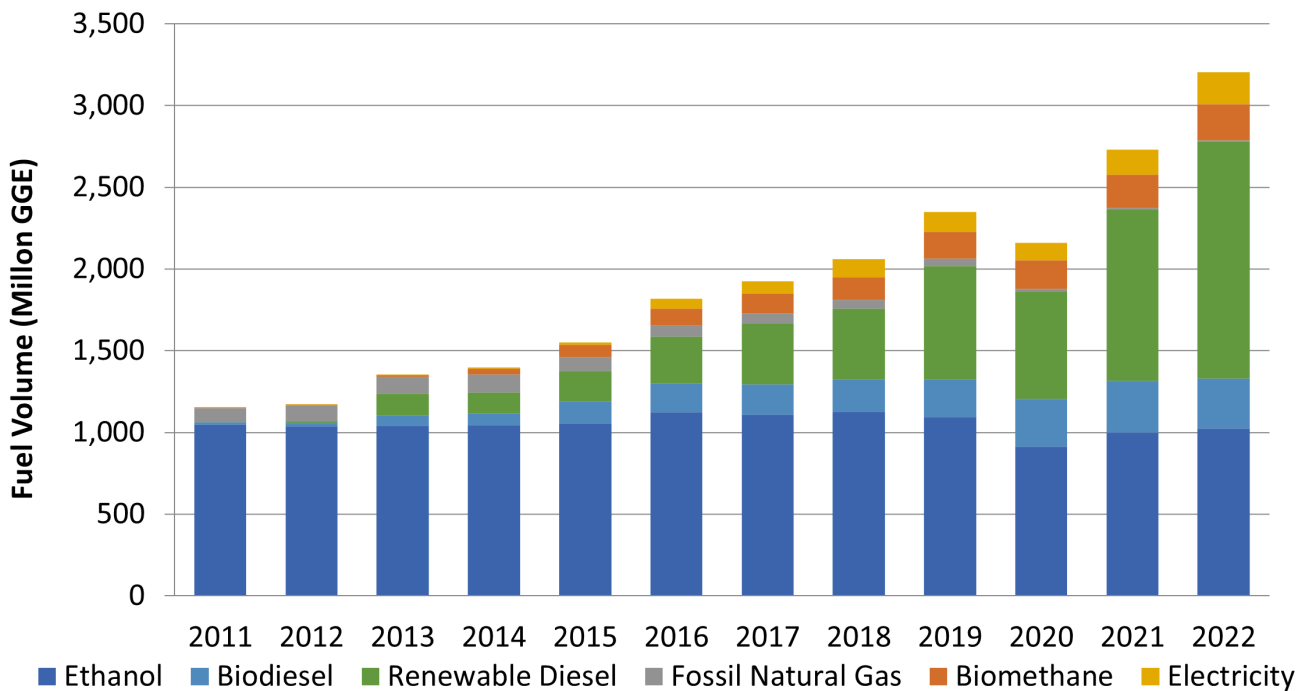


The LCFS also supports other existing State GHG reduction efforts; notably, the Short-Lived Climate Pollutant (SLCP) Reduction Strategy, Advanced Clean Cars II (ACC II) regulations, Advanced Clean Fleets (ACF) regulation, Clean Truck Partnership, Advanced Clean Trucks (ACT) regulation, 2020 Mobile Source Strategy, Sustainable Freight Action Plan (SFAP), Commercial Harbor Craft (CHC) regulation, In-Use Locomotive regulation, Innovative Clean Transit (ICT) regulation, and Renewable Portfolio Standard (RPS). SB 1383 (Lara, Chapter 395, Statutes of 2016) requires a 40% reduction in California’s methane emissions by 2030 and the LCFS facilitates significant private investment in technologies that provide the methane reductions from dairy, livestock manure, organic waste, and landfill management operations called for by SB 1383. On the vehicle side, ACC II serves as the primary mechanism to help deploy ZEVs in the light-duty vehicle (LDV) sector. The LCFS supports ACC II implementation by incentivizing electricity and hydrogen infrastructure through the ZEV infrastructure crediting provisions, providing credits for the delivery of low-CI electricity and hydrogen to vehicles, and through rebate and other transportation electrification support from the proceeds from LCFS credit sales earned by electric utilities. Similarly, the opportunity to generate LCFS credits helps to reduce the up-front costs for fleets to purchase new zero-emission trucks, locomotives, and buses and equipment to achieve the SFAP, ACF, ICT, In-Use Locomotive, and ACT goals. By recognizing the carbon intensity of renewable electricity used to produce transportation fuels, the LCFS rewards fuel providers across the supply chain for the displacement of fossil fuel consumption by biomethane, wind, solar, and other lower carbon technologies, as well as the use of renewable power for vehicle charging. Several of these regulations also require the use of renewable fuels during the transition to zero-emission technology. The ICT regulation requires large transit agencies to use renewable fuel in remaining combustion-powered buses, and the ICT and In-Use Locomotive regulations

support the use of hydrogen as well. The ACF regulation requires fleet turnovers beginning in 2024; however, this transition is contingent upon the availability of refueling infrastructure, which this LCFS proposal would incentivize.

The LCFS provides the necessary price signals and incentives to leverage private investment and scale the low-carbon fuel production needed to displace fossil fuels. This is borne out in the program’s history. As shown in Figure 2, California has doubled the volume of the State’s low-carbon fuel consumption in just 10 years and diversified the fuel mix considerably, due in large part to the LCFS program.

Figure 2: Alternative Fuel Volumes in California between 2011-2022



The 2022 Scoping Plan Update directly identifies that the stringency of the LCFS CI benchmarks should be increased, both pre- and post-2030, which is the key change staff is proposing for this rulemaking. The objective is to send clear, long-term market signals to support investment in low-carbon fuel production and technologies that are needed to achieve deep emissions reductions in the transportation sector while supporting the broader portfolio of zero-emission vehicle regulations and climate statutes. Another goal is to align the crediting opportunities in the LCFS with the fuel and technology pathways identified in the 2022 Scoping Plan Update. To encourage additional GHG reductions in key areas where decarbonization will be important to meet long-term climate goals, staff proposes to eliminate the current exemption for intrastate fossil jet fuel starting in 2028 and expand ZEV infrastructure crediting to the medium- and heavy-duty vehicle sector under the program. Given the need to quickly scale low-carbon fuel production in this decade and staff’s experience implementing the program for over a decade, staff also proposes to update and streamline several quantification methods and analysis tools so that the program does not unnecessarily slow down the investment or availability of low-carbon fuels and so other jurisdictions can establish similar programs without significant administrative needs. As a means of increasing the flexibility of the program to be

able to respond to rapid and unanticipated shifts in the market, such as significant overperformance of ACC II or ACF implementation, staff also proposes a mechanism that would automatically accelerate the carbon intensity benchmarks under certain conditions. Finally, in response to the near-term over-performance, staff has included a step down in the carbon intensity beginning in 2025.

A. Overview of the Low Carbon Fuel Standard

Transportation plays a key role in California’s economy and lifestyle. The production and use of traditional petroleum-derived transportation fuels—such as gasoline and diesel—are responsible for almost 50% of statewide GHG emissions, the largest source of GHG emissions in 2020.⁴ The LCFS is part of the State’s set of policies to meet California’s ambitious climate goals, which are described in the 2022 Scoping Plan Update. The 2022 Scoping Plan Update demonstrates that significant increases in low-carbon fuel and technologies are needed in a faster timeframe than we have historically seen.

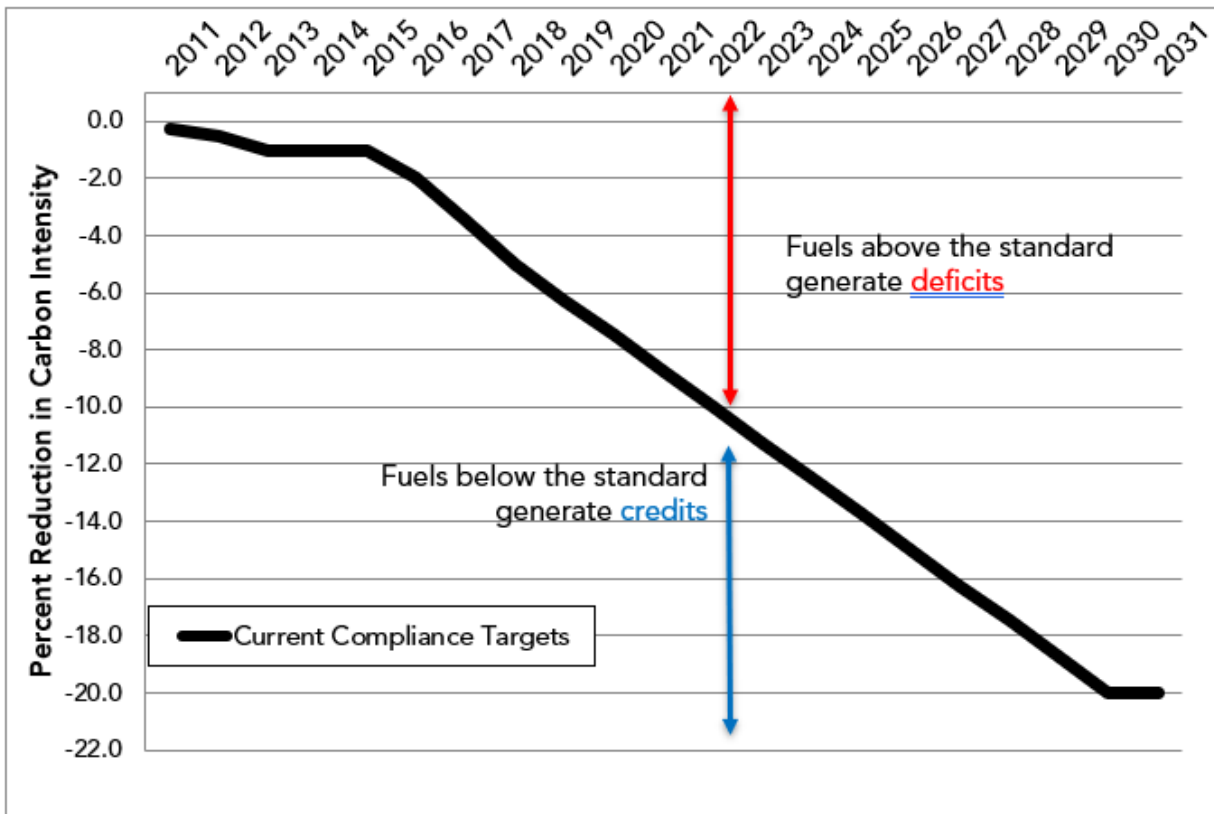
The LCFS is designed to decrease the carbon intensity of California’s transportation fuel pool and provide an increasing range of low-carbon and renewable alternatives, which reduce petroleum dependency and achieve air quality benefits.⁵

Providers of transportation fuels must cumulatively demonstrate that the mix of fuels they supply for use in California meets the LCFS carbon intensity standards, or benchmarks, for each annual compliance period. Regulated entities required to report fuels provided may demonstrate compliance through a system of credits and deficits. Credits are generated by supplying fuels with lower carbon intensity than the benchmark. Deficits result from supplying fuels with higher carbon intensity than the benchmark. This concept is illustrated in Figure 3. A deficit generator meets its compliance obligation by retiring credits it earns or otherwise acquires from another party equal to the deficits it has incurred. Credits and deficits are generally determined based on the quantity of fuel sold, the carbon intensity of the fuel, and the efficiency by which a vehicle converts the fuel into usable energy.

⁴ California Air Resources Board, *California Greenhouse Gas Emissions for 2000 to 2020, Trends of Emissions and Other Indicators*. Pages 10-14. 2022. https://ww2.arb.ca.gov/sites/default/files/classic/cc/inventory/2000-2020_ghg_inventory_trends.pdf. This includes upstream oil extraction and refining emissions.

⁵ Carbon Intensity (CI) is a measure of the GHG emissions associated with the various production, distribution, and consumption steps in the “life cycle” of a transportation fuel, denoted in units of gCO₂e/MJ.

Figure 3: Illustration of LCFS Mechanics – How Credits and Deficits are Calculated



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 CARB-certified carbon intensity score to participate in the LCFS, and the fuel type dictates which process is used to determine that CI. Additionally, there are CARB-approved LCFS project-based actions that may generate credits, such as by demonstrating carbon capture and sequestration, using solar-generated steam at oil and gas extraction sites, and investing in refinery improvements that reduce GHG emissions. Finally, the 2018 amendments added capacity-based crediting to support the deployment of ZEV refueling infrastructure. Crediting for ZEV infrastructure is based on the capacity of the hydrogen station or fast charging site minus the actual fuel dispensed. Credits and deficits are denoted in metric tons of GHG emissions. Credits may be banked and traded within the LCFS market to meet compliance obligations.

The LCFS carbon intensity benchmarks are an annually declining standard, which is defined in the LCFS regulation as a percentage reduction from the historical average carbon intensity of gasoline and diesel fuel in the year 2010. To determine the carbon intensity value of a particular fuel, the GHG emissions from the fuel's life cycle are summed and divided by the fuel's energy content (in megajoules). GHG emissions from each step can include carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O), which are adjusted by the Intergovernmental Panel on Climate Change global warming potentials to their CO₂ equivalent. Thus, carbon intensity is expressed in terms of grams of CO₂ equivalent per megajoule (gCO₂e/MJ).

The LCFS is based on the principle that each fuel has life cycle GHG emissions. This life cycle assessment (LCA) examines the GHG emissions associated with the production, transportation, and use of a given fuel. The LCA includes direct emissions from the energy and material inputs for the production, transport, and use of the fuels, as well as significant GHG emissions from market-driven changes, such as changes in land use for some crop-derived biofuels, and emissions that may result from market displacement effects (e.g., when a material is diverted from its historic use in order to produce a fuel, causing increased demand for another material to substitute the fuel for feedstock). The system of declining benchmarks that is used to calculate credits and deficits, and the obligation of deficit-generating fuels to be canceled out by credits, result in a decrease in the total life cycle GHG emissions from the transportation fuel pool in California.

A more complete description of how the LCFS regulation is designed to work, as well as its underlying scientific and economic principles, can be found in the initial and final statements of reasons for the original 2009 rulemaking,⁶ and the 2011,⁷ 2015,⁸ 2018,⁹ and 2019 LCFS rulemakings.¹⁰

⁶ California Air Resources Board, *Proposed Regulation to Implement the Low Carbon Fuel Standard Volume I Staff Report: Initial Statement of Reasons*. March 5, 2009.

<https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2009/lcfs09/lcfsisor1.pdf>

California Air Resources Board, *Proposed Regulation to Implement the Low Carbon Fuel Standard Volume II Appendices*, March 5, 2009. <https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2009/lcfs09/lcfsisor2.pdf>

California Air Resources Board, *Final Statement of Reasons for Rulemaking*. December 2009.

<https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2009/lcfs09/lcfsisor.pdf>

⁷ California Air Resources Board, *Staff Report: Initial Statement of Reasons for Rulemaking: Proposed Amendments to the Low Carbon Fuel Standard*. October 26, 2011.

<https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2011/lcfs2011/lcfsisor.pdf>

California Air Resources Board, *Final Statement of Reasons: Amendments to the Low Carbon Fuel Standard Regulation*. October 2012. <https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2011/lcfs2011/lcfsisor.pdf>

⁸ California Air Resources Board, *Staff Report: Initial Statement of Reasons for Rulemaking. Proposed Re-Adoption of the Low Carbon Fuel Standard Regulation*. December 31, 2014.

<https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2015/lcfs2015/lcfs15isor.pdf>

California Air Resources Board, *Final Statement of Reasons for Rulemaking, Including Summary of Comments and Agency Response: Re-adoption of the Low Carbon Fuel Standard Regulation*. 2015.

<https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2015/lcfs2015/fsorlcfs.pdf>

⁹ California Air Resources Board, *Public Hearing to Consider Proposed Amendments to the Low Carbon Fuel Standard Regulation and to the Regulation on Commercialization of Alternative Diesel Fuels. Staff Report: Initial Statement of Reasons*. March 6, 2018.

https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2018/lcfs18/isor.pdf?_ga=2.233093594.551189306.1692641515-1059366641.1629756188

California Air Resources Board, *Addendum to the Final Statement of Reasons for Rulemaking: Amendments to the Low Carbon Fuel Standard Regulation and to the Regulation on Commercialization of Alternative Diesel Fuels. Final Statement of Reasons*. January 3, 2019.

https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2018/lcfs18/lcfsaddendum.pdf?_ga=2.112540034.749536220.1693580753-1565224836.1601474474

¹⁰ California Air Resources Board, *Public Hearing to Consider Proposed Amendments to the Low Carbon Fuel Standard Regulation and to the Regulation on Commercialization of Alternative Diesel Fuels. Staff Report: Initial Statement of Reasons*. October 1, 2019.

<https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2019/lcfs2019/isor.pdf>

California Air Resources Board, *Amendments to the Low Carbon Fuel Standard Regulation, Final Statement of Reasons*. April 2020. <https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2019/lcfs2019/fsor.pdf>

B. History and Current Status of the Low Carbon Fuel Standard

CARB initially approved the LCFS regulation in 2009 as an early action measure under AB 32 and began implementation in 2010. Throughout the 14 years since the Board's original adoption, the basic framework of the current LCFS—including the use of LCA, the LCFS credit market, and the electronic registry of fuel reporting—has worked well and continues to support growth in an increasingly diverse and low-carbon transportation fuel pool.

CARB approved revisions to the LCFS in December 2011, which became effective on November 26, 2012, and were implemented by CARB on January 1, 2013. On July 15, 2013, the State of California Court of Appeal, Fifth Appellate District (Court) issued its opinion in POET, LLC versus California Air Resources Board (2013) 218 Cal.App.4th 681, resulting in a stay of the LCFS. The Court held that the LCFS adopted in 2009 and implemented in 2010 (referred to as 2010 LCFS) would remain in effect and that CARB could continue to implement and enforce the 2013 regulatory standards while taking steps to remedy California Environmental Quality Act and Administrative Procedure Act issues as required in the ruling.

To address the court ruling, CARB brought a revised LCFS regulation to the Board for readoption in February 2015. The 2015 rulemaking included many amendments, updates, and improvements to the program, including a compliance schedule that maintained the 2009 LCFS regulation's target of a 10% reduction in average carbon intensity by 2020 from a 2010 baseline. On September 24, 2015, the Board approved that revised LCFS regulation, which became effective on January 1, 2016.

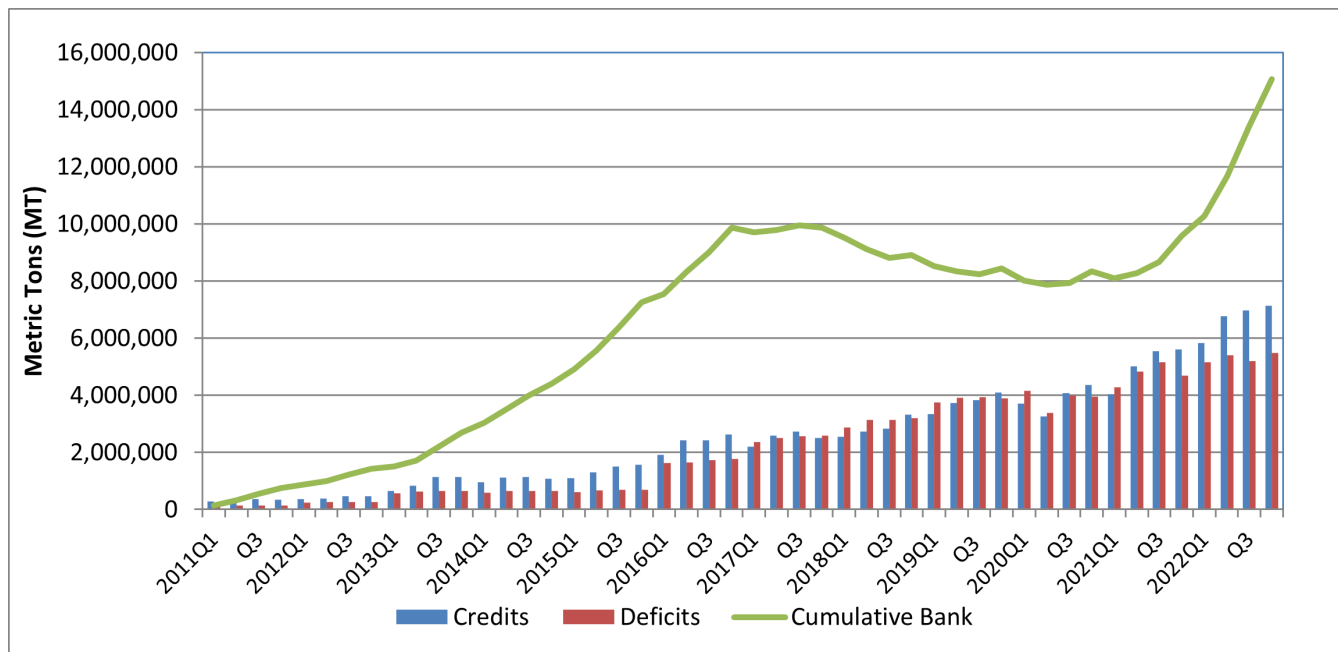
In September 2018, the Board approved amendments to the LCFS regulation, which became effective on January 4, 2019. The 2018 rulemaking included many amendments, updates, and improvements to the program, including strengthening the CI reduction benchmarks to a 20% reduction from a 2010 baseline by 2030, in line with the 2017 Scoping Plan Update and California's 2030 GHG target enacted through SB 32 (Pavley, Chapter 249, Statutes of 2016) and adding a third-party verification provision to enhance the integrity of the program.

As part of the hearings to adopt the amendments proposed in 2018, the Board directed the Executive Officer to monitor the cost containment provisions of the LCFS program, including the Credit Clearance Market, and to propose technical adjustments through future rulemaking to strengthen the cost containment provisions, if needed. The Board also directed the Executive Officer to work with stakeholders to establish an equity-based framework for the possible uses of base credit value from residential charging, consistent with legislative priorities. To address Board direction, CARB brought changes focusing on strengthening the cost containment provisions of the LCFS program and addressing equity in the use of LCFS credit value for electricity to the Board through a rulemaking in 2019. In April 2020, the Board approved the current LCFS regulation. The current regulation became effective on July 1, 2020.

California is receiving significant volumes of low-carbon fuels in response to the LCFS, including ethanol, biomass-based diesel, biomethane, and low-CI electricity. In addition to increased volumes, fuel producers have also been successfully reducing the carbon intensity of their fuels over the past years by using low-carbon feedstocks, improving production efficiency, and reducing fugitive emissions. The effect of both increasing volumes of low-carbon fuels and reduced carbon intensity of those fuels has meant that California's overall petroleum fuel use has declined by 1.3 billion gallons since 2019, the overall carbon intensity

of California’s transportation fuels has declined by 12.63% relative to 2010 levels, and the LCFS credit bank of excess credits has grown to its highest level to date with 15 million credits, as shown in Figure 7. The financial benefits are distributed among providers of various alternative fuels (as illustrated in Figure 3), geographically across California,¹¹ and across the participating credit generators.¹²

Figure 4: Quarterly Credits and Deficits for All Fuels Reported and Cumulative Credit Bank (Q1 2011 through Q4 2022)

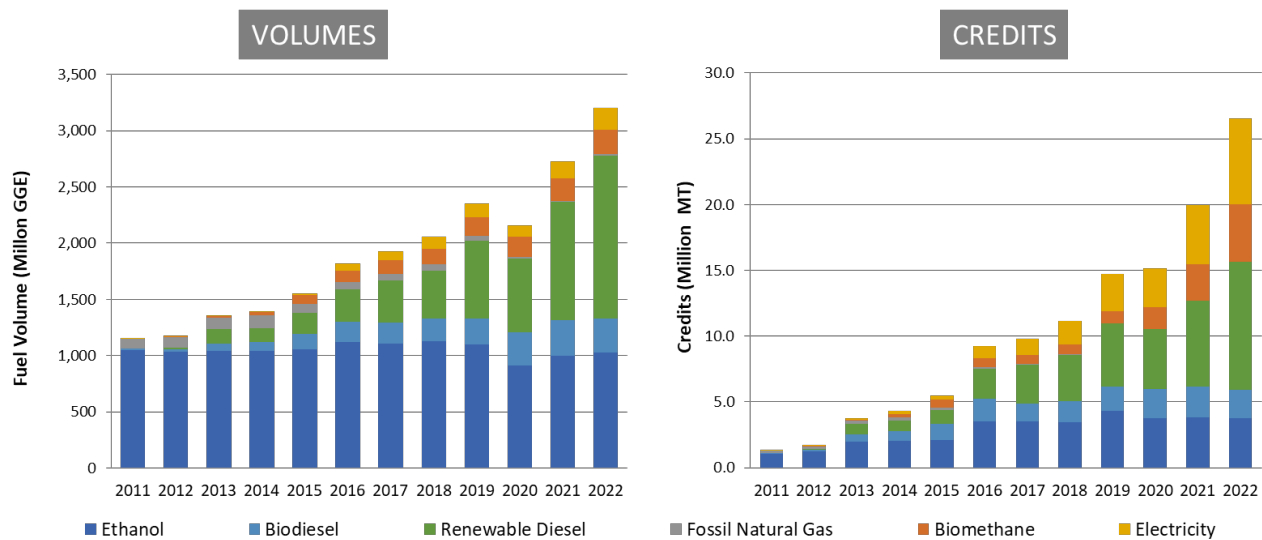


By decarbonizing the transportation fuel sector, the LCFS has resulted in increased diversification of transportation fuel options in California and less dependence on fossil fuels. Before the LCFS, the only alternative fuels with market share were natural gas and ethanol. Since the inception of the LCFS, California has doubled the volume of low-carbon fuel consumption and diversified the fuel mix considerably. Collectively, alternative fuels supported by the LCFS displaced over 3.9 billion gallons of petroleum fuel in 2022 in California. More recently, renewable diesel and electricity have taken on an increasingly larger share of the fuel pool, as shown in Figure 8. Electric vehicle (EV) charging has increased substantially in the last few years, and it is expected that electric vehicles will be an increasing portion of the market share, driven in part by California’s vehicle regulations, including ACC II, ICT, and ACF regulations in conjunction with recent federal incentives. Renewable diesel capacity also increased by over 500% between 2013 and 2020, and many U.S. fuel producers have made

¹¹ Beneficiaries include California municipal transit agencies, fueling facilities, equipment service providers, utilities, as well as fuel producers and project developers across the United States and abroad.
¹² California Air Resources Board, *LCFS Data Dashboard Figure 9: LCFS Credit Market Net Position Histogram*. (Updated on July 31, 2023). <https://ww2.arb.ca.gov/resources/documents/lcfs-data-dashboard>

announcements for expanded production in the coming years. Nearly half of California’s diesel pool was composed of alternative fuels in 2022.¹³

Figure 5: Annual Alternative Fuel Volumes and Credit Generation by Fuel Type



In addition to increases in renewable diesel and electricity, hydrogen and alternative jet fuel (AJF) quantities reported to the LCFS have increased as well. Since 2019, when AJF became eligible as an opt-in fuel in the LCFS, volumes have increased from about 1.8 million gallons in 2019 to about 11.6 million gallons in 2022, and those volumes continue to increase as momentum builds in the aviation sector and with new federal incentives. Hydrogen quantities, although still relatively small, nearly doubled from 2018 to 2019, and have more than quadrupled since 2018.¹⁴ The program is also supporting refueling infrastructure needed to refuel ZEVs. The 2018 LCFS amendments added the Hydrogen Refueling Infrastructure (HRI) and Direct Current (DC) Fast Charging Infrastructure (FCI) provisions. These provisions are designed to support the buildout of publicly-available ZEV refueling infrastructure for light-duty vehicles in California in the early years while refueling demand is low, with the expectation that vehicle demand will increase as refueling availability increases. Crediting is provided for eligible infrastructure based on the unused refueling capacity, and credit generation phases out naturally as fueling throughput increases and unused capacity decreases. The provisions limited infrastructure crediting to 5% of deficits and required applications to be submitted prior to 2026. To date, CARB has approved 75 hydrogen stations and over 3,200 DC fast chargers at 511 sites.¹⁵

Over 30 million LCFS credits were sold or traded in approximately 3,100 transactions in 2022, demonstrating an active credit market with an annual transactional value of nearly \$4 billion.

¹³ California Air Resources Board, *LCFS Quarterly Data Spreadsheet*. (Updated on July 31, 2023).

<https://ww2.arb.ca.gov/resources/documents/lcfs-data-dashboard>

¹⁴ *Ibid.*

¹⁵ California Air Resources Board, *LCFS ZEV Infrastructure Crediting webpage*. (Accessed on April 18, 2023).

<https://ww2.arb.ca.gov/resources/documents/lcfs-zev-infrastructure-crediting>

Credits in 2022 were generated primarily from renewable diesel (36%), electricity (24%), biomethane (16%), and ethanol (14%). More than 522 active entities are registered for reporting in the LCFS Reporting Tool and Credit Bank & Transfer System (LRT-CBTS), and more than 1,300 individual alternative fuel pathways have been approved with carbon intensities below the current benchmarks.

The current LCFS targets a 20% reduction in fuel carbon intensity by 2030 and maintains that benchmark for all subsequent years. A primary objective of this rulemaking is to strengthen the carbon intensity benchmarks of the LCFS regulation both pre- and post-2030 so that the LCFS continues to serve as a key policy to reduce GHG emissions from the transportation sector. Achieving the GHG reduction goals of the 2022 Scoping Plan Update will require significant changes in every sector of the State's economy. California's transportation industry remains the largest contributing sector to the GHG Inventory,¹⁶ and transitioning to ZEVs and deploying low-carbon fuels is critical for achieving California's climate and air quality targets.

Federal policy support plays a role in the fuels and technologies that come to California through the LCFS. The U.S. Environmental Protection Agency (U.S. EPA) implements a Renewable Fuel Standard (RFS) program (Code of Federal Regulations, title 40, part 80, sections 1100 et. Seq.) that mandates the blending of specific volumes of renewable fuels into gasoline and diesel sold in the U.S. to achieve a specified ratio for each year. As defined, "renewable fuels" under the RFS resemble the list of transportation fuels subject to the LCFS. The two policies are complementary and support a reduction in fossil fuel consumption and diversification of the fuel pool. In addition to the RFS, the Inflation Reduction Act (IRA) of 2022¹⁷ provides tax incentives and financial support for biofuel and hydrogen production. The newly created Hydrogen Production Tax Credit (45V)¹⁸ incentivizes the domestic production of clean hydrogen, which will make this emerging low-carbon fuel source more cost-competitive and help the country meet the ambitious goals of the Hydrogen Shot¹⁹, an effort to accelerate breakthroughs in hydrogen technology and cut the cost of clean hydrogen by 80% to \$1 per kilogram in one decade. This federal support represents a once-in-a-generation investment in clean fuel production and infrastructure, and California is poised to leverage the existing LCFS mechanism to bring investment to California. The LCFS also supports use of carbon capture and sequestration (CCS) in connection with transportation fuel production, and direct air capture (DAC) with carbon sequestration projects. These capital-intensive projects are also supported by the federal government through the 45Q tax credit for CCS^{20,21} and research and

¹⁶ California Air Resources Board, *Current California GHG Emission Inventory Data (2022 Edition)*. <https://ww2.arb.ca.gov/ghg-inventory-data>

¹⁷ 117th Congress, *Inflation Reduction Act of 2022*. Pub.L. No. 117-169. August 16, 2022. <https://www.congress.gov/bill/117th-congress/house-bill/5376/text>

¹⁸ The White House, *Building a Clean Energy Economy: A Guidebook to the Inflation Reduction Act's Investments in Clean Energy and Climate Action*. 74-76. January 2023. <https://www.whitehouse.gov/wp-content/uploads/2022/12/Inflation-Reduction-Act-Guidebook.pdf>

¹⁹ United States Department of Energy Office of Energy Efficiency & Renewable Energy, *Hydrogen Shot: Overview*. (Accessed on December 13, 2023). <https://www.energy.gov/eere/fuelcells/hydrogen-shot>

²⁰ Congressional Research Service, *Carbon Storage Requirements in the 45Q Tax Credit*. IF11639. June 28, 2021. <https://crsreports.congress.gov/product/pdf/IF/IF11639>

²¹ The Inflation Reduction Act of August 2022 expands and enhances the 45Q credit for CCS. Pub.L. No. 117-169 (August 16, 2022).

deployment grants from federal agencies.^{22,23} Investments in California leveraging federal support will be key to achieving the deep emissions reductions called for in AB 1279 and the 2022 Scoping Plan Update.

Like so many of CARB's innovative programs, the success of California's LCFS program is inspiring other jurisdictions to adopt their own clean fuels programs. CARB works closely with other jurisdictions that have chosen to adopt similar programs, including Oregon, Washington, and British Columbia. CARB also collaborates closely with other states and is seeing growing interest from several jurisdictions. Other jurisdictions including Japan, New Zealand, Australia, and the European Commission also continue to seek information and technical experience on the LCFS. As interest in the LCFS grows and other jurisdictions consider their own programs, CARB continues to improve efficiency and maintain program integrity to ensure that the LCFS remains an exportable policy.

C. Overview of the Proposed Amendments

This section provides a broad overview of amendments staff is proposing for adoption. Chapter II provides a more in-depth description of the purpose of the rulemaking and the problems that the proposal is intended to address. Appendix E provides a summary, purpose, and rationale for each proposed regulatory modification.

The most significant change in this proposal is to strengthen the CI reduction benchmarks both pre- and post-2030 in support of California's goal for achieving carbon neutrality by 2045 and achieving an 85% reduction in GHG emissions by 2045, as called for by AB 1279 and the 2022 Scoping Plan Update. The 2022 Scoping Plan Update, which identifies the outcomes needed to achieve carbon neutrality by 2045, was approved by the Board in December 2022. The State must accelerate the pace of clean energy and technology development, and the LCFS is one of the primary mechanisms for transforming California's transportation fuel pool with low-carbon alternatives. The benchmarks provide the basis for calculating credits for low-carbon fuels and deficits for high carbon fuels.

If adopted, the proposed amendments would require a 30% reduction in fuel CI by 2030 and a 90% reduction in fuel CI by 2045 from a 2010 baseline, as shown in the proposed CI benchmark schedule for gasoline and gasoline substitutes listed in Table 1, below, and shown in Figure 6. To accommodate rapid advances in transportation fuel production and use, the proposed amendments also include a near-term step-down and an Automatic Acceleration Mechanism (AAM). The step-down is a one-time 5% reduction in the CI benchmark in 2025 that increases the stringency of the CI target. The AAM is another tool to increase the stringency of the CI benchmark, but is activated only when specific regulatory conditions are

²² United States Department of Energy, *U.S. Department of Energy Announces \$131 Million for CCUS Technologies*. April 24, 2020. <https://www.energy.gov/articles/us-department-energy-announces-131-million-ccus-technologies>

²³ United States Department of Energy, *Funding Opportunity Announcement 2515, Carbon Capture R&D for Natural Gas and Industrial Point Sources, and Front-End Engineering Design Studies for Carbon Capture Systems at Industrial Facilities and Natural Gas Plants*. October 6, 2021. <https://www.energy.gov/fecm/articles/funding-opportunity-announcement-2515-carbon-capture-rd-natural-gas-and-industrial>

met. These triggered reductions in the CI benchmark would help bolster market stability in the event that transportation fuel decarbonization is growing rapidly and outpacing deficit generation in the program.

Table 1: Proposed Carbon Intensity Benchmarks for Gasoline and Fuels Used as a Substitute for Gasoline²⁴

Year	Average Carbon Intensity (gCO ₂ e/MJ)
2010	Reporting Only
2011	95.61
2012	95.37
2013	97.96
2014	97.96
2015	97.96
2016	96.50
2017	95.02
2018	93.55
2019	93.23
2020	91.98
2021	90.74
2022	89.50
2023	88.25
2024 ^a	87.01
2025 ^b	80.73
2026	78.50
2027	76.26
2028	74.03 ^δ
2029	71.79 ^δ
2030	69.55 ^δ

²⁴ Benchmarks for years 2011, 2013, 2016, 2019, and 2024 reflect reductions from revised base year (2010) CI values for California Reformulated Gasoline that were calculated using the CI for crude oil supplied to California refineries. For more information, see Table 1 in Appendix A.

Year	Average Carbon Intensity (gCO ₂ e/MJ)
2031	65.08 ^δ
2032	60.61 ^δ
2033	56.14 ^δ
2034	51.67 ^δ
2035	47.20 ^δ
2036	42.73 ^δ
2037	38.26 ^δ
2038	33.78 ^δ
2039	29.31 ^δ
2040	24.84 ^δ
2041	21.86 ^δ
2042	18.88 ^δ
2043	15.90 ^δ
2044	12.92 ^δ
2045	9.94 ^δ

^a The benchmark for years 2024 through 2045 reflect reductions from revised base year (2010) CI Values for CaRFG (99.15).

^b The benchmark schedule in 2025 has been updated to include a 5% increase in stringency, achieving an 18.75% CI reduction compared to the 13.75% CI reduction specified in the 2018 adopted regulation.

^δ These CI targets may be accelerated by the Automatic Acceleration Mechanism based on the regulatory criteria specified in section 95484(b) in the proposed Regulation Order (Appendix A).

The process for determining the annual carbon intensity benchmarks is detailed in Chapter VIII and Appendix C-1. Other proposed changes are identified in Table 2 below and include eliminating the current LCFS exemption for intrastate fossil jet fuel starting in 2028, expanding ZEV infrastructure crediting to the medium- and heavy-duty (MHD) sector, and adding hydrogen-based and electricity-based transaction types to be included in the third-party verification program for data reported under LCFS.

Additionally, amendments are proposed to further streamline existing requirements of the LCFS regulation and to update program tools and data.

Table 2 provides a summary of the proposed changes to the regulation. Staff began conceptually discussing many of these items through public workshops initiated in October of 2020, hosting nine workshops and two community meetings through August 2023. The pre-rulemaking public process is detailed in Chapter XI.

Table 2: Summary of Proposed Regulatory Amendments to the LCFS Regulation

Topic	Proposed Regulatory Updates
General	<p>Minor updates for typographical errors and specifications that do not materially affect requirements</p> <p>Update terminology for Data Management System</p>
Compliance, Program Benchmarks, and Credit Generation	<p>Strengthen the carbon intensity benchmarks both pre- and post-2030</p> <p>Include a step-down of the CI benchmark in 2025 and a mechanism to automatically strengthen the carbon intensity benchmarks based on defined market conditions</p> <p>Eliminate exemption for intrastate fossil jet fuel, beginning in 2028</p> <p>Modify crediting potential for zero-emission forklifts with lift capacities less than 12,000 lbs</p> <p>Allow all fuels to be added to buffer account, instead of only liquid fuels</p>
Equity-Focused Improvements	<p>Focus and increase investment requirements of residential base credit proceeds in ways that provide benefits for disadvantaged, low-income, rural, and tribal communities</p> <p>Extend and focus ZEV infrastructure crediting for light-duty vehicles in disadvantaged, low-income communities, or rural communities</p> <p>Expand ZEV infrastructure crediting to the medium- and heavy-duty sector to support ZEV infrastructure needed for medium- and heavy-duty ZEVs operating in heavily-impacted freight corridors</p>
Entities and Eligibility	<p>Include Multi-Family residences as Non-Residential</p> <p>Modify definition of fuel supply equipment (FSE) for electric transport refrigeration units</p>
Fuel Pathway Applications and CI Determination	<p>Update LCA modeling tools and emission factors</p> <p>Include a Tier 1 Calculator for hydrogen</p> <p>For projects breaking ground after December 31, 2029, add deliverability requirement for pipeline-injected biomethane and phase out pathways for avoided methane crediting by 2040 for biomethane used for transportation and 2045 for biomethane used for hydrogen production</p> <p>Add provisions for indirect accounting of low-CI hydrogen injected into hydrogen pipelines</p> <p>Add sustainability requirements for crop- and forestry- based feedstocks</p>

Topic	Proposed Regulatory Updates
Petroleum and Project-Based Credits	<p>Update crude oil Lookup Table</p> <p>Update the Oil Production Greenhouse Gas Emission Estimator (OPGEE) Model and process for future updates</p> <p>Phase out petroleum project credit generation by 2040</p> <p>Specify that direct air capture projects must be located in the United States to generate LCFS credits</p>
Verification Program	<p>Add third-party verification for hydrogen and electricity data types and deferral threshold considerations</p> <p>Require third-party validation of all applications for project-based crediting.</p> <p>Update deferral eligibility requirements to clarify that joint applicants are not eligible to defer verification</p> <p>Include meter calibration requirements for project and pathway applications</p>

II. The Problem that the Proposal is Intended to Address

In order to implement the 2022 Scoping Plan Update, California needs to reduce emissions by driving down fossil fuel demand in transportation, transitioning to zero-emission technology wherever feasible, and increasing the supply of low-carbon alternative fuels as quickly as possible. In this chapter, staff provides a description of the purpose of this rulemaking and how the proposed amendments to the LCFS support the State's climate and air quality targets. A description, purpose, and rationale for each of the proposed updates and revisions are provided in Appendix E.

To implement these objectives, staff is proposing a suite of amendments to the regulation to:

- Improve California's long-term ability to support the production and use of increasingly lower-CI transportation fuels and to improve the program's overall effectiveness;
- Update the annual carbon intensity benchmarks through 2030 and establish more stringent post-2030 benchmarks in alignment with the 2022 Scoping Plan Update;
- Increase the flexibility of the program to adjust for potential future market overperformance by including a mechanism that would automatically accelerate the compliance targets under certain conditions;
- Include a step-down in the near-term CI target to further support ambition;
- Incentivize fuel production and refueling infrastructure buildout needed to meet California's long-term climate goals and reduce dependence on petroleum fuels, including opportunities to leverage federal funding for low-carbon hydrogen production and ZEV fueling, and support the transition of biomethane fuel pathways for combustion out of transportation;
- Update standard values in the regulation, including emission factors, as well as life cycle assessment (LCA) modeling tools to use more detailed or recent data;
- Streamline implementation of the program; and
- Make minor updates for typographical errors and clarifying specifications.

A. Strengthen the Annual Carbon Intensity Benchmarks Pre- and Post-2030

Staff last revisited the annual carbon intensity benchmarks in 2018, following the approval of the 2017 Scoping Plan Update, which focused on achieving the 2030 SB 32 GHG reduction target. Through the 2018 rulemaking, the Board extended the carbon intensity benchmarks from a 10% reduction in 2020 to a 20% reduction in 2030 to align with SB 32 and the 2017 Scoping Plan Update. The climate policy landscape has continued to evolve since the 2018 rulemaking. In 2022, the Governor signed AB 1279, which requires an 85% reduction in anthropogenic GHG emissions below 1990 levels by 2045. The 2022 Scoping Plan Update lays out a path to achieve these targets and achieve carbon neutrality by 2045. Staff is proposing to update the LCFS program in response to current legislative direction and the 2022 Scoping Plan Update. Along with this high-level policy direction and technology-forcing emission standards and other policies adopted by the Board, low-carbon technology uptake is accelerating. Renewable diesel capacity has grown substantially and far exceeds what was previously modeled in 2018 when the current CI benchmarks were established. Electricity and hydrogen used as vehicle fuels have increased over 50% between 2019 and 2022 and are far outpacing the projections staff used to establish the existing CI benchmarks during the

previous 2018 rulemaking. This trend is expected to continue, as California implements the ACC II, ACT, ACF, Innovative Clean Transit, Cargo Handling Equipment, Ocean Going Vessels at Berth, Clean Miles Standard, Transport Refrigeration Unit, and In-use Locomotive regulations.

There is also much progress in the liquid and gaseous alternative fuel spaces. Biofuel production capacity has increased substantially in recent years, with many announcements nationwide and in California for new or expanded capacity. Momentum for alternative fuels is growing at the national level, as well. Biomethane supplies have also increased as more methane capture projects are developed.

Taken together, these trends suggest that the market is outpacing previous fuels and crediting projections used for the 2018 LCFS benchmark modeling and that re-evaluation of near-term targets is needed to accelerate action and plan beyond 2030. Staff recommends strengthening the pre- and post-2030 carbon intensity benchmarks to accelerate GHG reductions in transportation fuel. As part of this overall strengthening of the benchmarks, staff also recommends a near-term step-down of the 2025 benchmark and an acceleration mechanism to adjust the CI benchmarks if market conditions warrant.

Achieving California's mid- and long-term GHG and air quality goals will require a portfolio of low-carbon transportation fuels in amounts well beyond the current amounts. The transportation sector remains the largest contributing source of GHG emissions in the State inventory. The LCFS has been an effective measure for increasing the use of low-carbon alternatives to fossil fuels in California by providing significant economic benefits to the credit-generating entities who participate in the program, including municipal transit agencies, alternative fueling facilities, equipment service providers, fuel producers, and project developers across the United States and abroad. For example, the 2020 California GHG Emissions Inventory²⁵ shows that California continues to stay below its 2020 target for emissions. The data shows a decline in emissions from transportation, supported by the LCFS, which is driving increasing use of alternative fuels in the transportation sector.

The proposed amendments are expected to reduce life cycle GHG emissions of transportation fuels consumed in California by about 558 million metric tons in carbon dioxide equivalent (MMTCO_{2e}) cumulatively from 2024 to 2046 as compared to business as usual (see Chapter IV of this Staff Report for additional discussion of the projected GHG benefits). Greater diversification of the State's fuel portfolio will also support California's ongoing efforts to improve ambient air quality by displacing demand for fossil fuels. Chapter V of this Staff Report summarizes the air quality and public health benefits of the proposed regulation.

The LCFS regulation defines a carbon intensity benchmark for each year. The current LCFS benchmark schedule was designed to help California achieve the statutory target of 40% GHG emissions reduction by 2030, in line with the 2017 Scoping Plan Update and SB 32. However, the 2022 Scoping Plan Update calls for an accelerated deployment of fuels and ZEVs in support of achieving a 48% reduction of GHGs by 2030 and 85% below 1990 levels by 2045.

²⁵ California Air Resource Board, *Latest GHG Inventory shows California remains below 2020 emissions target*. October 19, 2020. <https://ww2.arb.ca.gov/news/latest-ghg-inventory-shows-california-remains-below-2020-emissions-target>

Using market data and techno-economic models to evaluate a variety of transportation fuel pathways, staff conducted a scenario analysis that informed the pre- and post-2030 target and annual benchmarks for carbon intensity reduction through 2045. This analysis helps staff explore possible compliance outcomes and facilitates an improved understanding of LCFS economics and compliance feasibility for different policy choices in each scenario.

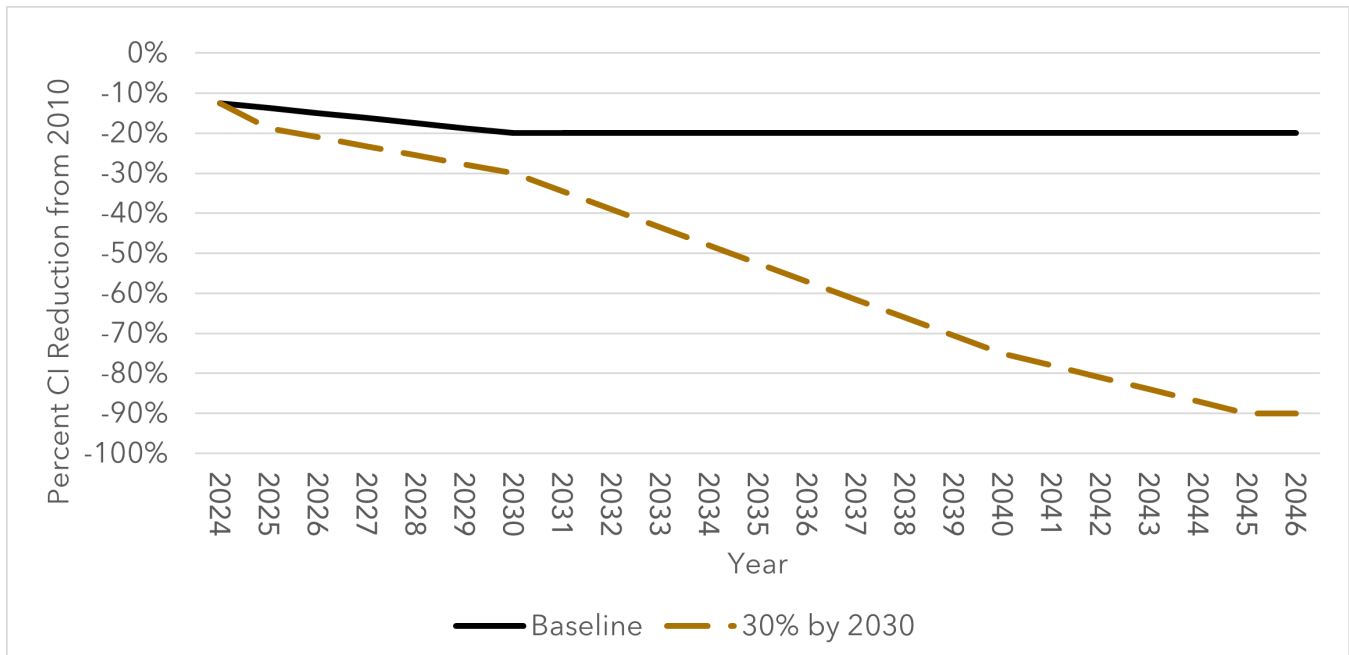
Staff developed the California Transportation Supply (CATS) model to evaluate the California fuel market and estimate an optimal fuel supply that may be delivered to California under various scenarios. Since CATS, and really no modeling tool, can fully capture all real-world conditions, the tool is primarily being used to compare results of different policy changes across the different scenarios. The CATS model is an optimization model that seeks to minimize the cost of supplying all defined fuel pools such that fuel demand constraints are met. The CATS model selects the fuel mixes likely available for California that minimize the cost of supplying all transport fuel demand in the State while meeting technology and policy constraints. The outputs from the CATS model do not constitute a forecast of credit prices, but rather how the market may evolve in response to different policy changes that may, or may not, be implemented.

The optimization model is constrained by a set of policies, technologies, and cost considerations that are intended to approximate current and future market conditions under different scenarios. Anticipated mobility demand each year is used to estimate energy demand by vehicle technology type (e.g., light-duty electric vehicle, gasoline vehicle, etc.), and the model then identifies a variety of fuel production pathways that could be optimally used to meet that demand given costs and policy considerations. Staff developed feedstock supply curves and feedstock to fuel conversion pathways for the model that are detailed in the California Transportation Supply (CATS) Model v0.2 – Technical Documentation.²⁶

Based on feedback received from stakeholders, staff evaluated a wide range of CI benchmark trajectories. Scenarios modeled both in-house by CARB and by external stakeholders indicate that a reduction of at least 30% by 2030 and 90% by 2045 is achievable and necessary to accelerate decarbonization of the transportation fuels sector and support the State's broader climate goals. Figure 6 shows staff's proposed benchmarks as compared to the benchmarks in the current regulation for the years 2024 through 2045. When considering the full period from 2024 through 2046, staff's proposal achieves 558 MMT more cumulative reductions relative to the current regulation. Chapter VIII and Appendix C-1 of this Staff Report provide additional details on the data sources and methodology that staff has relied on to evaluate feasible LCFS compliance scenarios.

²⁶ California Air Resources Board, *California Transportation Supply (CATS) Model v0.2 – Technical Documentation for August 2023 Example Scenario*. August 2023. https://ww2.arb.ca.gov/sites/default/files/2023-08/CATS%20Technical_1.pdf

Figure 6: Current and Proposed Annual Carbon Intensity Benchmarks



Additionally, the transportation fuels market is evolving quickly due to technological and economic breakthroughs, regulatory requirements, new federal incentives, and other jurisdictions implementing similar programs. This has resulted in rapid shifts in the market, particularly from rapidly growing ZEV market and conversion of fossil refineries to biofuel production, which have resulted in rapid and significant credit generation. To accommodate documented rapid advances in transportation fuel decarbonization that have already occurred, and which could occur again due to these rapid changes, the proposed amendments include both a near-term step-down in CI benchmark stringency in 2025, and an Automatic Acceleration Mechanism (AAM).

A step-down in stringency was strongly supported by feedback provided by stakeholders, particularly in response to February and May 2023 technical workshops. The step-down reflects the current effectiveness of the program, which suggests that the pace of CI reductions can be increased through the benchmarks.

Staff is proposing to include an AAM to increase the stringency of the CI benchmarks of the program when specific regulatory conditions are satisfied. Under the current staff proposal, the AAM would advance the upcoming year’s CI benchmark, and all subsequent years by one year. The acceleration mechanism provides a clear signal regarding how and when the benchmarks would be adjusted. An AAM can support the deeper transportation sector decarbonization needed through mid-century by increasing regulatory clarity for the market, acting alongside existing provisions that also help to provide program certainty, such as the maximum credit price²⁷ and the Credit Clearance Market (CCM).²⁸

²⁷ Cal. Code Regs., tit. 17, § 95487(a)(2)(D).

²⁸ Cal. Code Regs., tit. 17, § 95485(c).

An AAM would operate to potentially increase program stringency, using regulatory criteria, to accommodate documented rapid advances in transportation fuel decarbonization. An AAM would operate in a way that is predictable and easy to understand, based on publicly available data, and would bolster market stability during periods where credit generation rapidly and consistently outpaces deficit generation. Similar to maximum price and CCM provisions, an AAM would play an important role in supporting LCFS implementation, deterring market manipulation, and providing the certainty necessary for the long-term investments required to meet the State's decarbonization goals.

Staff engaged extensively with stakeholders to develop an AAM, including holding a dedicated workshop for this topic in May 2023. An AAM would only be activated by specific market conditions defined in the LCFS regulations that result in a specified imbalance in the number of credits versus deficits over a certain time period. Under staff's proposal, the AAM would be triggered when the credit bank to average quarterly deficit ratio exceeds three and credit generation exceeds deficit generation based on the prior year's reporting. If triggered, the AAM would accelerate all subsequent CI benchmarks by one year.

B. Eliminate Exemption for Intrastate Fossil Jet Fuel

Staff is proposing to eliminate the exemption for intrastate fossil jet fuel from the LCFS regulation starting in 2028. The aviation sector has historically relied on jet fuel produced from fossil fuels, and fossil jet fuel is currently exempted from generating deficits in the LCFS program. However, to achieve the deep emissions reductions called for in AB 1279 and the 2022 Scoping Plan Update, California must reduce GHG emissions from aviation.

In California, intrastate jet fuel constitutes about 10% of total jet fuel consumption and is responsible for 2% of GHG emissions in the California transportation sector. As emissions from other vehicle types decline, this percentage is expected to increase. Alternative jet fuel (AJF) production has increased since it became an eligible LCFS opt-in fuel in 2019, and with 11.6 million gallons produced in 2022. This provision would be limited to flights that take off and land within the State of California.

Momentum is growing for AJF, an alternative liquid fuel that can displace fossil jet fuel without engine modifications, along with interest in zero-emission technologies for aviation. At the federal level, a tax credit of up to \$1.25 per gallon is available to sustainable aviation fuel (SAF) producers.²⁹ In alignment with the federal support available for SAF, Governor Newsom highlighted the need to transition to low-carbon alternatives in his July 2022 letter to the CARB Chair, in which he directed CARB to adopt a 20% clean fuels target for the aviation sector.³⁰ The 2022 Scoping Plan Update anticipates a major shift away from fossil jet fuel by 2045, including 20% zero-emission aviation.

²⁹ Internal Revenue Service. *Sustainable Aviation Fuel Credit webpage*. (Updated on January 31, 2023). <https://www.irs.gov/credits-deductions/businesses/sustainable-aviation-fuel-credit>

³⁰ California Office of the Governor, *Governor's Letter to Chair Randolph*. July 22, 2022. <https://www.gov.ca.gov/wp-content/uploads/2022/07/07.22.2022-Governors-Letter-to-CARB.pdf?emrc=1054d6>

Several airlines have also announced GHG emission reduction targets, as well as multi-year agreements to source SAF for their operations. For example, United Airlines,³¹ Southwest Airlines,³² and American Airlines³³ have released plans to achieve carbon neutrality by 2050. Additionally, Alaska Airlines set new climate goals that include net-zero carbon emissions by 2040.³⁴ Finally, Delta Airlines has a goal to replace 10% of its fossil jet fuel with SAF by the end of 2030.³⁵ Production is ramping up to meet the increasing demand for low-carbon incentives. For example, multiple refineries in California are transitioning their existing facilities to produce bio-based alternative fuels, including AJF. AJF is a viable low-carbon alternative that can further reduce aviation carbon dioxide emissions and currently generates credits in the LCFS program. Adding fossil jet fuel as a required fuel under the program will build on the momentum in the aviation industry.

C. Expand Zero Emission Vehicle Infrastructure Crediting

During the 2018 rulemaking, the Board adopted the HRI and FCI provisions. These two crediting opportunities were designed to incentivize zero-emission light-duty vehicle (LDV) refueling infrastructure ahead of anticipated ZEV demand. The intent of these provisions was to help remove the “chicken-and-egg” issue of vehicle demand waiting on refueling development, and refueling infrastructure waiting on vehicle demand, by incentivizing rapid buildout of public refueling infrastructure. Dispensed fuel receives crediting in the LCFS, and these provisions added crediting for unused capacity at approved stations. The provisions have supported the buildout of dozens of hydrogen stations and thousands of fast chargers in California and play a key role in supporting the overall transition to ZEV technology, driven in large part by the ACC II regulation. New applications for these crediting provisions sunset at the end of 2025.

Staff is proposing amendments to expand the current ZEV infrastructure crediting provisions by adding crediting for MHD infrastructure and extending the LD crediting. As the State transitions to widespread ZEV deployment, it is imperative that all individuals in the State have access to cleaner technologies. Therefore, staff is proposing to continue the HRI and FCI incentivization for light-duty vehicle refueling in low-income, rural, or disadvantaged communities. This focused eligibility requirement aligns with identified priorities in the Clean Transportation Incentives Funding Plan³⁶, which provides funding for ZEVs deployed in these regions. Staff is also proposing to allow new light-duty FCI (LD-FCI) applications be located

³¹ United Airlines, *Our sustainable aviation fuel program*. (Accessed on October 10, 2023). <https://www.united.com/en/us/fly/company/responsibility/sustainable-aviation-fuel.html>

³² Southwest Airlines, *Environmentally Sustainable Goals*. (Accessed on October 10, 2023). <https://www.southwest.com/citizenship/planet/>

³³ American Airlines, *Pathway to net zero*. (Accessed on October 10, 2023). <https://news.aa.com/esg/climate-change/pathway-to-net-zero/>

³⁴ Alaska Airlines, *Flying with Purpose: Alaska Sets New Climate Goals, Including Net-zero carbon Emission by 2040*. April 21, 2021. <https://news.alaskaair.com/sustainability/alaska-airlines-net-zero-carbon-goals/>

³⁵ Delta Airlines, *Committed to Sustainability*. (Accessed November 22, 2023). <https://www.delta.com/us/en/about-delta/sustainability>

³⁶ California Air Resources Board, *Proposed Fiscal Year 2023-24 Funding Plan for Clean Transportation Incentives*. 59-60. October 6, 2023. <https://ww2.arb.ca.gov/sites/default/files/2023-10/Proposed%20Funding%20Plan%20Fiscal%20Year%202023-24.pdf>

more than 10 miles away from the nearest fast charger to help fill refueling gaps in the State. These provisions are designed to accelerate deployment of ZEV infrastructure in regions that support equitable access to low-carbon technology. The provisions would be limited to 0.5% each of deficits from the prior quarter.

California's ZEV goals are not limited to LDVs. The Innovative Clean Transit,³⁷ Advanced Clean Truck,³⁸ and Advanced Clean Fleet³⁹ rules, which have all been adopted since 2018, along with the Clean Truck Partnership,⁴⁰ will drive a rapid transformation to ZEV technology in the MHD sector in the very near future. As noted earlier, transitioning to ZEVs is critical for achieving California's climate and air quality targets, and California's path is established in the ACT and ACF regulations and the Clean Truck Partnership. Incentivizing early build-out of ZEV infrastructure will support the transition to MHD ZEVs required by the ACF regulation. ACF fleet turnovers begin in 2024 and transition drayage fleets to ZEV technology the fastest of any vocation, but this transition is contingent upon availability of refueling infrastructure for successful operation of these vehicles. Staff expects that LCFS support for ZEV truck refueling infrastructure will help provide significant air quality improvements to communities adjacent to major ports, distribution centers, and freight corridors.

To achieve fleet turnovers within this timeframe, refueling infrastructure suitable for MHD trucks must be available to maintain operations and provide certainty of fueling availability to truck and fleet owners. Staff is, therefore, proposing to create a version of the HRI and FCI provisions that incentivize MHD ZEV refueling infrastructure during the early years when refueling demand is low. Similar to the light-duty (LD) provisions, the MHD provisions will provide LCFS credits for the unused refueling capacity at eligible stations and sites, which will naturally phase out as more vehicles become operational and vehicle refueling demand increases. LCFS ZEV fueling infrastructure credits for the MHD sector will play a key role in supporting California's ZEV goals, and in particular the technology transition under the ACF regulation. Staff is proposing that MHD-HRI and MHD-FCI infrastructure must be sited within one mile of a ready or pending Federal Highway Administration Alternative Fuel Corridor—for hydrogen or electricity, respectively—where the majority of truck refueling is expected to occur, or adjacent to existing truck parking, to accommodate overnight charging. Locating ZEV refueling stations within one mile of major freight corridors and at existing truck parking is

³⁷ California Air Resources Board, *Innovative Clean Transit*. (Accessed on October 10, 2023).

<https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit>

³⁸ California Air Resources Board, *Advanced Clean Trucks webpage*. (Accessed on October 10, 2023).

<https://ww2.arb.ca.gov/our-work/programs/advanced-clean-trucks>

³⁹ California Air Resources Board, *Advanced Clean Fleet webpage*. (Accessed on October 10, 2023).

<https://ww2.arb.ca.gov/our-work/programs/advanced-clean-fleets>

⁴⁰ California Air Resources Board, *CARB and truck and engine manufacturers announce unprecedented partnership to meet clean air goals*. July 6, 2023. <https://ww2.arb.ca.gov/news/carb-and-truck-and-engine-manufacturers-announce-unprecedented-partnership-meet-clean-air>

expected to bring cleaner air for communities living adjacent to these areas currently heavily impacted by diesel truck pollution.^{41,42}

Unlike the existing LD-HRI and LD-FCI provisions, which support only public infrastructure, staff is proposing to extend eligibility for the MHD-HRI and MHD-FCI provisions to private infrastructure as well. Staff focused on public infrastructure for the existing LD infrastructure crediting provisions because the LD market lacked a robust publicly available refueling network. The MHD sector is fundamentally different and needs significant support to meet the refueling needs of both trucks utilizing public refueling infrastructure and private fleet refueling. Truck fleets rely heavily on both public and private refueling based on the duty cycles and vocations of the vehicles. Stakeholders have expressed that private refueling should also receive an incentive from the MHD infrastructure crediting provisions to support the early capital costs of installing ZEV refueling infrastructure. Private infrastructure has the advantage of being designed for a known refueling demand and can be sized accordingly to minimize costs, but still faces steep initial costs associated with the initial buildout of the infrastructure. In addition, fleets may transition their vehicles to ZE technology over the course of several years and will likely need support during the interim years while their fleet ramps up to the full capacity the refueling infrastructure was designed for. Due to the different levels of support needed for private refueling infrastructure compared to the public infrastructure without a known refueling demand, staff is proposing to provide half as many credits for private refueling infrastructure as public per charger or station. As with the existing infrastructure crediting provisions, staff is proposing to limit total credits available to the charging and hydrogen refueling provisions to 2.5% of prior quarter deficits, to provide a sufficient incentive without inflating overall credit supply.

D. Biomethane Crediting

Methane is a harmful short-lived climate pollutant (SLCP) that has an outsized impact on climate change in the near term. The United Nations Environment Programme's Global Methane Assessment⁴³ advises that achieving the least-cost pathways to limit warming to 1.5°C requires global methane emission reductions of 40% to 45% by 2030 alongside substantial simultaneous reductions of all climate forcers, including CO₂ and SLCPs. Action to reduce these powerful emissions sources today will provide immediate benefits—both to human health locally and to reduce warming globally—as the effects of our policies to transition to low-carbon energy systems and achieve carbon neutrality further unfold.

Biomethane⁴⁴ has played a role in contributing to the overall decrease in carbon intensity of the transportation fuel pool. With support from the LCFS and Renewable Fuel Standard (RFS)

⁴¹ California Office of Environmental Health Hazard Assessment, *Impacts of Greenhouse Gas Emission Limits Within Disadvantaged Communities: Progress Toward Reducing Inequities*. February 2022.

<https://oehha.ca.gov/media/downloads/environmental-justice/impactsofghgpoliciesreport020322.pdf>

⁴² California Office of Environmental Health Hazard and Assessment, *CalEnviroScreen 4.0*. (Updated October 2021). <https://oehha.ca.gov/calenviroscreen/report/calenviroscreen-40>

⁴³ United Nations Environment Programme and Climate and Clean Air Coalition, *Global Methane Assessment: Benefits and Costs of Mitigating Methane Emissions. Summary for Policymakers*. 2021.

https://wedocs.unep.org/bitstream/handle/20.500.11822/35917/GMA_ES.pdf

⁴⁴ When methane is derived from biogas, it is referred to as biomethane.

programs, in 2022 compressed natural gas (CNG) represented 5% of total MHD fuel demand and renewable natural gas (RNG) was 97% of the CNG fueling in California.⁴⁵ However, CNG transportation fuel demand is only about 3% of overall natural gas demand in California, and achieving deep GHG reductions will have to include displacing fossil gas in sectors of the economy beyond transportation.⁴⁶ Capturing methane from California's methane sources (e.g., landfills, dairies, and wastewater) is critical for achieving California's climate targets, including the targets identified by SB 32, SB 1383, and AB 1279. The 2022 Scoping Plan Update reinforces the message that while there is clearly a role for biomethane in decarbonizing California's energy use in the long term (particularly as a feedstock for renewable hydrogen production), biomethane used as an end-use vehicle fuel will decline as ZEVs penetrate the market, and this resource should be transitioned to other sectors. Biomethane can play a key role in decarbonizing stationary sources or other energy applications, and the 2022 Scoping Plan Update identifies additional end uses in the industrial, commercial, and residential sectors; production of hydrogen; and electricity generation by displacing the need for fossil gas. For the fuel to transition to other sectors in the long term, the existing market signals will need to transition accordingly to avoid stranded assets and the closure of methane capture projects. With this background, staff is proposing changes for pathways related to biomethane as a transportation fuel under the LCFS program. These changes would continue to incentivize the methane reductions needed in the next decade, while aligning with the 2022 Scoping Plan Update to shift biomethane to the production of renewable hydrogen or for use in other sectors by 2045.

Phase Out of Pathways for Biomethane Combustion Crediting

For projects that break ground after December 31, 2029, staff is proposing to phase out pathways for crediting biomethane used in CNG vehicles after December 31, 2040. Pathways for biomethane used to produce renewable hydrogen would be eligible to receive credits until December 31, 2045. This concept aligns with the overall transition to non-combustion transportation technology highlighted in the 2022 Scoping Plan Update, as well as the shifting of biomethane resources to hydrogen production. In addition, staff is proposing two other mechanisms related to biomethane used as a transportation fuel, highlighted below.

Pathways for Avoided Methane Crediting

For projects that break ground after December 31, 2029, staff is proposing that pathways for avoided methane crediting be available through 2040 for biomethane used as a transportation fuel, and through 2045 for biomethane used to produce hydrogen.

Deliverability Requirements

Currently, the LCFS regulation allows for indirect accounting of biomethane when injected into the North American natural gas pipeline. In 2022, a total of about 153 MMBtu of RNG was

⁴⁵ California Air Resources Board, *LCFS Quarterly Data Spreadsheet*. (Updated on July 31, 2023). <https://ww2.arb.ca.gov/resources/documents/lcfs-data-dashboard>

⁴⁶ California Air Resources Board, *Advanced Clean Fleets Resolution 23-13*. April 27, 2023. <https://ww2.arb.ca.gov/sites/default/files/barcu/board/res/2023/res23-13.pdf>

reported to the LCFS for credit generation, with the majority coming from RNG resources injected into the North American natural gas pipeline outside of California.

Adding a deliverability requirement would help to ensure that California is making progress on the State's methane reduction targets.⁴⁷ For projects that break ground after Dec 31, 2029, staff is proposing to require deliverability starting January 1, 2041 for pathways that include biomethane used in CNG vehicles or starting January 1, 2046 for biomethane used as an input to hydrogen production. In particular, staff proposes to align with the deliverability policy for biomethane in the California Energy Commission's Renewables Portfolio Standard (RPS) program (Public Utilities Code section 399.12.6) and the California Public Utilities Commission 1440 program. Specifically, the concept is to require demonstration that eligible biomethane is carried through common carrier pipelines that physically flow within California or toward end use in California. Such pipelines must flow toward California 50% of the time on an annual basis, as defined by the current RPS eligibility guidebook.^{48,49} This requirement encourages and rewards reducing methane emissions by injecting biomethane that displaces existing natural gas use in California, rather than rewarding biomethane outside of California that does not displace existing natural gas use in California or have any other connection to California. Biomethane fuel pathways that break ground before January 1, 2030 would not be subject to the deliverability requirements, which would encourage rapid buildout of biomethane capture projects this decade and supports the need to reduce methane emissions. The proposed deliverability requirements also would not apply to biomethane matched to hydrogen fuel pathways participating in the LCFS program.

E. Project-Based Crediting

The 2022 Scoping Plan Update identifies a general trend away from fossil fuel consumption in California and highlights the need to invest in low-carbon fuels to replace petroleum consumption in transportation. However, this transition will not happen overnight, and California must continue to reduce emissions from existing legacy fuel production facilities in the near term while fossil fuel demand persists. Staff is proposing changes to the project-based crediting provisions to align with the 2022 Scoping Plan Update to reduce GHG emissions across the economy while recognizing the broader trend away from fossil fuel production in tandem with demand.

Phase Out of Petroleum Project Crediting

Staff is proposing to phase out crediting of petroleum projects by 2040. The program currently supports projects for credit generation from crude using innovative methods, low-complexity/low-energy-use refineries, refinery investment, and renewable hydrogen refinery investment. Staff's proposal to phase out crediting of these projects by 2040 is consistent with projected reductions in demand for petroleum fuels, while also recognizing

⁴⁷ Only methane emissions occurring within California are included in the State's GHG inventory.

⁴⁸ California Energy Commission, *Renewables Portfolio Standard Eligibility Guidebook, Ninth Edition*. Publication Number: CEC-300-2016-006-ED9-CMF-REV. 9-10. January 2017.

<https://efiling.energy.ca.gov/getdocument.aspx?tn=217317>

⁴⁹ Staff is not proposing to include the requirement in the RPS eligibility guidebook to demonstrate direct environmental benefits to California as part of this amendment.

verifiable GHG reductions at existing fuel production facilities. Carbon capture and sequestration (CCS) projects are highlighted as an important strategy in the 2022 Scoping Plan Update for achieving the AB 1279 targets, and staff proposes to exclude them from this phase-out proposal.

Incorporate Location Requirements for Direct Air Capture Projects

Staff is proposing updates to the treatment of DAC with sequestration projects. In the 2018 rulemaking, the LCFS program made DAC with sequestration eligible for project-based CCS credits. DAC is an emerging technology that has the potential to remove large amounts of CO₂ already in the atmosphere and could aid in achieving California's long-term climate goals. It will continue to need support to be built to scale and to be deployed more broadly.

In an effort to align with federal incentives being provided for DAC projects, and to support the ongoing technology development needed to reduce future DAC deployment costs, staff is proposing to limit LCFS credit generation eligibility of DAC with sequestration projects to those located in the United States. This proposal better supports national efforts to deploy DAC projects and helps achieve national and State emission reduction goals. This limitation would not apply to DAC-to-fuel applications submitted as Tier 2 alternative fuel pathways, as the final fuels from these pathways must be supplied to California to be eligible for LCFS credits.

F. Crop-Based Biofuels Sustainability Criteria

In recognition that demand for crop-based biofuels can indirectly cause land use change globally, the LCFS regulation currently accounts for land use change emissions associated with crop-based biofuels assuming they are grown on pre-existing agricultural land. The LCFS regulation uses land use change emissions estimates by feedstock which were last assessed between 2013-2015 through an extensive expert workgroup. The existing regulatory provisions make fuel pathways from crop-based feedstocks more carbon intensive and disincentivizes sourcing biofuel feedstocks from crops with higher land-use change risks. The inclusion of land use change emissions in LCFS life cycle methodologies result in stronger incentives for waste-and-residue-based feedstocks, which are not associated with land use change impacts, relative to crops. As a result, the majority of biomass-based diesel in the LCFS has historically come from waste feedstocks like used cooking oil, animal fat and inedible distiller's corn oil. The same general trend holds true for sustainable aviation fuel, which utilizes the same feedstocks as biomass-based diesel. While the majority of biomass-based diesel is still derived from waste oil, the use of crop-derived, biomass-based diesel has increased in recent years. Additionally, the CI impact of direct land conversion is not currently assessed in LCFS pathways, commodity feedstocks are not tracked to their points of origin, and there is no prohibition on bringing new land into agricultural production in order to grow biofuel feedstocks. A rapid increase in oil crop demand for biofuel production could potentially add pressure to convert forested land or other land types into biofuel crop production.

To reduce the risk that rapid expansion of biofuel production and biofuel feedstock demand could result in deforestation or adverse land use change, CARB staff are proposing additional guardrails on the use of crop-based feedstocks for biofuel production. Specifically, CARB staff are proposing to require pathway holders to track crop-based and forestry-based feedstocks to their point of origin and require independent feedstock certification to ensure feedstocks are not contributing to impacts on other carbon stocks like forests. CARB staff are also proposing to remove palm-derived fuels from eligibility for credit generation, given palm oil has been

demonstrated to have the highest risk of being sourced from deforested areas.⁵⁰ Palm-derived fuel transactions have not been reported under the program or received any credits to-date.

G. Other Proposed Amendments

Additional proposed changes are summarized in Table 2 and detailed in Appendix E. Some of these changes serve to align with State goals and the 2022 Scoping Plan Update, namely modifying crediting potential for zero-emission forklifts and allowing indirect accounting for low-CI hydrogen injected into hydrogen pipelines. Other changes serve to simplify and streamline application and reporting requirements to encourage greater participation and improve administrative efficiency.

Electric Forklifts

As mentioned earlier, California is rapidly transitioning to ZEV technology in the transportation sector. In addition to on-road vehicles, this goal also applies to off-road equipment, including electric forklifts. The LCFS program has a role to play in implementing the ZEV turnover goals in Executive Order N-79-20. Given the scale of equipment turnover and technological transformation needed to achieve the State's goals, LCFS credits should be used in end-uses that need the most additional support to transition away from fossil fuel consumption. As part of this evaluation to understand where the transition is necessary for the forklift fleet, staff has re-evaluated the forklift baseline.

Battery-electric forklifts have been eligible for LCFS credit generation since the 2015 readoption. Much of the forklift inventory in the State has successfully transitioned to non-combustion technology, in line with State goals. This success story provides an opportunity for the LCFS program to re-evaluate the level of crediting appropriate for battery-electric forklifts. Accordingly, staff is revising the baseline for battery-electric forklifts by incorporating the 2010 status of forklift electrification into the baseline, and is proposing a 50% reduction in the Energy Economy Ratio for zero-emission forklifts with lift capacities less than 12,000 lbs. However, since larger forklifts were 100% fossil in the baseline, forklifts with lift capacities greater than 12,000 lbs. would remain at the established forklift Energy Economy Ratio.

Additionally, staff is proposing removing the estimation methodology used for reporting electricity for forklifts and requiring direct metering for all transactions. The requirement for

⁵⁰ European Commission, *Report from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on the status of production expansion of relevant food and feed crops worldwide*. Brussels. March 13, 2019. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52019DC0142>

European Commission, *Annexes to the Report from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on the status of production expansion of relevant food and feed crops worldwide*. Annexes 1 to 2. Brussels. March 13, 2019.

Searle, S., *Defining Low and High Indirect Land-Use Change Biofuels in European Union Policy*. The International Council on Clean Transportation. November 2018.

<https://theicct.org/sites/default/files/High%20low%20LUC%20Fact%20Sheet%2020181113.pdf>

metering will improve data accuracy and enable transactions verification while also aligning forklift reporting with all other reported electricity crediting.

Allow Indirect Accounting for Low Carbon Intensity Hydrogen Injected into Hydrogen Pipelines physically connected to California and Expansion of Indirect Accounting for Low Carbon Intensity Electricity for Hydrogen Utilized as a Transportation Fuel.

The 2022 Scoping Plan Update calls for a significant increase in the production of low-carbon hydrogen to displace fossil fuels. The Scoping Plan scenario projects a significant growth of renewable and low-CI hydrogen production, particularly for its use as a transportation fuel and for hard-to-electrify end uses. Given the nascent market and federal incentives to scale production, staff is proposing book-and-claim of low-CI hydrogen to support the 2022 Scoping Plan Update energy transition goal by overcoming bottlenecks in hydrogen production and supply. Currently, low-CI hydrogen must be physically delivered to its end-use for purposes of LCFS accounting. This provision was included before the 2022 Scoping Plan Update was completed, which showed the need for significant increased demand for this fuel in the transportation sector and the additional infrastructure necessary to produce and deliver hydrogen fuel. This framework is impractical for large-scale production of low-CI hydrogen that is sent to several off-takers through shared hydrogen pipelines. Book-and-claim of pipeline-injected hydrogen increases the flexibility of the program by allowing matching of low-CI hydrogen to transportation end uses, including use as a vehicle fuel for hydrogen fuel cell electric vehicles, and hydrogen used in the production of low-carbon transportation fuels such as renewable diesel and AJF. Staff proposes to expand the existing book-and-claim provisions to include low-CI hydrogen injected into the pipeline network that is physically connected to California to be credited under the LCFS as a transportation fuel or to produce alternative fuel for transportation. Staff will evaluate the need to remove book-and-claim for hydrogen in future rulemakings as the renewable hydrogen market matures.

In order to leverage available federal incentives and ensure the program is supporting low-carbon hydrogen, staff is proposing to align book-and-claim eligibility with the hydrogen production incentive eligibility under the Inflation Reduction Act. Specifically, staff is proposing well-to-wheel CI thresholds of less than or equal to 55 g/MJ for gaseous hydrogen and less than or equal to 95 g/MJ for liquid hydrogen. Staff is proposing to exclude hydrogen derived from fossil gas from book-and-claim eligibility unless low CI hydrogen is produced using book and claim of biomethane or with CCS and used as a transportation fuel.

In further support for low CI hydrogen production, staff is proposing allowing for dedicated power purchase agreements (PPAs) for low CI electricity to be used to indirectly match to lower the emissions intensity for both process electricity as well as for hydrogen production. The use of PPAs for this purpose is limited to hydrogen utilized as a transportation fuel. The low CI electricity must be new or expanded capacity, must be delivered to the local balancing authority where the hydrogen is produced, and must be matched on a quarterly basis. These requirements will help ensure against resource shuffling where existing renewable electricity is potentially redirected to hydrogen production and backfilled with non-zero electricity.

Other Amendments

A number of amendments are proposed to simplify and streamline application and reporting requirements in order to encourage greater participation and improve administrative efficiency. For example, the LCFS currently incorporates by reference Tier 1 CI Calculators designed to

streamline the fuel pathway application review and validation process for pathway types for which CARB staff have extensive experience evaluating. These calculators have predefined input fields for entering site-specific data and well-defined CI calculations. Staff is proposing to update the existing Tier 1 calculators to make them more user-friendly by streamlining inputs, updating emission factors, and changing the layout of the calculators. Staff also proposes to create a new Tier 1 CI calculator for hydrogen. The LCFS regulation also contains Temporary and Lookup Table pathways with fixed carbon intensity values that streamline participation for certain fuels. Using data gained from certifying hundreds of fuel pathways since the 2018 rulemaking, staff proposes to make revisions to the list of temporary pathways contained in Table 8 of the regulation. Staff is proposing to update the Lookup Table CI values for the following fuel pathways:

- California Reformulated Gasoline Blendstocks for Oxygenate Blending (CARBOB),
- Ultra Low Sulfur Diesel (ULSD),
- Compressed Natural Gas,
- Propane, and
- California Grid Electricity.

Additionally, staff is proposing to allow hydrogen production facilities (including renewable hydrogen) not co-located with refineries but supplying hydrogen directly to the refineries to implement eligible GHG reduction projects. Staff is also proposing to streamline reporting requirements to allow quarterly or annual submission of project reports, as is currently permitted for Refinery Investment Projects and Renewable Hydrogen Refinery Credit Projects. In addition, staff is proposing to update the displacement emission factor for innovative crude projects using solar electricity to align with the updated Emissions & Generation Resource Integrated Database (eGRID) emission factor for California grid electricity, for consistency with the treatment of electricity as a process energy for other fuel pathways.

Successful greenhouse gas reduction programs require a system to monitor, report, and verify data to maintain the integrity of the reduction program. Currently, the LCFS supplements the existing work of CARB staff with a verification system that requires regulated entities of certain credit generating types to retain the services of independent third-party verifiers. Fuel pathways are currently validated by third-party verifiers prior to CARB approval, and staff is proposing to apply this requirement to project-based crediting applications as well to align and streamline the approach between the two provisions with the accompanying benefits of validation for project-based crediting applications. Additionally, staff is proposing to align the verification requirements for electricity crediting types with other verification provisions. With the expected expansion of electrification in the transportation sector, staff is proposing to add verification requirements, which would newly require entities to verify their annual reports for the following transaction types:

- EV Charging Transaction Types;
- Electric Transport Refrigeration Units (eTRU), Electric Cargo Handling Equipment (eCHE), and Electric Power for Ocean-going Vessel (eOGV) Fueling;
- Forklift Electricity/Hydrogen Fueling;
- Fixed Guideway Electricity Fueling; and
- Fuel Cell Vehicle (FCV) Fueling transaction types, not limited to hydrogen from book-and-claim biomethane.

The current regulation requires CARB to regularly update the OPGEE Model and the Crude Lookup Table. CARB held two workshops in 2021 and 2022 to request feedback on the updated OPGEE model to the public. The model was subsequently updated based on stakeholder feedback and staff recently finalized the OPGEE model update. Staff used the updated OPGEE model to update the 2010 baseline crude CI, as well as the Crude Lookup Table, and proposes to incorporate the latest OPGEE model by reference into the regulation.

Staff is also proposing changes to the allocation and uses of base credits representing non-metered residential EV charging. The scope of these changes include:

- Changing the scope of the statewide Clean Fuel Reward from a light-duty rebate to a medium and heavy-duty rebate;
- Altering the minimum base credit contribution required to fund the Clean Fuel Reward along with the specific utility requirements for funding the program;
- Expanding the proportion of credit proceeds required to be invested in disadvantaged, low-income, rural, and tribal communities (holdback equity credits); and
- Enhancing the pre-approved projects eligible for funding of holdback equity credits.

The Clean Fuel Reward will change from a universal new light-duty EV rebate to be focused on new and used rebates for medium- and heavy-duty trucks that are exempted from the Advanced Clean Fleets regulation. This rebate will jumpstart the transition for a harder to transition segment of the truck sector that is not otherwise covered by other CARB regulations. The proportion of residential base credits will change to reflect this change in rebate from 60% of total base credits to 40% with a corresponding increase in “holdback credits.” As a result of this increase in holdback credits, staff is proposing increasing the requirements for investments in equity communities for the IOUs to 75% (from 50%) to match the requirements set by the Public Utilities Commission. Staff is also proposing new pre-approved categories for investment of holdback equity proceeds.

III. The Specific Purpose and Rationale of Each Adoption, Amendment, or Repeal

California Government Code section 11346.2(b)(1) requires a description of the specific purpose for each proposed adoption, or amendment, the problem the agency intends to address with the proposed LCFS regulation, and the rationale for determining that each proposed adoption and amendment is reasonably necessary to both carry out the purposes of CARB staff's proposed LCFS regulation and to address the problems for which it is proposed.

The overarching purpose of the proposed LCFS regulation is to decarbonize transportation through increasing the supply of low-carbon alternative fuels. The problems that LCFS needs to address are described above in Chapter II. Appendix E: Purpose and Rationale for LCFS Amendments presents the summary of each proposed amendment and describes its purpose and rationale for its role in increasing low-carbon alternative fuel supply.

IV. Benefits Anticipated from the Regulatory Action, Including the Benefits or Goals Provided in the Authorizing Statute

CARB anticipates that the proposed amendments will have the following general benefits to California businesses and individuals:

- Reduced GHG emissions near and long-term. The LCFS is specifically designed to reduce GHG emissions in the transportation sector, which is responsible for nearly half of GHG emissions in California. This will contribute to California's efforts to address climate change.
- Increased use of lower CI fuels and alternative fueled vehicles including renewable diesel, biomethane, and lower CI electricity and hydrogen for ZEVs. In addition to reducing GHG emissions, this will in many cases lower levels of localized air pollutants, which are the cause of many deleterious health effects on California residents, especially in priority communities and communities of color.
- Greater opportunities for California businesses to invest in the production of low-CI fuels and other credit generating opportunities.
- Reduced dependence on fossil fuels through decarbonizing the transportation fuel sector and supporting a diversified transportation fuel pool.

In the following sections, staff describes the estimated benefits of the proposed amendments to California businesses, small businesses, and individuals.

A. Summary of Emission Benefits

1. Greenhouse Gases

Staff expects the proposed amendments to reduce GHG emissions relative to the baseline by 558 million metric tons in carbon dioxide equivalent (MMT CO_2e) from 2024 through 2046. It is important to note that because the LCFS calculates emission reductions on a full life cycle basis, the GHG emission reductions occur both in California and out-of-state.

These GHG reduction estimates are derived from CATS outputs of the fuel quantities and average annual CI associated with each fuel, as well as GHG reductions associated with oil and gas extraction emissions.

2. PM_{2.5} and NO_x

The proposed amendments would affect air quality through four main categories: 1) changes in tailpipe emissions for on-road and off-road vehicles, 2) changes in aircraft emissions at airports, 3) changes in emissions at stationary sources from fuel production, and 4) changes in upstream emissions associated with oil and gas extraction where quantified.

Cumulatively from 2024 to 2046, the proposed amendments achieve reductions of 4,281 tons of PM_{2.5} and 25,586 tons of NO_x as compared to the business-as-usual baseline.

Chapter V provides a detailed summary of the air quality benefits of the proposed amendments.

B. Greenhouse Gas Reduction Benefit - Social Cost of Carbon

The benefit of GHG reductions achieved by the proposed amendments can be estimated using the social cost of carbon (SC-CO₂), which provides a dollar valuation of the damages caused by one ton of carbon pollution and represents the monetary benefit today of reducing carbon emissions in the future.

The U.S. Council of Economic Advisors and the Office of Management and Budget convened an Interagency Working Group on the Social Cost of Greenhouse Gases (IWG) to develop a methodology for estimating the SC-CO₂. The methodology relies on a standardized range of assumptions and can be used consistently when estimating the benefits of regulations across agencies and around the world.⁵¹ Staff used the current IWG-supported SC-CO₂ values to consider the social costs of actions taken to reduce GHG emissions. This is consistent with the approach presented in the 2022 Scoping Plan Update, is in line with U.S. Government Executive Orders including 13990 and the Office of Management and Budget Circular A-4 of September 17, 2003.^{52,53}

The IWG describes the social cost of carbon as follows:

“The social cost of carbon (SC-CO₂) for a given year is an estimate, in dollars, of the present discounted value of the future damage caused by a 1-metric ton increase in carbon dioxide (CO₂) emissions into the atmosphere in that year, or equivalently, the benefits of reducing CO₂ emissions by the same amount in that year. The SC-CO₂ is intended to provide a comprehensive measure of the net damages – that is, the monetized value of the net impacts – from global climate change that result from an additional ton of CO₂.

These damages include, but are not limited to, changes in net agricultural productivity, energy use, human health, property damage from increased flood risk, as well as nonmarket damages, such as the services that natural ecosystems provide to society. Many of these damages from CO₂ emissions today will affect economic outcomes throughout the next several centuries.”⁵⁴

⁵¹ United States Government Interagency Working Group on Social Cost of Greenhouse Gases, *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990*. February 2021. https://www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf

⁵² California Air Resources Board, *2022 Scoping Plan for Achieving Carbon Neutrality*. 27-28. November 16, 2022. https://ww2.arb.ca.gov/sites/default/files/2022-12/2022-sp_1.pdf

⁵³ Office of Management and Budgets. *Circular A-4*. September 17, 2023.

<https://www.transportation.gov/sites/dot.gov/files/docs/OMB%20Circular%20No.%20A-4.pdf>

⁵⁴ National Academies of Sciences, Engineering, and Medicine, *Valuing Climate Damages: Updating Estimation of Carbon Dioxide*. National Academies Press, Washington DC. 2017.

<https://nap.nationalacademies.org/catalog/24651/valuing-climate-damages-updating-estimation-of-the-social-cost-of> <https://nap.nationalacademies.org/catalog/24651/valuing-climate-damages-updating-estimation-of-the-social-cost-of>

The SC-CO₂ is year-specific and is highly sensitive to the discount rate used to adjust the value of the damages in the future due to CO₂. The SC-CO₂ increases over time as systems become more stressed from the aggregate impacts of climate change and future emissions cause incrementally larger damages. A higher discount rate decreases the value today of future environmental damages. This analysis uses the IWG standardized range of discount rates from 2.5 to 5% to represent varying valuation of future damages. Table 3 shows the range of IWG SC-CO₂ values (Consumer Price Index adjusted) used in California’s regulatory assessments which reflect the societal value of reducing carbon emissions by one metric ton.⁵⁵

Table 3: SC-CO₂ Discount Rates (in 2021\$ per Metric Ton of CO₂)

Year	5% Discount Rate	3% Discount Rate	2.5% Discount Rate
2020	\$16	\$57	\$85
2025	\$19	\$63	\$93
2030	\$22	\$68	\$100
2035	\$25	\$75	\$107
2040	\$29	\$82	\$115
2045	\$31	\$88	\$122
2050	\$36	\$94	\$130

The GHG reductions due to the proposed amendments are calculated in CO₂e which includes reductions in carbon, methane, and other GHGs. As the CI of a fuel is based on a life cycle assessment of GHG emissions from the use of a fuel converted to CO₂e units, there is not a simple way to assess the breakdown of emissions reduction by GHG (i.e., CO₂, methane, or other GHG) due to the proposed amendments.

As there is no Social Cost of CO₂e, there is not a straightforward metric to estimate the benefits of the proposed amendments. If all GHG reductions under the proposed amendments are assumed to be carbon dioxide reductions, the cumulative estimated benefits from the proposed amendments would range from approximately \$14 billion to \$61 billion (in 2021\$). In Table 4 staff calculated the avoided SC-CO₂ values (2021\$) by applying values in Table 3 to the annual GHG emissions change.

⁵⁵ United States Government Interagency Working Group on Social Cost of Greenhouse Gases, *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990*. 2021. https://www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf

Table 4: Avoided Social Cost of CO₂ from Proposed Amendments 2024-2046

Year	GHG Emission Reductions (MMT)	5% Discount Rate	3% Discount Rate	2.5% Discount Rate
2026	13	\$254	\$852	\$1,250
2030	20	\$438	\$1,368	\$1,997
2034	29	\$716	\$2,149	\$3,065
2038	34	\$921	\$2,670	\$3,775
2042	33	\$1,008	\$2,794	\$3,939
2046	21	\$680	\$1,841	\$2,550
Total	558	\$14,544	\$43,045	\$61,099

It is important to note that the SC-CO₂, while intended to be a comprehensive estimate of the damages caused by carbon globally, does not represent the cumulative cost of climate change and air pollution to society. There are additional costs to society outside of the SC-CO₂, including costs associated with changes in co-pollutants and the social cost of other GHGs including nitrous oxide. The IPCC has stated that the Interagency Working Group on the Social Cost of Greenhouse Gases (IWG) SC-CO₂ estimates are likely underestimated due to the omission of significant impacts that cannot be accurately monetized, including important physical, ecological, and economic impacts.⁵⁶

As mentioned, the SC-CO₂ calculation incorporates GHG emission reductions associated with methane reductions from the regulation. The LCFS supports CARB's work to meet Short Lived Climate Pollutant (SLCP) targets set by Senate Bill 1383 (Lara, Chapter 395, Statutes of 2016) by incentivizing dairies to capture and convert methane-rich biogas into transportation fuels (compressed natural gas, hydrogen, and electricity). Methane is a potent climate pollutant with a Global Warming Potential 25 times higher than CO₂. CARB staff used the SC-CH₄ values provided by the IWG, adjusted to 2021\$, shown in Table 5 to estimate the avoided social cost of in-state methane converted to fuel. These values are consistent with the 2021 IWG interim numbers but adjust for inflation using the California Consumer Price Index. Staff use conversion factors from the Livestock Offset Protocol⁵⁷ and U.S. Energy Information

⁵⁶ United States Environmental Protection Agency, *Social Cost of Carbon Fact Sheet*. December 2016. https://www.epa.gov/sites/default/files/2016-12/documents/social_cost_of_carbon_fact_sheet.pdf

⁵⁷ California Air Resources Board, *Compliance Offset Protocol Livestock Projects*. November 14, 2014. <https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2014/capandtrade14/ctlivestockprotocol.pdf>

Administration⁵⁸ to calculate the methane emission reductions associated with in-state dairy biogas volumes from the California Transportation Supply (CATS) model outputs, resulting in a conversion factor of 0.020 metric tons of methane per million British thermal unit (0.020MT/MMBtu).

Table 5: Social Cost of Methane Discount Rates (in 2021\$ per Metric Ton of CH4)

Year	5% Discount Rate	3% Discount Rate	2.5% Discount Rate
2020	\$739	\$1,641	\$2,188
2025	\$889	\$1,915	\$2,462
2030	\$1,039	\$2,188	\$2,735
2035	\$1,231	\$2,462	\$3,146
2040	\$1,368	\$2,735	\$3,556
2045	\$1,641	\$3,146	\$3,830
2050	\$1,778	\$3,419	\$4,240

Table 6 presents a sampling of years of avoided social cost of instate methane, and the cumulative total avoided social cost instate from 2024 to 2046, from the proposed amendments. The cumulative estimated benefits from the proposed amendments would range from approximately \$6 billion to \$16 billion (in 2021\$).

Table 6: Avoided Social Cost of Methane from Proposed Amendments 2024-2046 (million 2021\$)

Year	CH ₄ Emission Reductions (MT)	5% Discount Rate	3% Discount Rate	2.5% Discount Rate
2026	314,024	\$288	\$601	\$816
2030	292,597	\$304	\$640	\$800
2034	389,068	\$468	\$958	\$1,171
2038	447,125	\$605	\$1,223	\$1,529

⁵⁸ United States Energy Information Administration, *Energy Conversion Calculators*. (Updated June 16, 2023). <https://www.eia.gov/energyexplained/units-and-calculators/energy-conversion-calculators.php>

Year	CH ₄ Emission Reductions (MT)	5% Discount Rate	3% Discount Rate	2.5% Discount Rate
2042	0	0	0	0
2046	0	0	0	0
Total	5,350,641	\$6,146	\$12,593	\$15,990

C. Health Benefits

The proposed amendments to the Low Carbon Fuel Standard regulation would reduce fine particulate matter (PM_{2.5}) and oxides of nitrogen (NO_x) emissions, resulting in health benefits in California. CARB analyzed the value of health benefits associated with 12 health outcomes, most of which were added or updated through CARB's recent expansion of the health analysis⁵⁹: cardiopulmonary mortality, acute myocardial infarction, lung cancer incidence, asthma onset, asthma symptoms, hospitalizations for cardiovascular illness, hospitalizations for respiratory illness, hospitalizations for Alzheimer's disease, hospitalizations for Parkinson's disease, cardiovascular emergency department (ED) visits, respiratory ED visits, and work loss days.

These health outcomes have been identified by U.S. EPA as having a causal or likely causal relationship with exposure to PM_{2.5} based on a substantial body of scientific evidence.^{60,61} U.S. EPA has determined that both long-term and short-term exposure to PM_{2.5} plays a causal role in premature mortality, meaning that a substantial body of scientific evidence shows a relationship between PM_{2.5} exposure and increased risk of death. This relationship persists when other risk factors such as smoking rates, poverty, and other factors are taken into account. U.S. EPA has also determined a causal relationship between non-mortality cardiovascular effects (e.g., acute myocardial infarction) and short- and long-term exposure to PM_{2.5}, a likely causal relationship between non-mortality respiratory effects (including worsening asthma) and short- and long-term PM_{2.5} exposure, and a likely causal relationship between non-mortality neurological effects and long-term PM_{2.5} exposure.

CARB staff evaluated health impacts associated with exposure to PM_{2.5} and NO_x emissions from the proposed amendments. NO_x includes nitrogen dioxide, a potent lung irritant, which

⁵⁹ California Air Resources Board, *California Air Resources Board Updated Health Endpoints Bulletin*. 2022. https://ww2.arb.ca.gov/sites/default/files/2022-11/California%20Air%20Resources%20Board%20Updated%20Health%20Endpoints%20Bulletin%20-%20Edited%20Nov%202022_0.pdf

⁶⁰ United States Environmental Protection Agency, *Integrated Science Assessment for Particulate Matter*. December 2019. <https://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=347534>

⁶¹ United States Environmental Protection Agency, *Estimating PM_{2.5}- and Ozone-Attributable Health Benefits*. March 2021. https://www.epa.gov/sites/default/files/2021-03/documents/estimating_pm2.5-_and_ozone-attributable_health_benefits_tsd.pdf

can aggravate lung diseases such as asthma when inhaled.⁶² However, the most serious quantifiable impacts of NOx emissions occur through the conversion of NOx to fine particles of ammonium nitrate aerosols through chemical processes in the atmosphere. PM2.5 formed in this manner is termed secondary PM2.5. Both directly emitted PM2.5 and secondary PM2.5 are associated with adverse health outcomes. As a result, reductions in PM2.5 and NOx emissions are associated with reductions in these adverse health outcomes.

CARB staff's analysis of health outcomes from the proposed amendments is limited to fuel changes incremental to the baseline. The baseline includes implementation of technology changes expected from implementation of the on-road light duty (ACC II) and on-road heavy duty (ACT and ACF) regulations, and therefore the conservative LCFS analysis does not reflect the health benefits of transitioning to zero emission vehicles. However, the proposed amendments to the LCFS are expected to play a key role in supporting implementation of these vehicle-focused regulations, by reducing the cost of electricity and hydrogen used as vehicle fuels, supporting installation and operation of charging and hydrogen refueling stations, and promoting investment in transportation electrification in disadvantaged, low-income and rural communities. Although not quantified in the health outcomes analysis conducted by CARB staff, the LCFS program remains a key tool in supporting the transition to ZEV technology and the concurrent air quality and GHG benefits.

1. Incidence-Per-Ton Methodology

CARB uses the incidence-per-ton (IPT) methodology to quantify the health benefits of emissions reductions in cases where dispersion modeling results are not available. A description of this method is included on CARB's webpage. CARB's IPT methodology is based on a methodology developed by U.S. EPA.^{63,64}

Under the IPT methodology, it is assumed that changes in emissions are approximately proportional to changes in health outcomes. IPT factors are derived by calculating the number of health outcomes associated with exposure to PM2.5 for a baseline scenario using measured ambient concentrations and dividing by the emissions of PM2.5 or a precursor. The calculation is performed separately for each air basin using the following equation:

Equation 1: Incidence-per-ton calculation

$$IPT = \frac{\text{number of health outcomes in air basin}}{\text{annual emissions in air basin}}$$

⁶² United States Environmental Protection Agency, *Integrated Science Assessment for Oxides of Nitrogen – Health Criteria*. January 2016. <https://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=310879>

⁶³ Fann N., Fulcher C.M., & Hubbell B.J., *The influence of location, source, and emission type in estimates of the human health benefits of reducing a ton of air pollution*. *Air Quality, Atmosphere & Health*, 2:169-176. June 9, 2009. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2770129/>

⁶⁴ Fann, N., Baker, K. R., Chan, E. A., Eyth, A., Macpherson, A., Miller, E., & Snyder, J. *Assessing human health PM2.5 and ozone impacts from US oil and natural gas sector emissions in 2025*. *Environmental Science & Technology*, 52(15), 8095-8103. July 13, 2018. <https://pubs.acs.org/doi/full/10.1021/acs.est.8b02050>

Multiplying the emissions reductions from the proposed amendments in an air basin by the IPT factor then yields an estimate of the reduction in health outcomes achieved by the proposed amendments. For future years, the number of outcomes is adjusted to account for population growth. CARB's current IPT factors are based on a 2014-2016 baseline scenario, which represents the most recent data available at the time the current IPT factors were computed. IPT factors are computed for the two types of PM2.5: primary PM2.5 and secondary PM2.5 of ammonium nitrate aerosol formed from precursors.

2. Reduction in Adverse Health Impacts

CARB recently initiated an expanded health analysis to include additional health endpoints in order to provide a more comprehensive analysis of the benefits of the agency's plans and regulations. A description of the updated and new health outcomes was provided in CARB's Updated Health Endpoints Bulletin, released November 2022. This expansion was based on U.S. EPA's Technical Support Document for the Final Revised Cross-State Air Pollution Rule Update for the 2008 Ozone Season NAAQS and is associated with U.S. EPA's Environmental Benefit Mapping and Analysis Program – Community Edition version 1.5.8.⁶⁵

CARB staff estimates that the total number of cases statewide that would be reduced (from 2024 to 2046) from implementation of the proposed amendments are as follows:

- 364 (201 - 519) fewer cases of cardiopulmonary mortality;
- 74 (54 - 94) fewer cases of hospitalizations for cardiovascular illness;
- 97 (-37 - 227) fewer cases of cardiovascular ED visits;
- 41 (15 - 109) fewer cases of nonfatal acute myocardial infarction;
- 11 (0 - 22) fewer cases of hospitalizations for respiratory disease;
- 219 (43 - 457) fewer cases of respiratory ED visits;
- 27 (8 - 45) fewer cases of lung cancer incidence;
- 852 (818 - 884) fewer cases of asthma onset;
- 73,433 (-35,816 – 178,171) fewer cases of asthma symptoms;
- 53,427 (45,055 – 61,482) fewer cases of work loss days;
- 174 (133 - 212) fewer cases of hospitalizations for Alzheimer's disease;
- 25 (13 - 36) fewer cases of hospitalizations for Parkinson's disease;

These reductions in adverse health cases are expected to be seen across all ages in the State. Children in particular will benefit from the reduced cases of asthma onset and symptoms due to the proposed amendments. This may lead to better health outcomes in these children when they become adults since studies have shown that childhood asthma puts individuals at

⁶⁵ United States Environmental Protection Agency, *Technical Support Document (TSD) for the Final Revised Cross-State Air Pollution Rule Update for the 2008 Ozone Season NAAQS Estimating PM2.5- and Ozone-Attributable Health Benefits*. March 2021. https://www.epa.gov/sites/default/files/2021-03/documents/estimating_pm2.5-_and_ozone-attributable_health_benefits_tsd.pdf

greater risk for respiratory disease and lower respiratory function in adulthood.^{66,67} Adults are also expected to benefit from the proposed amendments due to fewer lost work days, nonfatal acute myocardial infarctions (heart attacks), lung cancer incidences, and reduced cardiopulmonary mortality. Seniors may benefit from reduced cases of hospitalizations for not just cardiovascular and respiratory diseases, but also neurological conditions (Alzheimer's and Parkinson's diseases). And there will be fewer ED visits for both cardiovascular and respiratory diseases across all ages in the population.

Table 7 shows the air basin distribution of avoided health endpoints for the proposed amendments for 2024 through 2046 in California, relative to the baseline.

⁶⁶ Sears, M. R., Greene, J. M., Willan, A. R., Wiecek, E. M., Taylor, D. R., Flannery, E. M., Cowan, J.O., Herbison, G.P., Silva, P.A., & Poulton, R., *A longitudinal, population-based, cohort study of childhood asthma followed to adulthood*. New England Journal of Medicine, 349(15), 1414-1422. October 9, 2003.

<https://www.nejm.org/doi/full/10.1056/nejmoa022363>

⁶⁷ McGeachie M.J., Yates K.P., Zhou X., Guo F., Sternberg A.L., Van Natta M.L., Wise R.A., Szeffler S.J., Sharma S., Kho A.T., Cho M.H., Croteau-Chonka D.C., Castaldi P.J., Jain G., Sanyal A., Zhan Y., Lajoie B.R., Dekker J., Stamatoyannopoulos J., Covar R.A., Zeiger R.S., Adkinson N.F., Williams P.V., Kelly H.W., Grasemann H., Vonk J.M., Koppelman G.H., Postma D.S., Raby B.A., Houston I., Lu Q., Fuhlbrigge A.L., Tantisira K.G., Silverman E.K., Tonascia J., Weiss S.T., & Strunk, R.C., *Patterns of growth and decline in lung function in persistent childhood asthma*. New England Journal of Medicine, 374(19), 1842-1852. May 12, 2016.

<https://www.nejm.org/doi/full/10.1056/nejmoa1513737>

Table 7: Avoided Mortality and Morbidity Incidents per Air Basin from 2024 to 2046 under the Proposed Amendments*

Air Basin	SC	SCC	SJV	SFB	SD	Statewide
Cardiopulmonary Mortality	208 (115 - 296)	8 (5 - 12)	56 (31 - 79)	38 (21 - 54)	18 (10 - 26)	364 (201 - 519)
Hospitalizations for Cardiovascular Disease	42 (31 - 54)	2 (1 - 2)	11 (8 - 14)	8 (6 - 10)	5 (3 - 6)	74 (54 - 94)
Cardiovascular ED Visits	56 (-22 - 132)	2 (-1 - 5)	13 (-5 - 31)	11 (-4 - 26)	5 (-2 - 12)	97 (-37 - 227)
Acute Myocardial Infarction	24 (9 - 63)	1 (0 - 2)	6 (2 - 15)	5 (2 - 13)	2 (1 - 5)	41 (15 - 109)
Hospitalizations for Respiratory Disease	7 (0 - 13)	0 (0 - 0)	2 (0 - 3)	1 (0 - 2)	1 (0 - 1)	11 (0 - 22)
Respiratory ED Visits	119 (23 - 247)	4 (1 - 9)	36 (7 - 74)	28 (5 - 58)	9 (2 - 19)	219 (43 - 457)
Lung Cancer Incidence	15 (5 - 25)	1 (0 - 1)	3 (1 - 6)	4 (1 - 6)	2 (0 - 3)	27 (8 - 45)
Asthma Onset	471 (452 - 489)	21 (20 - 22)	102 (98 - 105)	134 (128 - 139)	45 (43 - 47)	852 (818 - 884)
Asthma Symptoms	40,494 (-19,758 – 98,213)	1,840 (-898 – 4,459)	9,106 (-4,447 – 22,068)	11,227 (-5,469 – 27,274)	3,798 (-1,850 – 9,226)	73,433 (-35,816 – 178,171)
Work Loss Days	29,258 (24,676 – 33,666)	1,251 (1,055 – 1,439)	6,991 (5,897 – 8,043)	7,677 (6,472 – 8,837)	3,110 (2,622 – 3,580)	53,427 (45,055 – 61,482)
Hospitalizations for Alzheimer’s Disease	101 (78 - 123)	3 (2 - 4)	26 (20 - 32)	18 (13 - 22)	14 (11 - 18)	174 (133 - 212)
Hospitalizations for Parkinson’s Disease	14 (7 - 20)	1 (0 - 1)	3 (2 - 5)	3 (2 - 5)	2 (1 - 2)	25 (13 - 36)

* Numbers in parentheses throughout this table represent the 95% confidence interval.

** Air Basins listed: South Coast, South Coast Central, San Joaquin Valley, San Francisco Bay, San Diego County

Table 7 continued

Air Basin	SS	SV	NP	NC	NCC	Statewide
Cardiopulmonary Mortality	6 (4 - 9)	9 (5 - 14)	0 (0 - 1)	1 (0 - 1)	3 (2 - 4)	364 (201 - 519)
Hospitalizations for Cardiovascular Disease	1 (1 - 1)	2 (1 - 2)	0 (0 - 0)	0 (0 - 0)	1 (0 - 1)	74 (54 - 94)
Cardiovascular ED Visits	2 (-1 - 5)	2 (-1 - 5)	0 (0 - 0)	0 (0 - 0)	1 (0 - 2)	97 (-37 - 227)
Acute Myocardial Infarction	1 (0 - 2)	1 (0 - 3)	0 (0 - 0)	0 (0 - 0)	0 (0 - 1)	41 (15 - 109)
Hospitalizations for Respiratory Disease	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	11 (0 - 22)
Respiratory ED Visits	6 (1 - 12)	6 (1 - 12)	0 (0 - 1)	1 (0 - 1)	2 (0 - 5)	219 (43 - 457)
Lung Cancer Incidence	1 (0 - 1)	1 (0 - 1)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	27 (8 - 45)
Asthma Onset	16 (15 - 16)	22 (21 - 22)	1 (1 - 1)	2 (2 - 2)	10 (9 - 10)	852 (818 - 884)
Asthma Symptoms	1,414 (-688 – 3,436)	1,863 (-908 – 4,527)	96 (-47 - 233)	154 (-75 - 375)	827 (-403 - 2010)	73,433 (-35,816 – 178,171)
Work Loss Days	1,063 (896 - 1224)	1,449 (1221 - 1668)	58 (49 - 67)	117 (99 - 135)	577 (486 - 664)	53,427 (45,055 – 61,482)
Hospitalizations for Alzheimer’s Disease	2 (2 - 2)	2 (2 - 3)	0 (0 - 0)	0 (0 - 0)	1 (1 - 1)	174 (133 - 212)
Hospitalizations for Parkinson’s Disease	0 (0 - 1)	1 (0 - 1)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	25 (13 - 36)

Table 7 continued

Air Basin	MC	MD	LT	LC	GBV	Statewide
Cardiopulmonary Mortality	1 (1 - 2)	14 (8 - 20)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	364 (201 - 519)
Hospitalizations for Cardiovascular Disease	0 (0 - 0)	3 (2 - 4)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	74 (54 - 94)
Cardiovascular ED Visits	0 (0 - 1)	4 (-1 - 9)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	97 (-37 - 227)
Acute Myocardial Infarction	0 (0 - 0)	2 (1 - 4)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	41 (15 - 109)
Hospitalizations for Respiratory Disease	0 (0 - 0)	0 (0 - 1)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	11 (0 - 22)
Respiratory ED Visits	1 (0 - 2)	8 (2 - 16)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	219 (43 - 457)
Lung Cancer Incidence	0 (0 - 0)	1 (0 - 1)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	27 (8 - 45)
Asthma Onset	4 (4 - 4)	24 (23 - 25)	1 (1 - 1)	0 (0 - 0)	1 (0 - 1)	852 (818 - 884)
Asthma Symptoms	352 (-171 - 855)	2,140 (-1,042 - 5,199)	45 (-22 - 108)	28 (-14 - 68)	49 (-24 - 120)	73,433 (-35,816 - 178,171)
Work Loss Days	256 (216 - 295)	1,527 (1,287 - 1,758)	41 (35 - 48)	17 (14 - 20)	34 (29 - 40)	53,427 (45,055 - 61,482)
Hospitalizations for Alzheimer's Disease	0 (0 - 0)	6 (4 - 7)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	174 (133 - 212)
Hospitalizations for Parkinson's Disease	0 (0 - 0)	1 (0 - 1)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	25 (13 - 36)

3. Uncertainties Associated with the Mortality and Illness Analysis

Although the estimated health outcomes presented in this report are based on a well-established methodology, they are subject to uncertainty. Uncertainty is reflected in the 95% confidence intervals included with the central estimates in Table 7. These confidence intervals take into account uncertainties in translating air quality changes into health outcomes.

Other sources of uncertainty include the following:

- The relationship between changes in pollutant concentrations and changes in pollutant or precursor emissions is assumed to be proportional, although this is an approximation.
- Emission reductions are reported at a state level and do not capture local variations.
- Future population estimates are subject to increasing uncertainty as they are projected further into the future.
- Fuel use projections from the CATS model are estimates based on technoeconomic analysis, which approximates but does not capture all real-world conditions.
- Baseline incidence rates can experience year-to-year variation.

4. Monetization of Health Benefits

The reductions in adverse health impacts described above can be assigned monetary values so the health benefits can be directly compared to other costs and savings associated with the proposed amendments. These values are derived from economics studies and are based on the expenses that an individual must bear for air pollution related health impacts such as medical bills and lost work, or willingness to pay metrics, which in addition to capturing the direct expenses of the health outcomes also capture the value that individuals place on pain and suffering, loss of satisfaction, and leisure time. For more information on the methodology used to determine the monetary value of health outcomes, see Appendix C-1. The value per incident is shown in Table 8 below.

Table 8: Valuation per Incident for Avoided Health Outcomes (2021\$)

Category	Endpoint	Value Per Incident (2021\$)	Valuation Methodology	Notes
Premature Mortality	Premature Mortality	\$12,483,845	WTP	Shown at 2021 income levels. The estimate will grow annually proportional to income growth using U.S. EPA's central estimate for income elasticity of 0.40, and income growth forecast from BenMAP-CE.

Category	Endpoint	Value Per Incident (2021\$)	Valuation Methodology	Notes
Hospitalizations and ER Visits	HA, Parkinson's Disease	\$15,520	COI	Direct cost of hospitalization incident.
Hospitalizations and ER Visits	HA, Respiratory-2	\$11,815	COI	Direct cost of hospitalization incident.
Hospitalizations and ER Visits	HA, Alzheimer's Disease	\$14,539	COI	Direct cost of hospitalization incident.
Hospitalizations and ER Visits	HA, Cardio-, Cerebro- and Peripheral Vascular Disease	\$18,696	COI	Direct cost of hospitalization incident.
Hospitalizations and ER Visits	ER visits, All Cardiac Outcomes	\$1,403	COI	Direct cost of ER visit.
Hospitalizations and ER Visits	ER visits, respiratory	\$1,057	COI	Direct cost of ER visit.
Health Endpoint Onset/Occurrence	Incidence, Asthma	\$53,753	COI	Present value of lifetime healthcare cost and productivity losses using a 3% discount rate.
Health Endpoint Onset/Occurrence	Asthma Symptoms, Albuterol use	\$253	WTP for symptoms + COI for Albuterol use	Willingness to pay plus cost of albuterol.
Health Endpoint Onset/Occurrence	Incidence, Lung Cancer	\$30,377	COI	Direct medical cost of lung cancer. Cost discounted to present value at 3%.
Health Endpoint Onset/Occurrence	Acute Myocardial Infarction, Nonfatal	\$94,334	COI	Present value of 3 years medical cost and earnings lost over a 5-year period. Using a 3% discount rate.
Health Endpoint Onset/Occurrence	Work Loss Days	\$204	COI	Based on county-level median daily wages.

The statewide valuation of health benefits from 2024-2046 are shown in Table 9. The total statewide health benefits derived from criteria emissions reductions is estimated to be approximately \$5 billion, with \$4.9 billion resulting from reduced premature cardiopulmonary mortality and \$85 million resulting the reductions in other adverse health impacts. The spatial distribution of these benefits across the State follows the distribution of the health impacts by

air basin as described in Table 7. These monetized benefits from all COI based endpoint valuations are included in the macroeconomic modeling.

Table 9: Statewide Valuation from Avoided Health Outcomes (million 2021\$)

Avoided Health Incident	2026	2030	2034	2038	2042	2046	Total
Cardiopulmonary Mortality	138	127	203	279	264	268	4,892
Hospitalizations for Parkinson’s Disease	<1	<1	<1	<1	<1	<1	<1
Respiratory ED Visits	<1	<1	<1	<1	<1	<1	<1
Hospitalizations for Alzheimer’s Disease	<1	<1	<1	<1	<1	<1	3
Hospitalizations for Cardiovascular Disease	<1	<1	<1	<1	<1	<1	1
Cardiovascular ED Visits	<1	<1	<1	<1	<1	<1	<1
ER visits, respiratory	<1	<1	<1	<1	<1	<1	<1
Asthma Onset	2	1	2	3	2	2	46
Asthma Symptoms	1	1	1	1	1	1	19
Lung Cancer Incidence	<1	<1	<1	<1	<1	<1	1
Acute Myocardial Infarction	<1	<1	<1	<1	<1	<1	4
Work Loss Days	0	0	0	1	1	1	11
Total Valuation	141	129	206	284	268	273	4,977

D. Benefits to Typical California Businesses

LCFS incentives may encourage California firms, as well as other firms doing business in California, to invest early in innovative, low-CI fuel technologies and develop mature businesses earlier than firms not participating in the California market. Early investment may result in competitive advantages to these businesses as other state, federal, or international jurisdictions adopt similar carbon intensity standards.⁶⁸ The proposed amendments will also

⁶⁸ Currently Oregon, Washington, British Columbia, Canada, Brazil, and the European Union have LCFS-like policies in place.

help promote a wider range of clean fuels and vehicles for California businesses to choose from, including vehicles operating on electricity, hydrogen, and biomethane.

The proposed amendments also benefit California fuel providers that have compliance obligations under the Cap-and-Trade Program. As the LCFS reduces the CI of fuels, it changes the composition of the State's transportation fuel mix and dependence on traditional petroleum-based fuels. CARB designed the LCFS and Cap-and-Trade Programs to complement one another. Investments made to comply with one of the programs may result in reduced compliance requirements for the other program. Increased use of low-carbon fuel due to the LCFS will reduce fuel suppliers' GHG emissions covered by the Cap-and-Trade Program, reducing the Cap-and-Trade Program compliance obligation of these firms. Similarly, selling cleaner fuels or investing in emission reduction projects at California refineries and oil fields to comply with the Cap-and-Trade Program may also generate credits under the LCFS.

Cumulatively, from 2024 through 2046, the proposed amendments are estimated to increase total revenue for credit generating businesses as compared to the baseline scenario by \$149 billion, of which approximately \$128 billion is estimated to accrue to California businesses.

See Chapter VIII and the Standardized Regulatory Impact Analysis (Appendix C-1) for further discussion of benefits to typical California businesses.

E. Benefits to Small Businesses

Staff defines small businesses as independently owned businesses located in California, with 100 employees or less and annual revenues under \$10 million.

In addition to the benefits already discussed for California businesses, CARB estimates that small businesses will see benefits from the proposed amendments. Many of California's biodiesel producers, hydrogen producers, electric charging stations, hydrogen stations, and natural gas stations are small businesses. Staff identified the following small businesses in California, which represented 16% of the LCFS parties registered in the LCFS in September 2021:

- Three biodiesel providers
- Six natural gas (CNG and LNG) fueling station operators
- 21 electric charging station operators
- One propane provider

In total, these small businesses generated approximately 119,000 LCFS credits in 2021, which provided an estimated \$22 million in credit revenue as estimated using the 2021 average LCFS credit price of \$188.

The proposed amendments will increase the demand for low-CI fuels and are anticipated to increase the prices for LCFS credits relative to the baseline, thereby increasing revenue to these small businesses. In addition, larger potential revenue resulting from the proposed amendments may allow other small businesses to enter the market. Therefore, staff kept the 2021 credit total of 119,000 as a static proxy for future small business credit generation.

V. Air Quality

A. Baseline Assumptions

The economic and emissions impacts of the proposed amendments are estimated against a baseline scenario. As the proposed amendments retain the market flexibility of the current LCFS, it is not possible to predict the exact path or fuels used for future compliance.

The LCFS is a flexible policy tool to reduce emissions by encouraging the development and use of low-carbon transportation fuels to meet increasingly stringent annual carbon intensity benchmarks, similar to the Renewable Portfolio Standard for the electricity sector. The LCFS interacts with many different State and federal regulations. Estimating the baseline fuel demand requires accounting for compliance with existing regulations and standards, changes in fuel consumption as the fleet turns over to vehicles that meet more stringent emission standards, and the expected price of fuels in the future.

The baseline reflects the changing transportation fuel mix from implementation of State and federal laws and regulations that impact future on-road transportation fuel demand that existed or had been adopted as of Summer 2023, which include the ACF regulation, and both the existing ACC II and ACT regulations. The baseline also includes the newly signed Clean Truck Partnership. The baseline does not include any light-duty vehicle transportation fuel demand reductions that would result from successful implementation of vehicle-miles traveled (VMT) reductions. The baseline energy demand for medium- and heavy-duty sectors includes the same vehicle sales and population growth, VMT, and zero-emission technology assumptions currently reflected in CARB's latest version of its emission inventory tool, Emission FACTor 2021 (EMFAC2021). The light-duty vehicle energy demand is calculated using a combination of vehicle populations and growth modeled for the 2022 Scoping Plan Update, VMT from the Department of Motor Vehicles, and fuel efficiencies from EMFAC2021.

The most important policies that drive change in fuel demand and/or carbon intensity that are represented in the baseline are the following:

- Low Carbon Fuel Standard: Under the current LCFS, a 20% reduction in average fuel CI will be achieved by 2030. This target then remains constant for years 2030 and beyond.
- Advanced Clean Cars II: ACC II requires 100% of new vehicle sales to be zero-emission or plug-in hybrid electric by 2035 for manufacturers producing passenger cars, trucks, and SUVs.
- Advanced Clean Trucks: ACT requires truck manufacturers to sell ZEVs as an increasing percentage of their annual California sales from 2024 to 2035. By 2035, zero-emission truck/chassis sales must be 55% of Class 2b – 3 truck sales, 75% of Class 4 – 8 straight truck sales, and 40% of truck tractor sales.
- Advanced Clean Fleets: ACF requires trucking fleets to turn over their fleets to ZEV technology starting in 2024, with specific transition timelines based on fleet types. The ACF rule includes an end to combustion truck sales in 2036.
- U.S. Environmental Protection Agency's (U.S. EPA) Renewable Fuel Standard: The U.S. EPA's RFS mandates minimum volumes of renewable fuels, which are required to be blended into transportation fuels. Staff assumes that the RFS will continue to operate, providing monetary incentive for biofuels such as ethanol, biodiesel, renewable diesel, renewable natural gas, and electric vehicle

- deployment. While the U.S. EPA recently proposed mandated volumes for the RFS program through 2025, the program does not expire or sunset in 2025. In addition, the costs and supply variability provided across scenarios yield estimates and ranges that can account for the uncertainty in the post-2025 RFS.
- U.S. EPA Revised 2023 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emission Standards and National Highway Traffic Safety Administration (NHTSA) Corporate Average Fuel Economy standards for Model Years 2024-2026 Passenger Cars and Light Trucks: These regulations require vehicle manufacturers to comply with new GHG vehicle emission standards and fuel economy standards through 2026. U.S. EPA and NHTSA have also separately proposed more stringent GHG vehicle emission and fuel economy standards, respectively, for later model years.
 - Inflation Reduction Act of 2022: This bill revised Section 45 of the Internal Revenue Code to establish and/or increase the tax credits available for production of low-carbon fuels and CO₂ capture and storage/sequestration.
 - California Phase 2 GHG Standards for On-Road Medium- and Heavy-Duty Vehicles: This regulatory program primarily establishes greenhouse gas (GHG) emissions standards for new medium- and heavy-duty vehicles and engines.
 - The requirements of Clean Energy, Jobs, and Affordability Act of 2022⁶⁹ that dictates retail electricity be supplied by zero-carbon sources equal to 90% of supply in 2035, 95% in 2040, and 100% by 2045, with State agencies required to procure 100% zero-carbon electricity in 2035.
 - The longer-term requirements of the 100 Percent Clean Energy Act of 2018⁷⁰ that requires electricity be supplied by zero-carbon sources by 2045. This requirement will affect the CI of electricity.

B. Total Emissions Benefits

The proposed amendments will reduce GHG emissions and smog-forming and toxic air pollutants from the transportation sector by shifting to low-CI fuels which, in many cases, also release fewer pollutants when combusted than fossil fuels. Reductions in GHG emissions and improvements in California air quality under the proposed amendments are anticipated to result in fewer damages due to climate change and in health benefits for California individuals. These health benefits result in cost savings to individuals, businesses, and government agencies due to fewer premature mortalities, fewer hospital and emergency room visits, and fewer lost days of work. When combusted, transportation fuels emit harmful pollutants, which this proposal would help to eliminate. These pollutants include NO_x and fine particulate matter (PM_{2.5}). NO_x is a precursor to ozone and secondary particulate matter formation. Exposure to ozone and to PM_{2.5}, which are inhalable particles with diameters that are generally 2.5 micrometers and smaller, is associated with increases in premature death, hospitalizations,

⁶⁹ California Legislature, *Senate Bill 1020 Clean Energy, Jobs, and Affordability Act of 2022*. Signed September 16, 2022. https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=202120220SB1020

⁷⁰ California Legislature, *Senate Bill 100 California Renewables Portfolio Standard Program: emissions of greenhouse gases*. Signed September 10, 2018. https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180SB100

visits to doctors, use of medication, and emergency room visits due to exacerbation of chronic heart and lung diseases and other adverse health conditions.

The baseline includes the technology changes that are expected from implementation of on-road light-duty (ACC II), on-road heavy-duty (ACT and ACF), and off-road (At-Berth and TRU) regulations. In the Standardized Regulatory Impact Analysis (Appendix C-1), staff analyzed the benefits from the proposed changes to the LCFS regulation incremental to the baseline. Those benefits from the proposed changes to the LCFS regulation incremental to the baseline include quantification of the upstream emissions benefits of reduced California oil and gas extraction, which staff estimates will come from reduced demand for petroleum fuels in the future. During the COVID-19 pandemic and the stay-at-home orders, there was a drastic reduction in demand for petroleum fuels as residents stayed home. Data collected under the Regulation for the Mandatory Reporting of Greenhouse Gas Emissions for 2020 and 2021 show a reduction in oil and gas sector GHG emissions relative to previous years driven primarily from the reduced demand for petroleum fuels that occurred during 2020.⁷¹ The 2022 edition of the AB 32 Annual GHG Inventory also shows a 13% reduction in oil and gas sector emissions from 2019 to 2020.⁷² As such, a reduction in GHG, criteria, and toxic emissions from oil and gas extraction is expected to result from corresponding petroleum fuel demand reductions, further expanding the benefits of this regulation. The methodology used to estimate the emissions impact and the incremental impacts of the proposed amendments (relative to the baseline) are detailed in Appendix C-1.

1. Greenhouse Gas Emissions Benefits of the Proposed Amendments

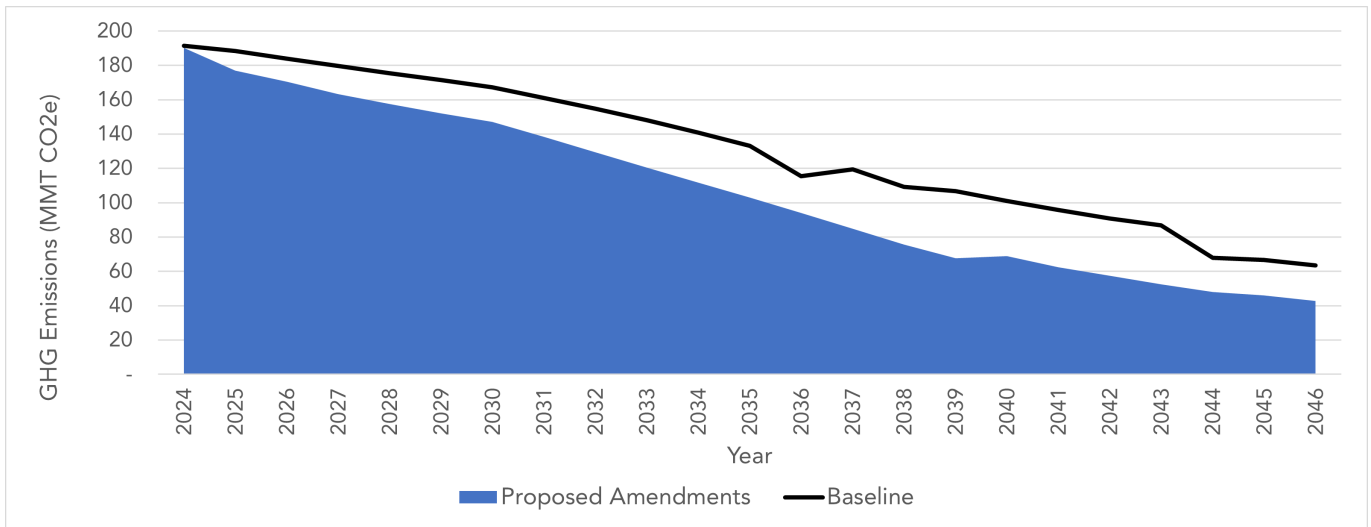
Figure 7 summarizes the annual life cycle greenhouse gas emissions reductions under the baseline and the proposed amendments scenario. Staff expects the proposed amendments to reduce GHG emissions relative to the baseline by 558 million metric tons in carbon dioxide equivalent (MMTCO₂e) from 2024 through 2046. It is important to note that because the LCFS calculates emission reductions on a full life cycle basis, the GHG emission reductions occur both in California and out-of-state.

These GHG reduction estimates are derived from the California Transportation Supply (CATS) outputs of the fuel quantities and average annual CI associated with each fuel, as well as GHG reductions associated with oil and gas extraction emissions.

⁷¹ California Air Resources Board, *Mandatory Greenhouse Gas Reporting 2021 Emissions Year Frequently Asked Questions*. November 4, 2022. <https://ww2.arb.ca.gov/sites/default/files/classic/cc/reporting/ghg-rep/reported-data/2021mrrfaqs.pdf>

⁷² California Air Resources Board, *California Greenhouse Gas Emissions for 2000 to 2020 Trends of Emissions and Other Indicators*. October 26, 2022. https://ww2.arb.ca.gov/sites/default/files/classic/cc/inventory/2000-2020_ghg_inventory_trends.pdf

Figure 7: Annual GHG Emissions of Baseline and Proposed Amendments



2. Criteria Pollutant Emission Benefits of Proposed Amendments

The proposed amendments would affect air quality through four main categories: 1) changes in tailpipe emissions for on-road and off-road vehicles, 2) changes in aircraft emissions at airports, 3) changes in emissions at stationary sources from fuel production, and 4) changes in upstream emissions associated with oil and gas extraction where quantified.

Fossil fuels contain benzene, toluene, ethyl benzene, and xylenes (BTEX compounds), which can be emitted to the air and contaminate soil and water. Gasoline engine exhaust contains benzene, 1,3-butadiene, formaldehyde, and acetaldehyde. Diesel engine exhaust contains diesel particulate matter, which is a toxic air contaminant. Generally, all exhaust from the combustion of hydrocarbon fuels contains benzene as a product of incomplete combustion (PIC). Staff expects reductions in these criteria pollutants and toxics due to decreased use of fossil fuels in regions with heavy use of motor vehicles and diesel engines, such as big population centers (e.g., South Coast) and areas with heavy truck use (San Joaquin Valley), and regions with commercial airports. Converting from fossil jet fuel to alternative jet fuel yields significant benefits, averaging an annual reduction of 346 tons of NOx and 28 tons of PM2.5 from the proposed amendments.

Reducing criteria pollutants and toxic emissions from fuel combustion in line with California’s air quality goals requires deploying ZEVs and ensuring the availability of fueling infrastructure to support ZEV deployment. In the Standardized Regulatory Impact Assessment (SRIA), CARB staff estimated air quality benefits attributable to the proposed amendments. The emissions analysis includes expected reductions in emissions from upstream oil and gas extraction that would be expected to result from corresponding petroleum fuel demand reductions. First, staff estimated upstream extraction-based criteria pollutant emission changes associated with reduced petroleum demand. To estimate the emission benefits of reduced upstream oil extraction, staff focused on the proportion of demand reduction associated with fossil diesel declines expected from the LCFS proposal, given that staff expects diesel demand may persist longer than gasoline demand in California and future in-state extraction reductions may be limited by the pace of diesel demand reductions. The reductions shown in Table 10 also include estimated changes in emissions that occur from changes in renewable fuel use in vehicles, feedstock and fuel transport, and changes in renewable fuel production.

In summary, the proposed amendments achieve reductions of PM2.5 and NOx through 2046, shown in Table 10. These emissions reductions are driven in part by increased use of renewable diesel and alternative jet fuel, which displace fossil diesel and fossil jet fuel. As noted earlier, emissions reductions from phasing down oil extraction and refining operations in tandem with petroleum demand reductions are included in this analysis. In total, the proposed amendments achieve reductions of 4,281 tons of PM2.5 and 25,586 tons of NOx in aggregate through 2046.

Table 10: NOx and PM2.5 Emission Changes under the Proposed Amendment Scenario (tons per day)

Year	NOx (tpd)	PM2.5 (tpd)
2024	-0.4	-0.1
2025	-2.2	-0.3
2026	-2.2	-0.3
2027	-2.5	-0.3
2028	-2.7	-0.4
2029	-2.5	-0.4
2030	-2.1	-0.3
2031	-2.8	-0.4
2032	-3.0	-0.4
2033	-3.0	-0.4
2034	-3.0	-0.4
2035	-3.1	-0.5
2036	-3.2	-0.5
2037	-3.4	-0.5
2038	-3.8	-0.6
2039	-3.9	-0.6
2040	-4.0	-0.8
2041	-4.0	-0.8
2042	-3.6	-0.7
2043	-3.7	-0.7

Year	NOx (tpd)	PM2.5 (tpd)
2044	-3.7	-0.8
2045	-3.6	-0.7
2046	-3.7	-0.8

VI. Environmental Impact Analysis

CARB is the lead agency for the proposed regulation and has prepared an environmental impact analysis (EIA) pursuant to its certified regulatory program (title 17, CCR, sections 60000 through 60008) to comply with the requirements of the California Environmental Quality Act (CEQA). CARB's regulatory program, which involves the adoption, approval, amendment, or repeal of standards, rules, regulations, or plans for the protection and enhancement of the State's ambient air quality has been certified by the California Secretary for Natural Resources under Public Resources Code section 21080.5 of CEQA (title 14, CCR, section 15251(d)). Public Resources Code section 21080.5 allows public agencies with certified regulatory programs to prepare a "functionally equivalent" or substitute document in lieu of an environmental impact report or negative declaration, once the program has been certified by the Secretary for the Resources Agency as meeting the requirements of CEQA. CARB, as a lead agency, prepares a substitute environmental document (referred to as an "Environmental Impact Analysis" or "EIA") as part of the Staff Report to comply with CEQA (title 17, CCR, section 60005).

The Draft EIA for the proposed amendments is included in Appendix D. The Draft EIA provides a programmatic environmental analysis of an illustrative, reasonably foreseeable compliance scenario that could result from implementation of the proposed amendments.

For the purpose of determining whether the proposed LCFS regulation would have a potential adverse effect on the environment, CARB evaluated the potential physical changes to the environment resulting from reasonably foreseeable compliance responses.

Reasonably foreseeable compliance responses associated with the proposed amendments include the following responses, which could result in changes to the existing physical environment: modifications to cultivation volume and transport of feedstock; changes to location and types of feedstock; new or modified processing facilities for feedstock and finished fuel production; increased transportation of finished alternative fuels to blending terminals or retail fuel sites; construction and operation of new facilities to produce renewable diesel, renewable gasoline, AJF, and renewable propane; construction of biomass gasification and pyrolysis systems for hydrogen and renewable natural gas production; construction of new anaerobic facilities to digest manure from dairies, sewage from wastewater treatment plants, and organic waste diverted from landfills; construction of infrastructure to collect biogas and produce methane; construction of stand-alone and bolt-on cellulosic processing units for renewable fuels production; increase in collection of yard waste or removal of forest litter and agricultural residues; construction of electrolysis units and substitution of renewable natural gas for fossil gas in production of hydrogen; construction of solar and wind electricity generation projects; modification to existing or new industrial facilities to capture CO₂ emissions; construction of new infrastructure such as pipelines, wells and other surface facilities; construction and operation of additional refueling hydrogen stations and EV charging stations; modifications to electricity distribution and transmission infrastructure; modifications to existing crude production facilities to accommodate solar and wind electricity, solar heat, and/or solar steam generation; electrification of equipment and installation of renewable

electricity and battery storage systems at petroleum refineries and alternative fuel production facilities; expansion of public transit systems; and land use changes and changes to fuel-associated shipment patterns.

While many impacts associated with the compliance responses identified for the proposed amendments could be reduced to less-than-significant levels through conditions of approval applied and mitigation measures to project-specific development, the authority to apply that mitigation lies with land use agencies or other agencies approving the development projects, not with CARB. Consequently, if a potentially significant environmental effect cannot be feasibly mitigated with certainty, the EIA takes a conservative approach and identifies the impact as significant and unavoidable while disclosing the impact for CEQA compliance purposes. As such, reasonably foreseeable compliance responses associated with the proposed amendments could result in potentially significant and unavoidable environmental impacts. Table 11 summarizes the potential environmental impacts of the proposed amendments.

Table 11: Summary of Potential Environmental Impacts

Impact Number	Resource Area Impact	Significance
1-1	Short-Term Construction-Related and Long-Term Operational-Related Impacts on Aesthetics	Potentially Significant and Unavoidable
2-1	Short-Term Construction-Related and Long-Term Operational-Related Impacts on Agriculture and Forest Resources	Potentially Significant and Unavoidable
2-2	Agricultural and Forest Resource Impacts Related to Feedstock Cultivation	Potentially Significant and Unavoidable
3-1, 3-2	Short-Term Construction-Related and Long-Term Operational-Related Impacts on Air Quality	Potentially Significant and Unavoidable
3-3	Short-Term Construction-Related and Long-Term Operational Impacts from Odors	Less than Significant
4-1, 4-2	Short-Term Construction-Related and Long-Term Operational-Related Impacts to Biological Resources	Potentially Significant and Unavoidable
5-1	Short-Term Construction-Related and Long-Term Operational-Related Effects to Cultural Resources	Potentially Significant and Unavoidable
6-1, 6-2	Short-Term Construction-Related and Long-Term Operational-Related Impacts to Energy Resources	Less than Significant
7-1	Short-Term Construction-Related and Long-Term Operational-Related Impacts to Geology and Soils	Potentially Significant and Unavoidable

Impact Number	Resource Area Impact	Significance
7-2	Long-Term Operational-Related Impacts to Geology and Soil Associated with Land Use Changes	Potentially Significant and Unavoidable
8-1	Short-Term Construction-Related and Long-Term Operational-Related Impacts to Greenhouse Gas Emissions	Beneficial
9-1, 9-2	Short-Term Construction-Related and Long-Term Operational-Related Impacts Related to Hazards and Hazardous Materials	Potentially Significant and Unavoidable
10-1, 10-2	Short-Term Construction-Related and Long-Term Operational-Related Impacts to Hydrology and Water Quality	Potentially Significant and Unavoidable
11-1	Short-Term Construction-Related and Long-Term Operational-Related Impacts on Land Use	Potentially Significant and Unavoidable
11-2	Long-Term Operational Impacts on Land Use Related to Feedstock Production	Potentially Significant and Unavoidable
12-1	Short-Term Construction-Related Impacts to Mineral Resources	Less than Significant
12-2	Long-Term Operational-Related Impacts on Mineral Resources	Potentially Significant and Unavoidable
13-1, 13-2	Short-Term Construction-Related and Long-Term Operational-Related Impacts to Noise and Vibration	Potentially Significant and Unavoidable
14-1	Short-Term Construction-Related and Long-Term Operational-Related Impacts to Population and Housing	Less than Significant
15-1	Short-Term Construction-Related and Long-Term Operational-Related Impacts to Public Services	Less than Significant
16-1	Short-Term Construction-Related and Long-Term Operational-Related Impacts to Recreation	Less than Significant
17-1, 17-2	Short-Term Construction-Related and Long-Term Operational-Related Impacts to Transportation	Potentially Significant and Unavoidable
18-1	Short-Term Construction-Related and Long-Term Operational-Related Impacts on Tribal Cultural Resources	Potentially Significant and Unavoidable
19-1	Long-Term Operational-Related Impacts to Utilities and Service Systems	Potentially Significant and Unavoidable
20-1	Short-Term Construction-Related and Long-Term Operational-Related Impacts on Wildfire	Less than Significant

Staff prepared a Notice of Preparation and made it available for review and comment for 30 days, per the CEQA Guidelines (Cal. Code Regs., tit. 14, § 15082(b)). The comment period for the Notice of Preparation began on February 13, 2023 and ended on March 15, 2023. Written comments on the Draft EIA will be accepted starting January 5, 2024 through February 20, 2024. The Board will consider the Final EIA and responses to comments received on the Draft EIA before taking action to adopt the proposed amendments. If the proposed amendments are adopted, a Notice of Decision will be posted on CARB's website and filed with the Secretary of the Natural Resources Agency for public inspection (Cal. Code Regs., tit. 17, § 60004.2(d)).

VII. Environmental Justice

State law defines environmental justice (EJ) as the fair treatment and meaningful involvement of people of all races, cultures, incomes, and national origins with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies (Gov. Code, § 65040.12, subd. (e)(1)). The advancement of state and federal law on environmental justice was greatly influenced by the Principles of Environmental Justice.⁷³ Environmental justice includes, but is not limited to, the following:

- The availability of a healthy environment for all people;
- The deterrence, reduction, and elimination of pollution burdens for populations and communities experiencing the adverse effects of that pollution, so that the effects of the pollution are not disproportionately borne by those populations and communities;
- Governmental entities engaging and providing technical assistance to populations and communities most impacted by pollution to promote their meaningful participation in all phases of the environmental and land use decision making process; and
- At a minimum, the meaningful consideration of recommendations from populations and communities most impacted by pollution into environmental and land use decisions (Gov. Code, § 65040.12, subd. (e)(2)).

The Board approved its Environmental Justice Policies and Actions (Policies) on December 13, 2001, to establish a framework for incorporating environmental justice into CARB's programs consistent with the directives of State law. These policies apply to all communities in California but are intended to address the disproportionate environmental exposure burden borne by low-income communities and communities of color. Environmental justice is one of CARB's core values and fundamental to achieving its mission for all Californians.

CARB continues to integrate environmental justice into its rulemaking, policy development and other key decision-making and implementation activities, including the LCFS. In October 2022, the Board laid out a Vision for Environmental Justice and Racial Equity that reaffirms the Board's goal to create and implement policies, regulations and programs that address environmental justice and provide tangible and immediate gains for historically oppressed people.⁷⁴

With the passage of AB 32, CARB was charged with developing a Scoping Plan that outlines how California will achieve its climate goals and to update it every five years. The Board was also required to convene an Environmental Justice Advisory Committee (EJAC) to advise the Board during the development and subsequent updates of the Scoping Plan, and any other

⁷³ Delegates to the First National People of Color Environmental Leadership Summit, *The Principles of Environmental Justice (EJ)*. 1991. <https://www.ejnet.org/ej/principles.html>

⁷⁴ California Air Resources Board, *Vision for Environmental Justice and Racial Equity*. October 24, 2022. <https://ww2.arb.ca.gov/sites/default/files/2023-04/CARB%20Vision%20Racial%20Equity%20Final%20ENG.pdf>

pertinent matter in implementing AB 32. The EJAC consists of representatives of communities in the State with significant exposure to air pollution, including disadvantaged communities with minority or low-income populations. Four iterations of the Committee have been convened. The first EJAC advised on the initial 2008 Scoping Plan, the second was convened in March 2013 to advise the Board on the 2013 Scoping Plan Update, the third in 2015 to advise on the 2030 Target Scoping Plan Update, and the fourth in 2021 to advise on the 2022 Scoping Plan Update.⁷⁵ More than five dozen of the EJAC's recommendations were incorporated into the 2022 Scoping Plan Update.

In September 2022, Governor Newsom issued Executive Order N-16-22, which directs California agencies and departments developing or updating strategic plans from 2023 to 2026 to reflect the use of data analysis and inclusive practices to more effectively advance equity and respond to identified disparities with changes to the organization's mission, vision, goals, data tools, policies, programs, operations, community engagement, tribal consultation policies and practices, and other actions as necessary to serve all Californians. The Order also directs departments to gather input from disadvantaged and underserved communities as part of this process.

A. Uplifting Equity

CARB hosted 11 public workshops to discuss potential future changes to the LCFS program since 2020, including two community-oriented meetings in May and June 2023. Environmental justice advocates have attended all the workshops and provided verbal or written feedback on behalf of their organizations and community members. LCFS staff has also met with advocates throughout the informal pre-rulemaking process and the EJAC approved a resolution with recommendations for the LCFS program in August 2023.⁷⁶ The input of advocates and community members has helped staff refine many proposed LCFS amendments.

The central goals of the LCFS program are to reduce greenhouse gas emissions from the transportation sector and improve air quality by incentivizing the production of zero- and low-carbon energy fuels and infrastructure. Environmental justice advocates and community members have shared support for these fundamental goals throughout the public process and there is an ongoing recognition that many frontline communities are located adjacent to ports, rail, and major freight paths such as freeways. This section highlights program design features and proposals that align with EJ requests.

The LCFS program has been successful at increasing the supply of alternative fuels in California, helping to double the volume of low-carbon fuel consumption in just 10 years and displacing over 25 billion gallons of petroleum fuels with low-carbon fuels since 2011. Staff is proposing to increase the stringency of the program with measures that will enable an even

⁷⁵ Environmental Justice Advisory Committee, *AB 32 Environmental Justice Advisory Committee Charter*. 2023. <https://ww2.arb.ca.gov/sites/default/files/barcu/board/books/2023/032323/23-3-4ejaccharter.pdf>

⁷⁶ Environmental Justice Advisory Committee, *Draft Recommendations to the California Air Resources Board (CARB) on the Low Carbon Fuel Standard Regulation Updates*. August 28, 2023. <https://ww2.arb.ca.gov/sites/default/files/2023-08/EJAC%20DRAFT%20Low%20Carbon%20Fuel%20Standard%20Recommendations%20Version%202%20082823.pdf>

faster transition to zero- and low-carbon fuels, where greater benefits should accrue for frontline communities:

1. A 'step down' in the CI reduction target in 2025 from the current 13.75% to 18.75%;
2. A change in the 2030 CI reduction target from 20% to 30% with a target of 90% CI reduction in 2045;
3. An acceleration mechanism that will automatically trigger a set increase in the CI reduction target if certain specified market conditions are met.

Raising the carbon intensity reduction requirement of transportation fuel through the LCFS incentivizes the use of increasingly lower carbon fuel and is consistent with the EJAC's 2022 Scoping Plan recommendation to increase the stringency of the LCFS program.⁷⁷ Credits for low-carbon fuels will support the mobile source regulations that are driving the transition to zero-emission vehicle (ZEV) technology, such as the Advanced Clean Cars II and Advanced Clean Fleets regulations. The step-down will also help send a near-term signal to prompt investment in cleaner fuels.

As California moves toward a zero-emission transportation future, the LCFS is crucial in supporting the transition from fossil-based fuels. The program also supports other regulations in California that encourage or require the use of renewable diesel, such as the Innovative Clean Transit and In-use Locomotive regulations. Since legacy fleets, locomotives and airplanes will operate for decades more before they are completely replaced with zero-emission technology, it's important that the transportation fuel used during this time is increasingly lower-carbon and reduces the negative health impacts from the combustion of fossil-based fuels. The growing displacement of fossil-based fuels with renewable biofuels, supported by LCFS credit revenue, continues to improve air quality through the reduction in particulate matter and NOx emissions, as explained in Chapter IV. This is especially important in communities located near major transportation corridors and around airports and ports where legacy fleets will continue to operate.

In line with EJ recommendations, LCFS staff is proposing to expand incentives for electrification zero emission vehicles to accelerate the transition to electric and hydrogen-powered vehicles by extending light-duty vehicle infrastructure crediting and introducing a new medium- and heavy-duty vehicle (MHD) infrastructure credit.⁷⁸ Staff proposes to accept applications for public light-duty refueling infrastructure past the current end-date of December 31, 2025, with the provision that all new Fast Charging Infrastructure (FCI) and Hydrogen Refueling Infrastructure (HRI) applications for light-duty vehicles must be in low-income, disadvantaged or rural communities or more than 10 miles from the nearest fast charger to maximize coverage. For MHD FCI and HRI refueling infrastructure, staff is proposing to add capacity credits for up to 10 years of crediting to support the transition to zero emission technology in trucking fleets. This policy will incentivize the development of MHD refueling

⁷⁷ Environmental Justice Advisory Committee, *Environmental Justice Advisory Committee 2022 Scoping Plan Recommendations*: NF44 & NF54. 15-16. September 30, 2022.

<https://ww2.arb.ca.gov/sites/default/files/barcu/board/books/2022/090122/finalejacrecs.pdf>

⁷⁸ Recommendations NF6, NF7, NF8, and NF52. Environmental Justice Advisory Committee, *Environmental Justice Advisory Committee 2022 Scoping Plan Recommendations*. September 30, 2022.

<https://ww2.arb.ca.gov/sites/default/files/barcu/board/books/2022/090122/finalejacrecs.pdf>

infrastructure for battery-electric and hydrogen fuel cell-electric trucks and support the trucking industry's transition to ZEVs, reducing emissions and criteria pollutants across the State and in communities heavily impacted by freight travel.

Staff is proposing changes to the allocation and use of base credits generated by utilities from non-metered residential electric vehicle charging that will go farther in reducing emissions in communities near freight corridors. Under the Staff Proposal, the Clean Fuel Reward program will change from a new light-duty EV rebate to rebates for new and used medium- and heavy-duty zero emission trucks that are exempted from the Advanced Clean Fleets regulation. This will help accelerate the transition for this hard-to-transition segment of the trucking sector that is not covered by other CARB regulations. The proportion of residential base credits will change to reflect this change in rebate from 60% of total base credits to 40% with a corresponding increase in "holdback credits." As a result of this increase in holdback credits, staff is proposing to increase the requirements for investments in equity communities from 50% to 75% for investor-owned utilities, as well as proposing new pre-approved categories for investment of these credits. These new categories reflect priorities from the 2022 Scoping Plan Update as well as community input and include re-skilling and workforce development for transportation electrification, and transportation projects identified in AB 617 Community Emission Reduction Plans.

CARB staff are also proposing additional guardrails on the use of crop-based feedstocks for biofuel production. These changes will help to reduce the risk that rapid expansion of biofuel production and biofuel feedstock demand could result in deforestation or adverse land use change, a concern that was raised multiple times during the LCFS and Scoping Plan Workshops from EJ and environmental organizations.

Staff is also proposing to include deficit-generating fossil jet fuel for intrastate flights in the LCFS, beginning in 2028. This proposal aligns with the 2022 Scoping Plan Update toward decarbonizing the aviation sector, and with EJAC's recommendation to further integrate opt-in sectors into the regulation.^{79,80} The use of alternative jet fuels, which generate credits under the LCFS, will achieve particulate matter emissions reductions that benefit communities living near airports. Adding fossil jet fuel as a deficit generator also strengthens the signal to invest in zero-emission aviation technology, as modeled in the 2022 Scoping Plan Update in the 2040s.

B. Conclusion

Many elements of the Low Carbon Fuel Standard support key environmental justice-related recommendations, including the reduction of fossil fuel use, promotion of cleaner fuels, and the incentivization of charging and fueling infrastructure in disadvantaged communities. LCFS

⁷⁹ Recommendation NF54 in the Environmental Justice Advisory Committee 2022 Scoping Plan Recommendations.

⁸⁰ Environmental Justice Advisory Committee, *Draft Recommendations to the California Air Resources Board (CARB) on the Low Carbon Fuel Standard Regulation Updates*. August 28, 2023.

<https://ww2.arb.ca.gov/sites/default/files/2023-08/EJAC%20DRAFT%20Low%20Carbon%20Fuel%20Standard%20Recommendations%20Version%202%20082823.pdf>

complements other State policies as part of a suite of policies in California's portfolio of strategies to support reducing petroleum dependence by 94% by 2045.

VIII. Standardized Regulatory Impact Analysis

This section summarizes the economic impact of the Proposed Regulation as presented in the Standardized Regulatory Impact Analysis (SRIA), which can be found in Appendix C-1, as well as on the Department of Finance website. CARB responses to comments received from the Department of Finance can be found in Appendix C-3.

A. Changes Since the Release of the Standardized Regulatory Impact Assessment

The proposed amendments have been updated since the release of the SRIA on September 8, 2023. The changes and their potential impacts on the economic analysis are found below.

1. Verification Costs

Staff updated the verification cost estimates to include the expected costs to companies that own/operate between 1 and 10 fueling supply equipment (FSE), provisions for deferred verification for companies generating less than 6,000 credits per year, and less intensive verification requirements for fuel reporting entities reporting only electricity transactions. This change resulted in approximately \$2.25 billion less verification costs over the lifetime of the regulation.

a) Direct Costs

The total net cost of the proposed regulation from 2024 to 2046 is estimated to be approximately \$32 billion, with total direct costs of approximately \$160.5 billion and total revenue from LCFS credit sales of approximately \$128.4 billion. Direct costs of the amendments include the cost of compliance to in-state high carbon fuel producers that generate deficits (e.g., petroleum refiners), changes in statewide high carbon-intensity fuel expenditures of \$7 billion, and the cost of third-party verification for electric and hydrogen fuel supply equipment, which were not previously subject to verification before these proposed amendments, of \$5.5 billion. The highest annual cost occurs in 2039 with an estimated direct cost of \$11.1 billion.

2. REMI Modeling: Correction to References and Update of Population Projections

The SRIA incorporated Department of Finance’s economic and population projections of U.S. Real Gross Domestic Product, income, and employment,⁸¹ as well as California civilian employment by industry,⁸² released with the 2023-2024 May Revision to the Governor’s Budget on May 12, 2023 and Department of Finance demographic forecasts for California population forecasts updated in July 2021.⁸³ The text of the SRIA accurately describes the use of the July 2021 population projections in the SRIA’s macroeconomic analysis, but the footnote reference number 86 in the SRIA erroneously references the July 2023 interim population projection. Footnote 86 of the SRIA should instead read:

California Department of Finance, *Demographic Research Unit. Report P-3: Population Projections, California, 2010-2060* (Baseline 2019 Population Projections; Vintage 2020 Release). 2021.

After the completion of the analysis, Finance released a population projection interim series informed by available 2020 Census data dated July 19, 2023.⁸⁴ The interim projection released July 2023 has been incorporated into the macroeconomic results presented in the Form 399 and the following sections.

The macroeconomic results presented in the SRIA were presented in a 2021-dollar value. Per the direction of Department of Finance in their SRIA Comment Letter, the Form 399 presents the results of the macroeconomic analysis in 2023-dollar values. The economic analysis contained in the sections below also use 2023-dollar values.

3. Social Cost of Methane

Staff updated the avoided social cost of methane to account for all pathways that have dairy biogas as their feedstock and to match the years between the CATS model outputs and Annual SC-CH₄ values. Staff also corrected the conversion factor cited in the text to align with the calculation which used 0.020 metric tons of methane per million British thermal unit (instead of “per British thermal unit”). This resulted in an approximate doubling of avoided social cost: the SRIA identified values between 3 billion to 9 billion (2021\$), the updated values are between 6 and 16 billion, depending on the discount rate selected.

⁸¹ California Department of Finance, *National Economic Forecast – Annual & Quarterly* (Updated in April 2023). <https://dof.ca.gov/Forecasting/Economics/economic-forecasts-u-s-and-california/>

⁸² California Department of Finance, *Economic Research Unit. California Economic Forecast – Annual & Quarterly* (Updated in April 2023). <https://dof.ca.gov/Forecasting/Economics/economic-forecasts-u-s-and-california/>

⁸³ California Department of Finance, *Demographic Research Unit, Report P-3: Population Projections, California, 2010-2060* (Baseline 2019 Population Projections; Vintage 2020 Release). 2021.

⁸⁴ California Department of Finance, *Demographic Research Unit. Report P-3: Population Projections, California, 2020-2060* (Baseline 2019 Population Projections; Vintage 2023 Release). 2023. Zip File.

4. Small Business Benefits

Staff corrected the number of biodiesel producers considered small businesses from two to three and changed the ratio of small businesses to reflect the number as compared to the California, not national, total companies in the LCFS. Per this correction, small businesses represented 16% of the LCFS parties registered in the LCFS in September 2021.

B. The creation or elimination of jobs within the State of California.

REMI Policy Insight Plus Version 3.0.0 is used to estimate the macroeconomic impacts of the proposed amendments on the California economy including changes to employment demands and output based on expected costs and benefits by industry.

Table 12 presents the impact of the proposed amendments on total employment in California across all industries. Employment comprises estimates of the number of jobs, full-time and part-time, by place of work for all industries. Full-time and part-time jobs are counted at equal weight. Employees, sole proprietors, and active partners are included, but unpaid family workers and volunteers are not included. The employment impacts represent the net change in employment, which consist of positive impacts for some industries and negative impacts for others.

The statewide employment impacts of the proposed amendments are estimated to have a slightly positive impact on employment (approximately +0.02% of California employment) through 2027, followed by a slightly negative impact on employment (approximately 0 to -0.03% of California employment) through 2046 (Figure 8). The positive impacts on employment primarily result from the credits generated by low-CI fuels. The demand for these credits leads to expansion in the industries producing these fuels. After 2040, the CATS model predicts the costs for DAC will be lower than the costs of obtaining credits directly from low-CI fuel producers. As a result, the latter years of the assessment are characterized by high production costs for high-CI fuel producers, but less benefits overall for low-CI fuel producers. Increases in production costs and reductions in credit revenue for low-CI fuel producers negatively affect employment projections, as producers must cut employment to compensate for overall profit losses. Overall, the changes in employment do not exceed 0.05% of baseline California employment in any one year during the regulatory horizon.

The analysis will not fully capture all employment benefits from the proposed amendments. For instance: specific employment benefits for direct air capture were not included in the analysis due to a modeling limitation, the specific fuel pathways' supply chains are not perfectly captured in the model but instead modeled at a more aggregate level, and credit revenue to the electricity industry may be spent in ways that were not modeled, such as increased zero-emission infrastructure or rebates to EV customers which could result in increases in construction or consumer spending larger than those shown in this analysis. Importantly, the analysis of employment benefits captures only the portion that would occur in California, which is a subset of overall employment benefits for low-CI fuel industries resulting from the proposed amendments.

Table 12: Total California Employment Impacts⁸⁵

Year	California Employment	Change in Total Jobs	% Change
2026	25,898,820	4,096	0.02%
2030	26,126,846	-5,301	-0.02%
2034	26,441,359	-3,448	-0.01%
2038	27,000,858	-911	0.00%
2042	27,527,827	-9,442	-0.03%
2046	28,102,362	-12,909	-0.05%
Average	26,711,377	-4,085	-0.01%

Figure 8 illustrates employment impacts by major sector. The services and manufacturing sectors receive the majority of job increases until 2040 when all sectors show a decrease in job growth. The services and manufacturing sectors are projected to have initial increases in employment as resources are invested in development of low-CI fuel technologies, and then experience a decrease in employment over the baseline after the first five years. The decrease in employment after 2040 corresponds to the more stringent CI targets that increase operational costs without increasing output, given the stringency of the CI targets and the increase in direct air capture crediting.

⁸⁵ After the completion of the SRIA analysis, Finance released a population projection interim series informed by available 2020 Census data dated July 19, 2023. The interim projection released July 2023 has been incorporated into the macroeconomic results presented in this Form 399.

Figure 8: Employment Impacts by Major Sector

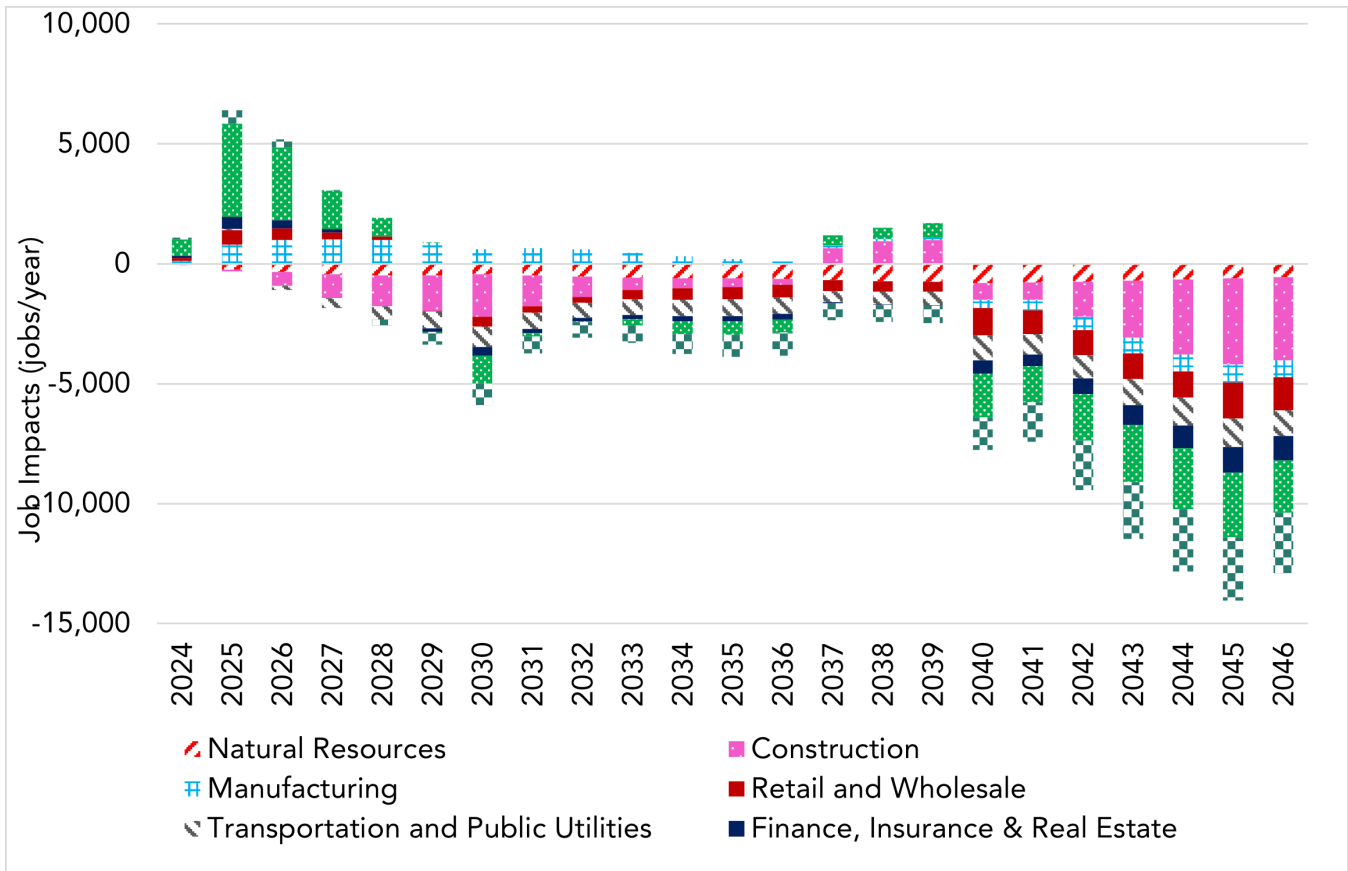


Table 13 presents changes in employment for industries directly impacted by the proposed amendments. Losses in jobs are largest in the petroleum and coal products manufacturing industry and are caused by reduced demand for these high-CI fuels as demand increases for low-CI fuels and increased production costs from the deficits generated by fossil gasoline and diesel fuels, with an average annual loss of 1,168 jobs when compared to the baseline. Basic chemical manufacturing employment increases by an average of 429 jobs annually, driven by credits generated by hydrogen, renewable diesel, ethanol, and alternative jet fuels and additional demand for these fuels. The electrical power generation, transmission, and distribution industry is expected to increase jobs by 741 positions annually associated with credit generation from electricity projects. Overall, between 2026 and 2046, California employment grows by 2.2 million jobs, increasing from 25.9 million jobs in 2026 to 28.1 million jobs in 2046.

Overall California’s employment continues to grow and averages 26.7 million jobs between 2024 and 2046. On average, across all industries the estimated job impacts are approximately 4,085 fewer jobs created when compared to the baseline, with over a quarter of those job losses coming from the petroleum sector. This net decline in employment, similar to the net cost of the Proposed Alternatives, is because all of the deficit generating businesses – and therefore the cost of the proposed amendments – are within California, while job growth associated with credit-generating businesses and revenues from low-CI fuel credits are distributed across the U.S. The decreases in employment for high-CI fuel producers is countered by increases in employment growth in industries that include producers of low-CI

fuels. These industries include basic chemical manufacturing, natural gas distribution, and electrical power generation, transmission, and distribution. For example, between 2026 and 2046, California employment grows by 2.2 million jobs, going from 25.9 million jobs in 2026 to 28.1 million jobs in 2046.

Table 13: Employment Changes of Proposed Regulation 2024-2046

Industry	Units	2026	2030	2034	2038	2042	2046	Average
Petroleum and coal products manufacturing (324)	Change in jobs	-665	-864	-1230	-1561	-1591	-1176	-1,168
Petroleum and coal products manufacturing (324)	Percent Change	-5.13%	-6.78%	-9.81%	-12.57%	-12.82%	-9.43%	-9.31%
Basic chemical manufacturing (3251)	Change in jobs	417	409	486	535	373	246	429
Basic chemical manufacturing (3251)	Percent Change	6.36%	6.06%	6.95%	7.43%	5.08%	3.28%	6.13%
Natural gas distribution (2212)	Change in jobs	37	28	21	-2	226	283	81
Natural gas distribution (2212)	Percent Change	0.27%	0.21%	0.17%	-0.02%	1.91%	2.47%	0.68%
Electric power generation, transmission, and distribution (2211)	Change in jobs	295	354	883	1,361	1,037	434	741
Electric power generation, transmission, and distribution (2211)	Percent Change	0.72%	0.92%	2.41%	3.87%	3.09%	1.35%	2.09%

C. The creation of new business or the elimination of existing businesses within the State of California.

The proposed amendments are not expected to directly result in business creation or elimination; specifically, the proposed amendments do not require any new businesses to be created nor do they require closure of any existing businesses.

However, the LCFS program has supported the creation or expansion of many businesses in California and the U.S., as shown by the hundreds of credit-generating participants in the program. The proposed amendments are anticipated to also support business creation or expansion in the areas of low-CI fuels. In industries that experience increased costs, the proposed amendments may also contribute to business contraction or eliminations. However, due to the variety of businesses that participate in the LCFS and the breadth of their business models, staff cannot predict a specific number of businesses created nor eliminated.

The macroeconomic modeling of the proposed amendments can also be used to understand some of the potential impacts to business creation and elimination. REMI Policy Insight Plus Version 3.0.0 is used to estimate the macroeconomic impacts of the proposed amendments on the California economy. Although the REMI model cannot directly estimate the creation or elimination of businesses, the model does estimate impacts to California jobs and output which can be used to understand some of the potential impacts to businesses. Reductions in output could indicate elimination of businesses within an industry. Conversely, increased output within an industry could signal the potential for additional business creation if existing businesses cannot accommodate all future demand. There is no threshold that identifies the creation or elimination of business.

The Statewide jobs and output impacts of the proposed amendments are small relative to the total California economy suggesting the proposed amendments will have a minimal impact on overall business expansion or contraction. The largest employment increase is estimated to be 0.02% for 2025 compared to the baseline. The largest employment decrease is estimated to be 0.05% for 2044 through 2046 compared to the baseline. Output is expected to decrease for the lifetime of the regulation compared to the baseline. The largest output decrease in the State is estimated to be 0.16% for 2040 through 2045. However, impacts to specific industries are larger or smaller as described in the previous sections.

D. The expansion of businesses currently doing business within the State of California.

The proposed amendments will increase the demand for low-carbon fuels, which provides an opportunity for businesses, both in-state and out-of-state, to increase revenue from the sale of low-carbon fuels in California. The sale of LCFS credits provides an additional revenue stream for these firms, enabling them to increase their market share and increase their competitiveness against high-CI fuels such as fossil gasoline or diesel.⁸⁶ In Table 15, staff monetized the value of the revenues generated by both in-state and out-of-state low-CI fuels. The value will vary based on the actual credit price.

Moreover, LCFS incentives may encourage California firms, as well as other firms doing business in California, to invest early in innovative, low-CI fuel technologies and develop mature businesses earlier than firms not participating in the California fuel market. Early investment may result in competitive advantages to these businesses as other state, federal,

⁸⁶ The LCFS incentive is incremental to incentives created by federal biofuel/low-carbon fuel policy, including the RFS.

or international jurisdictions adopt similar carbon intensity standards.⁸⁷ The proposed amendments will also help promote a wider range of clean fuels and vehicles for California businesses to choose from, including vehicles operating on electricity, hydrogen, and biomethane.

The proposed amendments also benefit California fuel providers that have compliance obligations under the Cap-and-Trade Program. As the LCFS reduces the CI of fuels, it changes the composition of the State’s transportation fuel mix and dependence on traditional petroleum-based fuels. CARB designed the LCFS and Cap-and-Trade Programs to complement one another. Investments made to comply with one of the programs may result in reduced compliance requirements for the other program. Increased use of low-carbon fuel due to the LCFS will reduce fuel suppliers’ GHG emissions covered by the Cap-and-Trade Program, reducing the Cap-and-Trade Program compliance obligation of these firms. Similarly, selling cleaner fuels or investing in emission reduction projects at California refineries and oil fields to comply with the Cap-and-Trade Program may also generate credits under the LCFS.

Table 14 summarizes the estimated increase in revenue to small and typical credit generating California companies⁸⁸ from the sale of LCFS credits due to the proposed amendments. To apportion credits between in-state and out-of-state businesses, staff used an assumed percentage for production in-state and out-of-state for each fuel type, which is detailed in Appendix C-1. Cumulatively, from 2024 through 2046, the proposed amendments are estimated to increase total revenue for credit generating businesses as compared to the baseline scenario by \$149 billion, of which approximately \$128 billion is estimated to accrue to California businesses.

Table 14: Estimated Increase in Revenue from LCFS Credit Sales under the Proposed Amendments Relative to Baseline (million 2021\$)

Year*	Typical California Businesses	California Small Business	Total California Businesses	Out-of-State Businesses	Total California and Out-of-State
2024	298	2	301	166	467
2025	4,108	19	4,127	1,326	5,454
2026	4,329	19	4,348	1,532	5,880
2027	4,019	15	4,034	1,290	5,325
2028	4,221	16	4,237	1,111	5,348
2029	4,016	15	4,031	951	4,982
2030	2,697	9	2,706	511	3,217

⁸⁷ Currently Oregon, Washington, British Columbia, Canada, Brazil, and the European Union have LCFS-like policies in place.

⁸⁸ “Typical credit generating California companies” are all California credit generators, excluding small businesses with less than 100 employees and earning less than 10 million in annual revenue.

Year*	Typical California Businesses	California Small Business	Total California Businesses	Out-of-State Businesses	Total California and Out-of-State
2031	4,769	15	4,784	732	5,516
2032	5,681	16	5,697	819	6,516
2033	6,033	16	6,050	735	6,785
2034	6,215	16	6,232	731	6,963
2035	6,426	16	6,443	635	7,078
2036	6,633	16	6,649	500	7,149
2037	8,895	22	8,918	708	9,625
2038	9,304	24	9,328	724	10,052
2039	9,733	26	9,760	765	10,525
2040	8,041	26	8,067	-	8,067
2041	8,827	26	8,853	1,353	10,206
2042	7,158	22	7,180	1,286	8,466
2043	5,676	19	5,695	1,244	6,939
2044	4,346	15	4,361	1,195	5,556
2045	3,357	12	3,370	1,245	4,614
2046	3,234	12	3,246	1,064	4,310
Total	128,017	399	128,416	20,623	149,040

* Years shown are samples from the regulatory period of 2024-2046. "Total" is the cumulative sum of revenues in all years from 2024 to 2046.

In addition to the benefits for California businesses, CARB estimates that small businesses will see benefits from the proposed amendments. Many of California's biodiesel producers, hydrogen producers, electric charging stations, hydrogen stations, and natural gas stations are small businesses. Staff identified the following small businesses in California, which represented 16% of the LCFS parties registered in the LCFS in September 2021:

- Three biodiesel providers
- Six natural gas (CNG and LNG) fueling station operators
- 21 electric charging station operators
- One propane provider

In total, these small businesses generated approximately 119,000 LCFS credits in 2021, which provided an estimated \$22 million in credit revenue as estimated using the 2021 average LCFS credit price of \$188.

The proposed amendments will increase the demand for low-CI fuels and are anticipated to increase the prices for LCFS credits relative to the baseline, thereby increasing revenue to these small businesses. In addition, larger potential revenue resulting from the proposed amendments may allow other small businesses to enter the market. Therefore, staff kept the 2021 credit total of 119,000 as a static proxy for future small business credit generation.

E. Significant Statewide Adverse Economic Impact Directly Affecting Business, Including Ability to Compete

The Executive Officer has made an initial determination that the proposed regulatory action would not have a significant statewide adverse economic impact directly affecting businesses, including the ability of California businesses to compete with businesses in other state, or on representative private persons.

F. The competitive advantages or disadvantages for businesses currently doing business within the State

The proposed amendments will increase the demand for low-carbon fuels, which provides an opportunity for businesses, both in-state and out-of-state, to increase revenue from the sale of low-carbon fuels in California. Indeed, California has continued to reduce emissions, and emissions per capita, while observing robust economic growth. Table 15 shows the potential LCFS credit revenue for several low-carbon fuels in 2025, 2030, 2035, 2040, and 2045. To allow comparison across fuels, the potential revenues are expressed as an equivalent gallon of either gasoline (GGE) or diesel (DGE) that the low-CI fuel displaces. The sale of LCFS credits provides an additional revenue stream for these firms, enabling them to increase their market share and increase their competitiveness against high-CI fuels such as fossil gasoline or diesel.⁸⁹ In Table 15, staff monetized the value of the revenues generated by both in-state and out-of-state low-CI fuels. The value will vary based on the actual credit price.

⁸⁹ The LCFS incentive is incremental to incentives created by federal biofuel/low-carbon fuel policy, including the RFS.

Table 15: Value Added from LCFS Credit for Low Carbon Fuels under the Proposed Amendments

Fuel	Average CI Value (gCO ₂ e/MJ)	2025	2030	2035	2040	2045	Units
<i>Proposed Amendments Estimated Credit Price*</i>		\$221	\$76	\$138	\$221	\$105	\$/MT
Corn Ethanol**	55	0.66	0.13	-0.12	-0.77	-0.55	\$/gge
Electricity**	64	5.39	1.52	1.54	0.52	-0.37	\$/gge
Hydrogen**	-79	7.20	2.25	3.40	4.31	1.38	\$/dge
Biodiesel**	40	1.37	0.35	0.28	-0.15	-0.42	\$/dge
Renewable Diesel**	44	1.25	0.31	0.20	-0.27	-0.48	\$/dge
Landfill NG	45	0.96	0.22	0.08	-0.41	-0.51	\$/dge
Dairy NG	-293	11.01	3.68	6.35	9.64	4.26	\$/dge

* The following EERs were used for this calculation: 2.5 for hydrogen, 3.4 for electricity, and 0.9 for landfill NG and dairy NG.⁹⁰

** Hydrogen CI shown is the average of all hydrogen pathways as of August 2023 in the CATS model. Electricity CI is the average value from SP projections from 2023-2046. Corn ethanol CI is the average of projections from 2023-2046 as of August 2023 in the CATS model. Biodiesel and renewable diesel CIs are the average of waste and virgin oil pathway CIs as of August 2023 in the CATS model.

Moreover, LCFS incentives may encourage California firms, as well as other firms doing business in California, to invest early in innovative, low-CI fuel technologies and develop mature businesses earlier than firms not participating in the California fuel market. Early investment may result in competitive advantages to these businesses as other state, federal, or international jurisdictions adopt similar carbon intensity standards.⁹¹ The proposed amendments will also help promote a wider range of clean fuels and vehicles for California

⁹⁰ “Energy Economy Ratio (EER)” means the dimensionless value that represents the efficiency of a fuel as used in a powertrain as compared to a reference fuel. EERs are often a comparison of miles per gasoline gallon equivalent (mpge) between two fuels.

⁹¹ Currently Oregon, Washington, British Columbia, Canada, Brazil, and the European Union have LCFS-like policies in place.

businesses to choose from, including vehicles operating on electricity, hydrogen, and biomethane.

The proposed amendments also benefit California fuel providers that have compliance obligations under the Cap-and-Trade Program. As the LCFS reduces the CI of fuels, it changes the composition of the State's transportation fuel mix and reduces dependence on traditional petroleum-based fuels. CARB designed the LCFS and Cap-and-Trade Programs to complement one another. Investments made to comply with one of the programs may result in reduced compliance requirements for the other program. Increased use of low-carbon fuel due to the LCFS will reduce fuel suppliers' GHG emissions covered by the Cap-and-Trade Program, reducing the Cap-and-Trade Program compliance obligation of these firms. Similarly, selling cleaner fuels or investing in emission reduction projects at California refineries and oil fields to comply with the Cap-and-Trade Program may also generate credits under the LCFS.

Because the proposed amendments are designed to increase the competitiveness of low-CI fuels in California, California businesses that produce low-CI fuels may become more competitive. Petroleum fuel producers will face increased compliance costs under the proposed amendments. California sectors that rely heavily on fossil transportation fuel may also face higher prices, resulting in a potential competitive disadvantage relative to out-of-state entities that are not subject to the LCFS. However, as sectors transition to lower CI transportation fuels, they will realize lower operational costs and increased competitiveness associated with a more diverse liquid fuel pool and/or vehicle efficiency gains associated with transitioning to zero emission vehicles. Staff analysis of costs associated with this transition suggest that the cost per mile driven will decline by 42% between 2022 and 2046. Although LCFS credits help support increased deployment of zero emission vehicles by providing funding for both zero emission infrastructure and vehicle purchases, this analysis does not claim the vehicle-side benefits of increased zero emission vehicle deployment because those benefits have previously been attributed to the implementation of CARB's vehicle regulations. Additionally, any potential impact of the proposed amendments on the competitiveness of California businesses will likely be reduced as more low-carbon fuel policies similar to California's LCFS are adopted across North America. Oregon, Washington, and British Columbia all have similar clean fuels programs to California's program, and several other states are considering their own programs.

G. The increase or decrease of investment in the state

Private domestic investment consists of purchases of residential and nonresidential structures and of equipment and software by private businesses and nonprofit institutions. It is used as a proxy for impacts on investments in California because it provides an indicator of the future productive capacity of the economy.

The proposed amendments require implementing processes that substitute low-carbon sources of energy, such as waste oils and renewable electricity, in place of fossil fuel sources. The proposed amendments, and the LCFS more broadly, are structured to encourage ongoing innovation and improvement in reducing the carbon intensity of transportation fuels as well as investment in innovative direct air capture and carbon capture, utilization, and sequestration approaches. Over the past decade, the LCFS has resulted in approximately 650 Tier 2 fuel pathway certifications under the current CA-GREET3.0 model, which includes more complex and innovative production methods than are represented by more conventional pathways. The proposed amendments are expected to continue to incentivize investment in low-carbon fuel

production. The proposed amendments will also lead to an overall higher price for LCFS credits relative to the baseline, which will send a signal for research, development, and deployment of innovative technologies and fuels that support California’s long-term GHG emissions reduction goals.

The economic modeling utilized for the economic analysis is not structured to capture these types of innovation in the transportation fuel market and focuses on the direct impacts of the proposed amendments. Given the limitations of the model and the fact that some of the benefits of the proposed amendments likely have an unquantifiable impact on innovation in the transportation fuels sector, as modeled, the proposed amendments result in slight annual private investment decreases of \$11 million on average. The difference in private investment for the proposed amendments is modest and does not exceed 0.10% of baseline investment across the analytical time period for any one year and averages no percentage change over the regulatory horizon (Table 16).

Table 16: Change in Private Investment

Year	Private Investment (2023M\$)	Change (2023M\$)	% Change
2026	631,710	-28	0.00%
2030	684,020	-386	-0.06%
2034	739,174	99	0.01%
2038	811,556	684	0.08%
2042	882,928	102	0.01%
2046	957,233	-752	-0.08%
Average	766,518	-11	0.00%

H. The incentives for innovation in products, materials, or processes

As mentioned above, the proposed amendments will incentivize research, development, and deployment of innovative technologies and fuels that support California’s long-term GHG emissions reduction goals and displace fossil fuels.

All fuel producers will have an increased incentive to innovate and deploy new methods that reduce the CI of their fuels. The proposed amendments will additionally provide long term price stability for LCFS credits, which is essential for low-CI fuel producers to make investments in long-term capital projects and research and development.

I. The benefits of the regulation to the health and welfare of California residents, worker safety, and the state's environment.

The proposed amendments are designed to reduce toxic air contaminant, criteria pollutant, and GHG emissions by decrease the carbon intensity of California's transportation fuel pool and reducing dependence on petroleum fuel. Cumulatively, from 2024 to 2046, the proposed amendments are expected to reduce statewide transportation emissions by approximately 4,281 tons of PM2.5 and 25,586 tons of NOx relative to the baseline. The total statewide valuation of avoided health outcomes from 2024 to 2046 is approximately \$5 billion. These reductions in toxic air contaminants and criteria pollutant emissions may improve safety for workers, particularly at freight hubs, where substitution of renewable diesel for fossil diesel will reduce exposure to harmful air pollution. For detailed information on health and emissions benefits of the proposed regulation, see Chapter IV.

The proposed regulations provide credit generating revenue to California businesses of \$128.4 billion over the lifetime of the regulation. The total monetized benefit from credit revenue and avoided health outcomes of the proposed amendment is \$133.4 billion.

As Californians transition away from fossil fuels and into more energy efficient ZEVs and lower-carbon fuel alternatives, CARB staff estimates that the fuel costs Californians pay to travel will also decrease, resulting in billions of dollars in savings on fuel costs each year. The regulations CARB has adopted (e.g. ACC II, ACF/ACT) in combination with the LCFS will help to increase the deployment of vehicles with higher fuel efficiency (e.g. BEVs/FCEVS) and reduce the costs of the alternative fuels into the future.

CARB staff estimates the amount of money Californians spend on transportation costs across all vehicle classes could be up to 42% lower in 2045 than compared to the amount of money spent on transportation in 2021. This translates into an annual savings of over \$20 billion⁹² in fuel expenditures in 2045 alone. Each year between 2025 and 2045 CARB estimates the annual fuel cost savings will increase as Californians transition away from fossil gasoline and diesel expenditures and increase their use of more efficient vehicles and the use of low-carbon fuels. In 2021, expenditures on fossil gasoline and fossil diesel made up approximately 93% of the State's total transportation fuel costs, and on a per mile basis gasoline and diesel combined cost Californians approximately \$0.20 per mile. In 2045, with implementation of CARB's vehicle regs and LCFS, California will have significantly reduced the amount of fossil gasoline and diesel used in California. CARB staff estimated that in 2045, over 75% of the State's transportation fuel expenditures will go to non-fossil alternative fuels like electricity, hydrogen, and low-carbon biofuels, and that Californian's will be paying \$0.12 per mile traveled, for an overall 42% savings in fuel costs per mile statewide (see Figure 9 and Table 17). For the light duty sector, the savings will be even more pronounced, with costs going from \$0.19 per mile to \$0.08 per mile by 2045, an over 50% reduction in costs as the light-duty sector transitions away from fossil fuels and becomes mostly ZEVs supplied by electricity and hydrogen.

⁹² These costs savings were not reflected in the SRIA because the economic modeling conducted for the SRIA was limited to calculating the direct costs associated with the purchase of LCFS credits.

The SRIA for this rulemaking (Appendix C-1) included Table 22 which provided a potential cost-pass through for select fossil fuels. However, this metric was incomplete as it looked only at fossil fuels and did not capture all of the transportation fuels that will be available in response to these regulatory updates. The fuel cost per mile metric described above incorporates the costs for all transportation fuels into one metric and provides a more comprehensive and accurate metric of costs to California consumers. Furthermore, retail fossil fuel prices are strongly influenced by many factors beyond LCFS credit prices (e.g., global events, holiday weekends, seasonal fluctuations, refinery disruptions and decisions about production that affect supply, refinery pricing decisions, seasonal fuel blends, taxes) and fossil fuel producer pricing strategies are complex and reflect local and regional market conditions. Few of these factors are determined by government entities, including the State of California. Between 2017 and 2022, the retail price of gasoline fell as low as \$3.08 and rose as high as \$5.41, and similarly for diesel, the retail price ranged between \$3.07 and \$6.02.⁹³ Predicting how LCFS credit price changes impact these complex pricing strategies and the per gallon gasoline and diesel prices paid at the pump in the future by consumers is beyond the scope of this work.

Instead of providing a per gallon price, the SRIA included a narrow analysis on retail fossil fuels as an estimate of the upper bound of possible consumer price impacts based on the carbon content of fuel, without consideration for the complex fossil fuel pricing strategies or the availability and impact of other competing fuels (e.g., biofuels, electricity, hydrogen, etc.) on fuel prices. The SRIA took a very conservative approach- assuming, for example, that maximum possible costs of the program compliance would be passed through to fossil fuel consumers while no benefits of program credits (e.g., for competing fuels) would be passed through as savings to consumers. Importantly, the SRIA did not represent the actual cost pass-through that would happen in the real world. Actual costs of pass-through depends on how much fossil fuel is still in use, the supply of clean fuel, and credits in the market. In addition to having a narrow and incomplete focus on fossil fuel cost impacts, the SRIA was a point-in-time analysis that represented policy decisions that are different than this regulatory proposal and it is no longer an up-to-date assessment to reference in the context of current proposed changes to the Program. As laid out above, fossil fuel in use and deficits under the Program will go down over time as the zero-emissions vehicle (ZEV) population increases. Clean fuels will increase as the program becomes more stringent and a stronger market signal is supported and the costs of some of the lowest carbon fuels will fall over time as the technology to produce and use these fuels is deployed. Federal incentives and funding will also help support clean fuel production and deployment at lower costs. Finally, the program has a price ceiling to ensure credit prices do not go unchecked. This further ensures that the cost pass-through is managed and unnecessary costs of the program are not passed on to consumers.

In short, just as LCFS credit prices have not shown any historical correlations with retail gasoline prices, there is no expectation that a more stringent Program would lead to higher

⁹³ United States Energy Information Administration, *Annual Retail Gasoline and Diesel Prices* (Updated on July 31, 2023). https://www.eia.gov/dnav/pet/pet_pri_gnd_dcus_sca_a.htm

fossil fuel transportation costs for Californians in view of the combination of factors detailed above that can impact retail gasoline prices.

Figure 9: California's Fuel Expenditures by Type

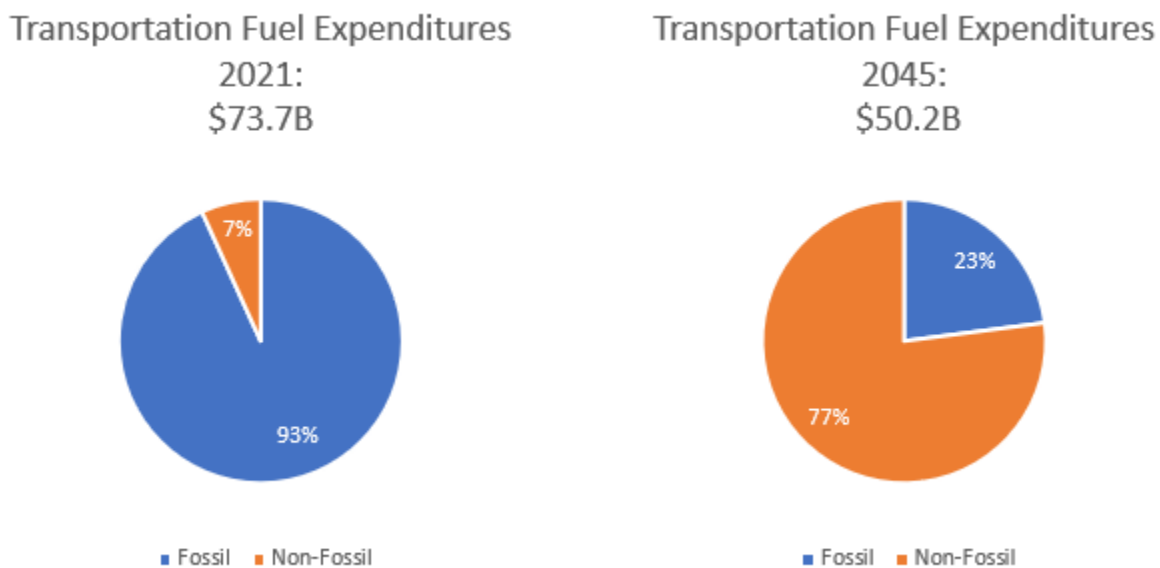


Table 17: Transportation Cost Metrics

Transportation Cost Metrics	2021	2030	2045
Total Expenditures (Billions)	\$73.7	\$62.5	\$50.2
Average cost-per-mile for all fuels	\$0.21	\$0.17	\$0.12

IX. Evaluation of Regulatory Alternatives

Government Code section 11346.2, subdivision (b)(4) requires CARB to consider and evaluate reasonable alternatives to the proposed regulatory action and provide reasons for rejecting those alternatives. This section discusses alternatives evaluated and provides reasons why these alternatives were not included in the proposal. As explained below, no alternative proposed was found to be less burdensome and equally effective in achieving the purposes of the regulation in a manner that ensures full compliance with the authorizing law.

The primary objectives of the proposed LCFS regulation include the following:

1. Improve California's long-term ability to support the production and use of increasingly lower-CI transportation fuels and to improve the program's overall effectiveness;
2. Update the annual carbon intensity benchmarks through 2030 and establish more stringent post-2030 benchmarks in alignment with the 2022 Scoping Plan Update;
3. Increase the flexibility of the program to adjust for potential future market over-performance by including a mechanism that would automatically accelerate the compliance targets under certain conditions;
4. Include a step-down in the near-term CI target to further support ambition;
5. Incentivize fuel production and refueling infrastructure buildout needed to meet California's long-term climate goals and reduce dependence on petroleum fuels, including opportunities to leverage federal funding for low-carbon hydrogen production and ZEV fueling, and support the transition of biomethane fuel pathways for combustion out of transportation;
6. Update standard values in the regulation, including emission factors, as well as life cycle assessment (LCA) modeling tools to use more detailed or recent data;
7. Streamline implementation of the program; and
8. Make minor updates for typographical errors and specifications of intent.

A. Alternatives to the Regulation

CARB solicited public input regarding alternatives to the proposed amendments. This solicitation was presented and discussed at a workshop held on November 9, 2022.⁹⁴ In the

⁹⁴ California Air Resources Board, *Low Carbon Fuel Standard Public Workshop: Concepts and Tools for Compliance Target Modeling*. November 9, 2022. <https://ww2.arb.ca.gov/sites/default/files/2022-11/LCFSPresentation.pdf>

solicitation, staff requested that alternatives be submitted by December 2, 2022. Several stakeholders responded to the solicitation by proposing alternatives.

Staff analyzed two regulatory alternatives to the proposed amendments and analyzed two additional concepts, which are discussed in detail Section B. Both regulatory alternatives increase the stringency of benchmarks beyond the baseline since more low-CI fuels are entering the market than previously expected, and CI reductions are outpacing the current benchmark schedule. They both reach a 90% benchmark reduction in 2045 but have different rates of change in the interim years in order to provide analysis on the comparative cost and benefits of more rapidly declining benchmarks in early years as compared to later years.

While the overall benchmark schedule of the first alternative (based off proposals and stakeholder feedback) is more stringent than the baseline, it is less stringent than the proposed amendments and has a 3% step-down, achieving a 28% CI reduction in 2030. The second alternative (based off proposals and stakeholder feedback) is more aggressive than the proposed amendments and achieves a CI reduction target of 35% by 2030, after a 5% step-down and a linear compliance trajectory from 2025 to 2030. Both alternatives reach the same 90% CI reduction in 2045 as the proposed amendments but have different compliance curves from 2025-2045 to account for the difference in their 2030 targets, as shown in Figure 10 and Table 18. Although the scenarios reach the same end-goal of 90% CI reduction in 2045, Alternative 1 is the least stringent through 2030, while Alternative 2 reflects the higher costs of front-loading the stringency of the CI targets through 2030.

Figure 10: Carbon Intensity Compliance Curves for Each Alternative

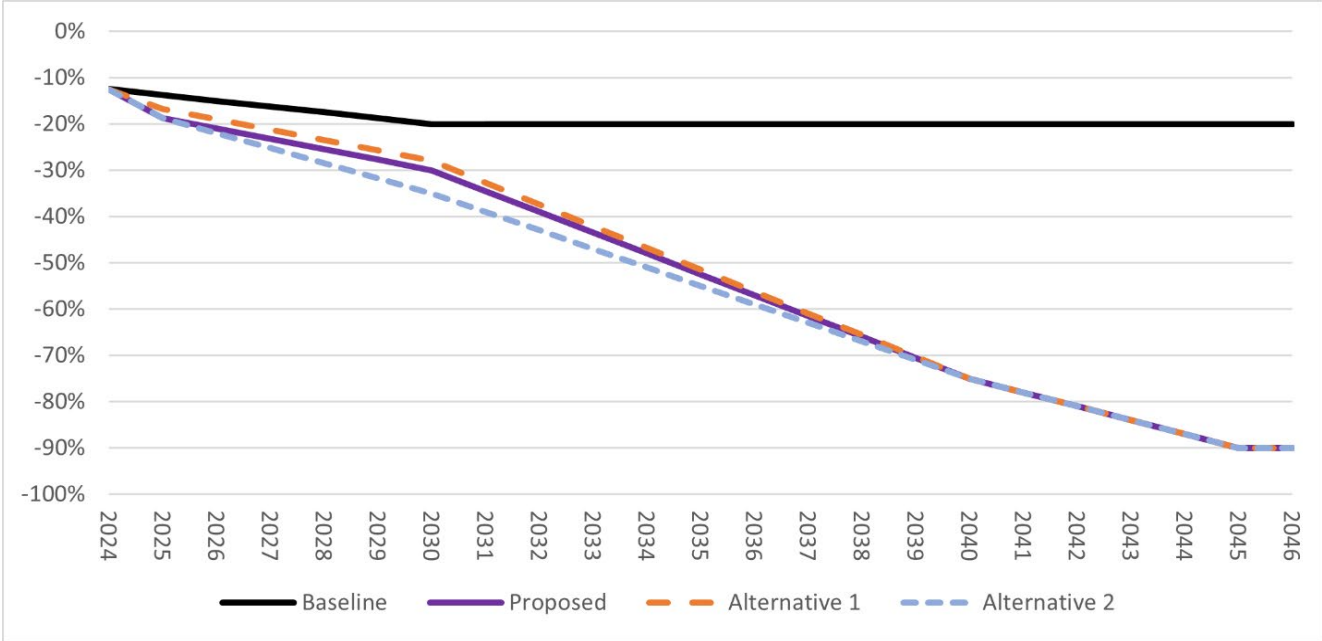


Table 18: CI Target Benchmark Percent Reduction for the Proposed Amendments and Alternatives

Year	Proposed Amendments	Alternative 1	Alternative 2
2024	12.5%	12.4%	12.4%
2025	18.75%	16.8%	18.6%
2026	21.0%	19.0%	21.9%
2027	23.25%	21.3%	25.2%
2028	25.5%	23.5%	28.5%
2029	27.75%	25.8%	31.7%
2030	30.0%	28.0%	35.0%
2031	34.5%	32.7%	39.0%
2032	39.0%	37.4%	43.0%
2033	43.5%	42.1%	47.0%
2034	48.0%	46.8%	51.0%
2035	52.5%	51.5%	55.0%
2036	57.0%	56.2%	59.0%
2037	61.5%	60.9%	63.0%
2038	66.0%	65.6%	67.0%
2039	70.5%	70.3%	71.0%
2040	75.0%	75.0%	75.0%
2041	78.0%	78.0%	78.0%
2042	81.0%	81.0%	81.0%

Year	Proposed Amendments	Alternative 1	Alternative 2
2043	84.0%	84.0%	84.0%
2044	87.0%	87.0%	87.0%
2045	90.0%	90.0%	90.0%
2046	90.0%	90.0%	90.0%

1. Alternative 1

Compared to the proposed amendments, Alternative 1 has a less stringent CI compliance curve before 2030. It then accelerates to meet the same 90% carbon reduction in 2045 but is more stringent than the baseline. Compared to the proposed amendments, this scenario is less stringent in the early years when aggressive CI reductions are expected to be more expensive and challenging to meet because some renewable fuel production has yet to reach economies of scale. Figure 11 shows the resultant low-CI fuel volumes.

Alternative 1 is more easily attainable given current supplies of low-CI fuels and requires fewer additional low-CI fuels in early years. Accordingly, Alternative 1 includes several policy mechanisms that have the effect of limiting the number of credits created from existing low-CI pathways. For example, Alternative 1 includes a complete phase out of light-duty battery electric forklifts from the program. Alternative 1 also includes a limit on total credits from diesel fuels or sustainable aviation fuel produced from virgin oil feedstocks. Figure 11 and Figure 12 depict the alternative fuel volume and total fuel mix for Alternative 1.

Figure 11: Low-CI Fuel Volumes in the Alternative 1 Scenario

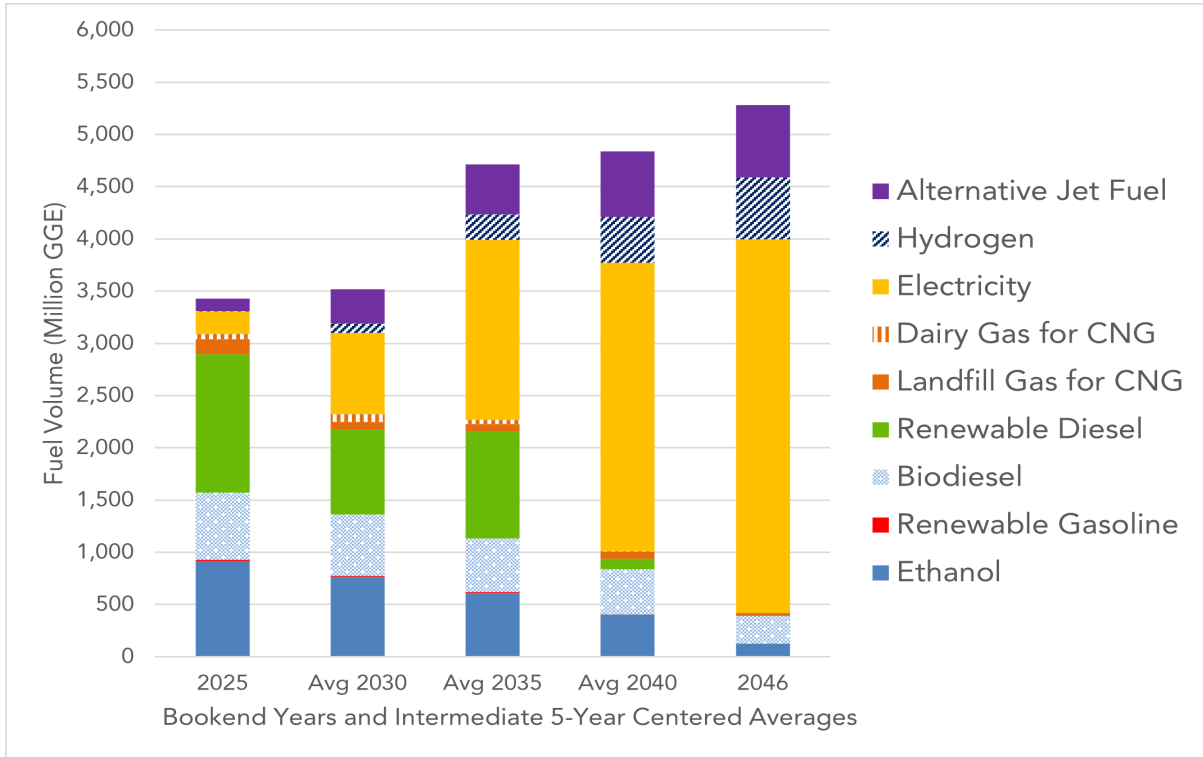
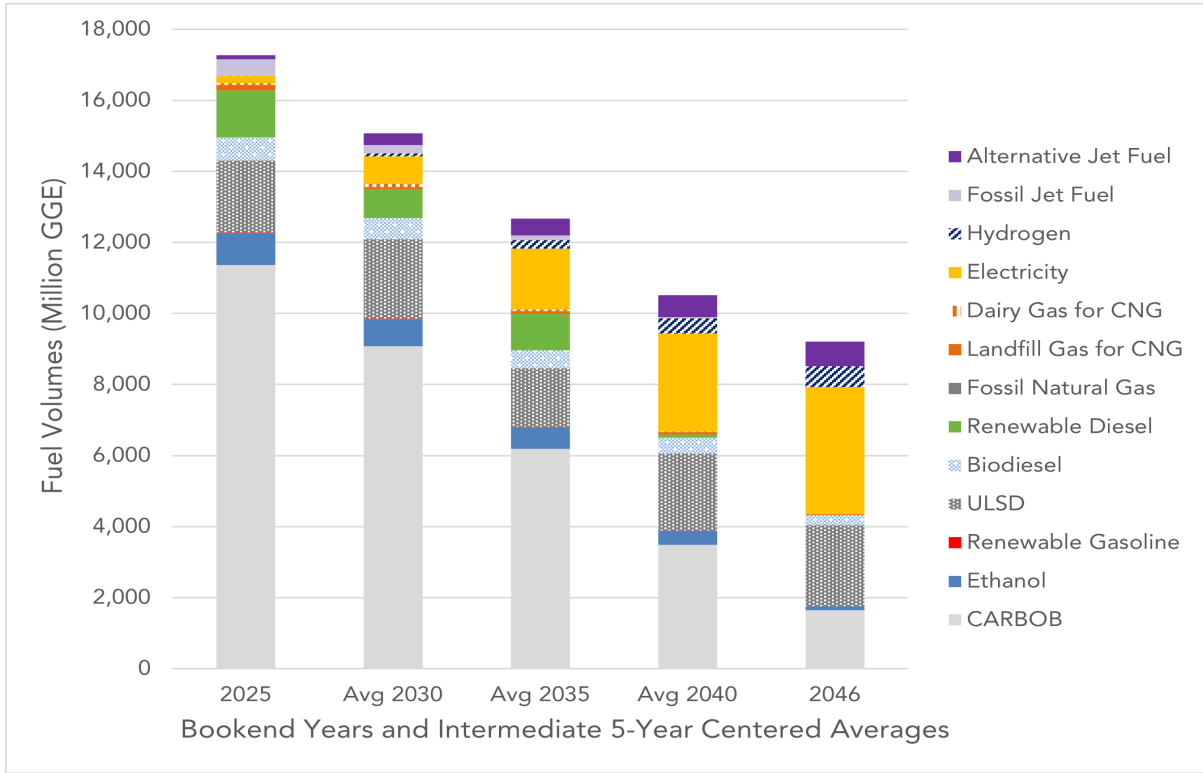


Figure 12: Fuel Mix – Alternative 1 Scenario



a) Costs

Alternative 1 has total costs of \$162 billion, approximately 1% more than the proposed amendments. The main reason is that diesel fuel is a larger part of the fuel mixture and continues generating large amounts of in-state deficits through 2046. This is because renewable diesel produced from virgin oil feedstock is phased out, waste oil feedstocks are used to produce alternative jet fuel, and more fossil diesel is needed to fuel the remaining vehicles with internal combustion engines. Credit revenues to low-carbon fuel producers in California are \$126 billion, 2% less than the proposed amendments.

Table 19: Estimated Total Direct Costs to California of Alternative 1 to Deficit Generators and on Statewide Fuel Expenditures Relative to Baseline (million 2021\$)

Year	Verification Cost	Purchasing Credits	Statewide Fuel Expenditures	Total Cost	Total Revenues	Net Cost
2024	18	736	10	764	508	255
2025	24	2617	107	2,748	1,906	843
2026	33	2915	176	3,124	2,241	883
2027	45	2636	259	2,941	1,930	1,011

Year	Verification Cost	Purchasing Credits	Statewide Fuel Expenditures	Total Cost	Total Revenues	Net Cost
2028	60	4138	262	4,459	3,275	1,184
2029	78	4395	206	4,678	3,604	1,074
2030	98	3077	123	3,299	2,633	665
2031	122	6196	158	6,475	5,214	1,261
2032	145	6507	240	6,893	5,678	1,215
2033	171	6713	340	7,223	5,877	1,346
2034	199	6800	374	7,373	6,117	1,257
2035	229	6837	378	7,444	6,259	1,185
2036	259	6770	387	7,416	6,292	1,124
2037	288	11407	343	12,038	10,478	1,560
2038	318	11953	298	12,569	10,158	2,411
2039	346	11966	281	12,594	9,819	2,775
2040	373	12024	270	12,667	8,280	4,387
2041	399	11383	265	12,047	9,692	2,355
2042	424	9158	261	9,843	7,721	2,122
2043	445	7542	240	8,227	6,175	2,051
2044	465	6138	231	6,834	4,865	1,969
2045	484	4958	-71	5,371	3,718	1,653
2046	503	4658	-70	5,091	3,595	1,496
Total	5,525	151,525	5,068	162,118	126,035	36,083

b) Benefits

i) Emissions

Alternative 1 reduces GHG emissions by 461 MMTCO₂e compared to the baseline scenario (as shown in Figure 13). This is approximately 18% fewer reductions than the proposed amendments. Accordingly, the social cost of carbon benefits for Alternative 1 from reduced CO₂e range from approximately \$12 to \$50 billion, values approximately 18% lower than the proposed amendments. Table 20 shows the change in NO_x and PM_{2.5} as compared to the baseline. Alternative 1 results in a reduction in cumulative NO_x emissions by 14,605 tons and a decrease in PM_{2.5} emissions by 1,508 tons. Compared to the proposed amendments, Alternative 1 increases NO_x emissions by an additional 10,981 tons and increases PM_{2.5} emissions by 2,773 tons. Alternative 1 has more NO_x and PM_{2.5} emissions than the proposed amendments because this scenario uses less renewable diesel than the proposed amendments.

Figure 13: Alternative 1 - GHG Emissions

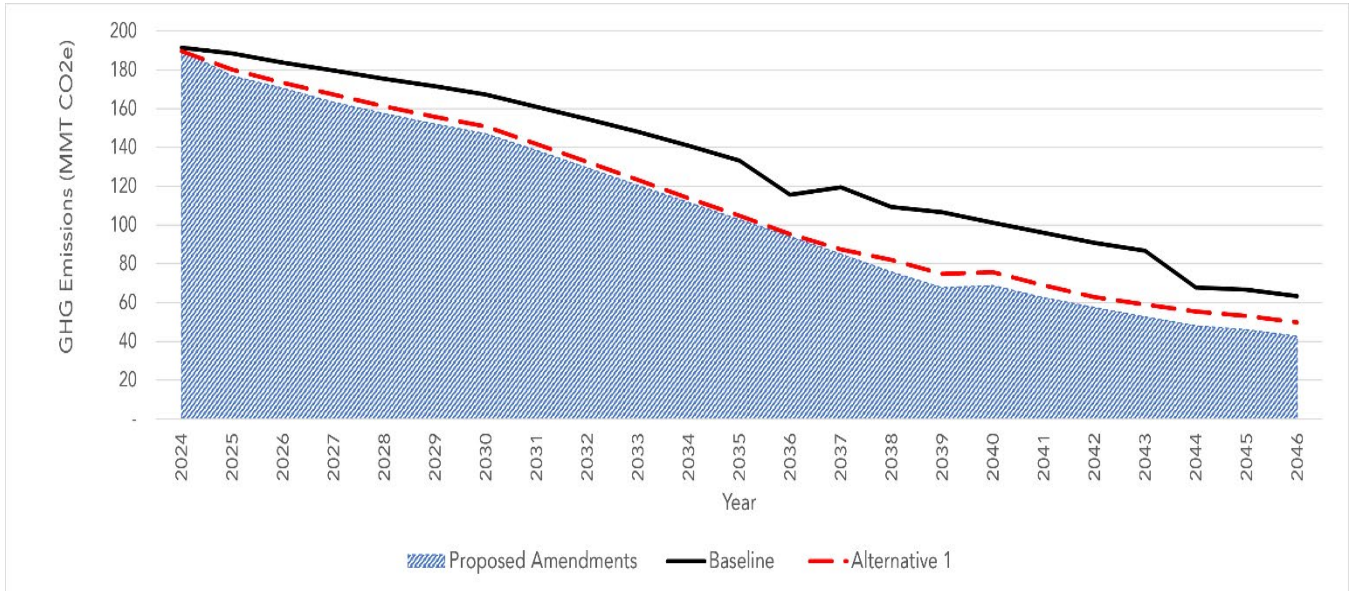


Table 20: Alternative 1 – NOx and PM2.5 Emission Changes (tons per day)

Year	NOx (tpd)	PM2.5 (tpd)
2024	-0.5	-0.1
2025	-1.2	-0.1
2026	-1.1	-0.1
2027	-2.0	-0.3
2028	-2.3	-0.3
2029	-1.5	-0.2
2030	-1.0	-0.1
2031	-0.8	0.0
2032	-1.7	-0.2
2033	-2.3	-0.3
2034	-2.8	-0.4
2035	-3.0	-0.4
2036	-3.2	-0.5
2037	-2.1	-0.3
2038	-1.0	-0.1
2039	-0.9	0.0
2040	-0.9	-0.1
2041	-1.0	-0.1
2042	-1.3	-0.2
2043	-1.9	-0.1
2044	-2.3	-0.1
2045	-2.5	-0.1
2046	-2.7	-0.1

ii) Health Benefits

Staff used the methods described in Chapter IV, to estimate avoided cardiopulmonary mortality, hospitalizations for cardiovascular illness and respiratory illness, and emergency room visits for respiratory illness and asthma that would be expected to result from implementing Alternative 1 when compared to the Baseline scenario. The results are presented in Table 21 for each California air basin. As shown in Table 22, Alternative 1 has a valuation of health benefits at \$1.58 billion compared to the proposed amendments with a valuation of \$4.98 billion, a difference of \$3.4 billion less in health benefits. The lower avoided health impacts of Alternative 1 are primarily associated with increases in PM_{2.5} over the baseline due to lower utilization of renewable diesel.

Table 21: Alternative 1 - Avoided Mortality and Morbidity Incidents from 2024 to 2046

Air Basin	SC	SCC	SJV	SFB	SD	Statewide
Cardiopulmonary Mortality	48 (27 - 67)	6 (3 - 8)	30 (17 - 43)	12 (6 - 17)	13 (7 - 18)	119 (66 - 168)
Hospitalizations for Cardiovascular Disease	9 (7 - 12)	1 (1 - 2)	6 (4 - 7)	2 (2 - 3)	3 (2 - 4)	24 (17 - 30)
Cardiovascular ED Visits	14 (-5 - 32)	1 (-1 - 3)	7 (-3 - 17)	4 (-1 - 8)	3 (-1 - 8)	32 (-12 - 75)
Acute Myocardial Infarction	6 (2 - 15)	1 (0 - 2)	3 (1 - 8)	1 (1 - 4)	1 (0 - 4)	13 (5 - 36)
Hospitalizations for Respiratory Disease	1 (0 - 3)	0 (0 - 0)	1 (0 - 2)	0 (0 - 1)	0 (0 - 1)	4 (0 - 7)
Respiratory ED Visits	29 (6 - 59)	3 (1 - 6)	20 (4 - 41)	9 (2 - 18)	6 (1 - 13)	74 (14 - 153)
Lung Cancer Incidence	3 (1 - 5)	0 (0 - 1)	2 (1 - 3)	1 (0 - 2)	1 (0 - 2)	9 (3 - 14)
Asthma Onset	105 (102 - 109)	14 (13 - 14)	55 (53 - 57)	42 (40 - 43)	31 (29 - 32)	270 (260 - 280)
Asthma Symptoms	10,221 (-5,020 – 24,634)	1,248 (-610 – 3,021)	5,059 (-2,476 – 12,235)	3,585 (-1,749 – 8,695)	2,619 (-1,276 – 6,359)	24,920 (-12,197 – 60,258)
Work Loss Days	7,117 (6,012 – 8,176)	833 (703 - 959)	3,847 (3,247 – 4,423)	2,402 (2,025 – 2,763)	2,140 (1,804 – 2,463)	17,862 (15,077 – 20,538)
Hospitalizations for Alzheimer's Disease	15 (13 - 16)	2 (2 - 2)	12 (10 - 15)	5 (4 - 6)	9 (7 - 12)	47 (38 - 55)
Hospitalizations for Parkinson's Disease	2 (1 - 3)	0 (0 - 1)	2 (1 - 2)	1 (1 - 1)	1 (1 - 2)	7 (4 - 10)

Table 21 continued

Air Basins	SS	SV	NP	NC	NCC	Statewide
Cardiopulmonary Mortality	3 (2 - 5)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	1 (1 - 2)	119 (66 - 168)
Hospitalizations for Cardiovascular Disease	1 (0 - 1)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	24 (17 - 30)
Cardiovascular ED Visits	1 (0 - 2)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 1)	32 (-12 - 75)
Acute Myocardial Infarction	0 (0 - 1)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	13 (5 - 36)
Hospitalizations for Respiratory Disease	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	4 (0 - 7)
Respiratory ED Visits	3 (1 - 6)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	1 (0 - 3)	74 (14 - 153)
Lung Cancer Incidence	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	9 (3 - 14)
Asthma Onset	9 (8 - 9)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	5 (5 - 5)	270 (260 - 280)
Asthma Symptoms	785 (-382 - 1,908)	59 (-29 - 141)	-27 (13 - -67)	-30 (15 - -74)	425 (-207 - 1,032)	24,920 (-12,197 - 60,258)
Work Loss Days	583 (491 - 671)	13 (11 - 15)	-19 (-16 - -22)	-30 (-26 - -35)	293 (247 - 337)	17,862 (15,077 - 20,538)
Hospitalizations for Alzheimer's Disease	1 (1 - 1)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 1)	47 (38 - 55)
Hospitalizations for Parkinson's Disease	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	7 (4 - 10)

Table 21 continued

Air Basin	MC	MD	LT	LC	GBV	Statewide
Cardiopulmonary Mortality	-1 (0 - -1)	7 (4 - 10)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	119 (66 - 168)
Hospitalizations for Cardiovascular Disease	0 (0 - 0)	1 (1 - 2)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	24 (17 - 30)
Cardiovascular ED Visits	0 (0 - 0)	2 (-1 - 4)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	32 (-12 - 75)
Acute Myocardial Infarction	0 (0 - 0)	1 (0 - 2)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	13 (5 - 36)
Hospitalizations for Respiratory Disease	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	4 (0 - 7)
Respiratory ED Visits	0 (0 - -1)	4 (1 - 8)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	74 (14 - 153)
Lung Cancer Incidence	0 (0 - 0)	0 (0 - 1)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	9 (3 - 14)
Asthma Onset	-1 (-1 - -2)	12 (11 - 12)	1 (1 - 1)	0 (0 - 0)	0 (0 - 0)	270 (260 - 280)
Asthma Symptoms	-126 (61 - -305)	1,069 (-521 - 2,597)	40 (-20 - 98)	-2 (1 - -6)	-4 (2 - -10)	24,920 (-12,197 - 60,258)
Work Loss Days	-103 (-87 - -118)	757 (638 - 871)	37 (32 - 43)	-2 (-2 - -3)	-4 (-3 - -5)	17,862 (15,077 - 20,538)
Hospitalizations for Alzheimer's Disease	0 (0 - 0)	3 (2 - 3)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	47 (38 - 55)
Hospitalizations for Parkinson's Disease	0 (0 - 0)	0 (0 - 1)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	7 (4 - 10)

Table 22: Alternative 1 Number of Avoided Health Outcomes and Valuation (million 2021\$)

Avoided Health Incident	2026	2030	2034	2038	2042	2046	Total
Cardiopulmonary Mortality	68	48	184	26	8	2	1,555
Hospitalizations for Parkinson's Disease	<1	<1	<1	<1	<1	<1	<1
Respiratory ED Visits	<1	<1	<1	<1	<1	<1	<1
Hospitalizations for Alzheimer's Disease	<1	<1	<1	<1	<1	<1	1
Hospitalizations for Cardiovascular Disease	<1	<1	<1	<1	<1	<1	<1
Cardiovascular ED Visits	<1	<1	<1	<1	<1	<1	<1
ER visits, respiratory	<1	<1	<1	<1	<1	<1	<1
Asthma Onset	<1	<1	2	<1	<1	<1	15
Asthma Symptoms	<1	<1	<1	<1	<1	<1	6
Lung Cancer Incidence	<1	<1	<1	<1	<1	<1	<1
Acute Myocardial Infarction	<1	<1	<1	<1	<1	<1	1
Work Loss Days	<1	<1	<1	<1	<1	<1	4
Total Valuation	69	49	187	26	8	2	1,583

c) Economic Impacts

Alternative 1 is less stringent than the proposed amendments since Alternative 1 uses less stringent CI targets, which in turn result in a smaller credit market overall and lower compliance costs. Lower compliance costs translate to a smaller overall effect on the California economy, but at the cost of not achieving as many GHG emissions reductions.

The macroeconomic impact analysis results shown in Table 23 indicate that Alternative 1 would result in more positive impacts on gross state product (GSP), personal income, employment (Figure 14), output (Figure 15) and private investment when compared to the proposed amendments, but that the impacts would still on average be negative for GSP, employment, and output. This trend is expected, as Alternative 1 is the least stringent in the earlier years of the program and makes up for this early lag by accelerating the rate of CI reductions in the later years of the program to achieve the same endpoint as the proposed amendments, 90% CI reduction in 2046. In general, the California economic indicators decline more in later years as achieving higher CI targets becomes more difficult and costly.

Table 23: Summary of Economic Impacts of Alternative 1

	GSP	GSP	Personal Income	Personal Income	Employment	Employment	Output	Output	Private Investment	Private Investment
Year	Change (2023M\$)	% Change	Change (2023M\$)	% Change	Change (2023M\$)	% Change	Change (2023M\$)	% Change	Change (2023M\$)	% Change
2026	236	0.00%	152	-0.01%	4,096	0.02%	-1,576	-0.02%	-28	0.00%
2030	-1,069	-0.05%	-106	-0.02%	-5,301	-0.02%	-5,345	-0.08%	-386	-0.06%
2034	-1,916	-0.05%	847	0.01%	-3,448	-0.01%	-7,377	-0.10%	99	0.01%
2038	-2,101	-0.06%	3,056	0.04%	-911	0.00%	-9,424	-0.12%	684	0.08%
2042	-4,804	-0.09%	1,088	0.00%	-9,442	-0.03%	-14,073	-0.16%	102	0.01%
2046	-5,023	-0.09%	-1,371	-0.05%	-12,909	-0.05%	-13,317	-0.14%	-752	-0.08%
Average	-2,283	-0.05%	657	0.02%	-1,388	0.00%	-7,351	-0.09%	324	0.04%

Figure 14: Alternative 1- Employment Impacts by Major Sector (Jobs)

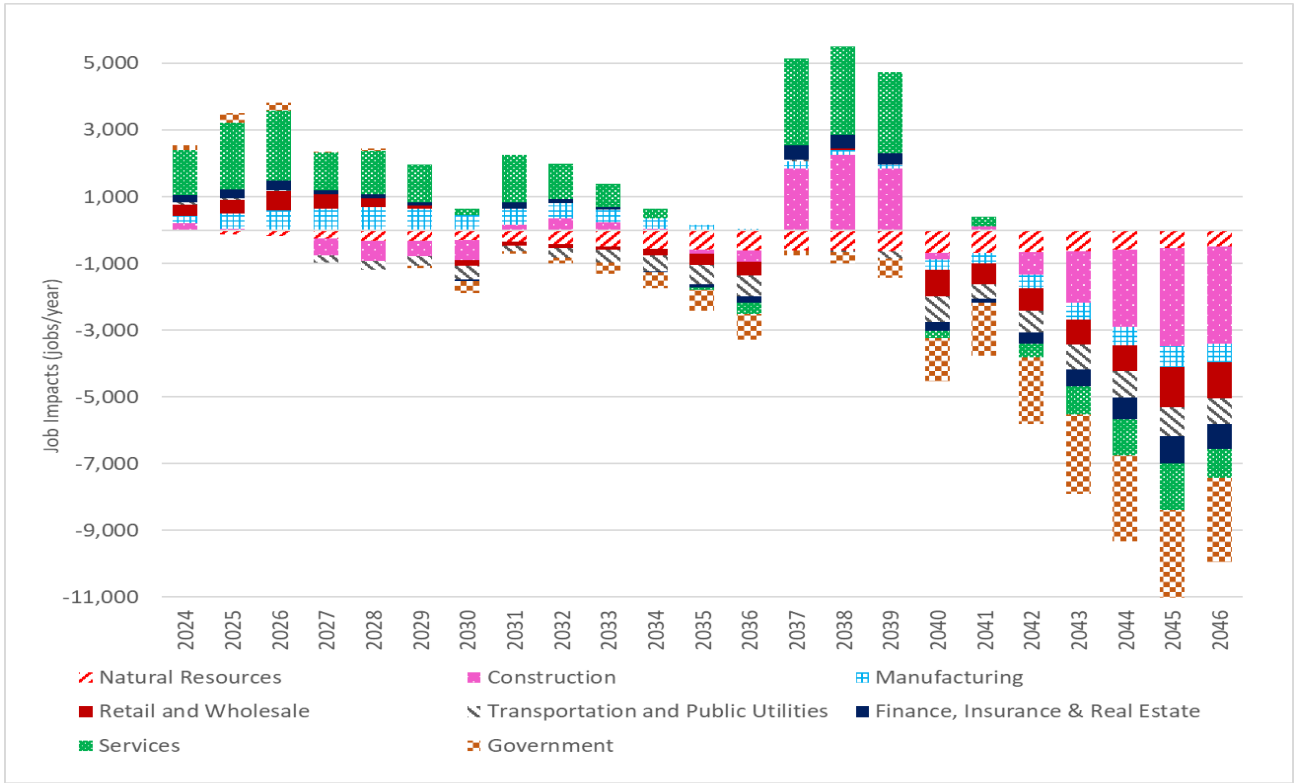
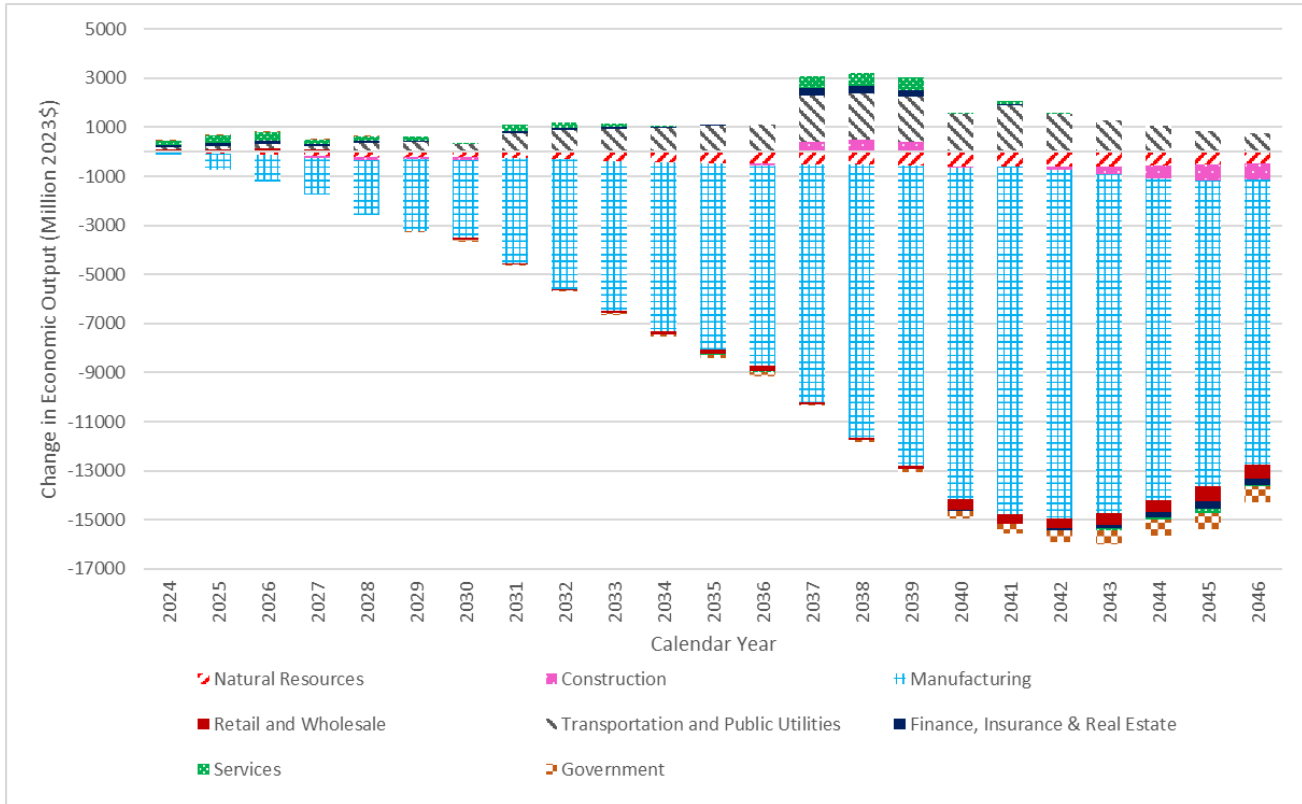


Figure 15: Alternative 1 - Change in Output by Major Sector (2023M\$)



d) Cost-Effectiveness

Alternative 1 has a cost effectiveness of \$78 per metric ton CO_{2e}, calculated as the net cost to California (relative to baseline) divided by the cumulative GHG reductions (relative to baseline). This is \$21 more per metric ton CO_{2e} than the proposed amendments, and results in 17% fewer GHG reductions.

e) Reason for Rejecting

Alternative 1 is rejected for several reasons. While all scenarios will ultimately achieve a 90% CI reduction by 2045, the Alternative achieves the fewest emissions reductions of the scenarios considered over the duration of the program, particularly in the near-term through 2030. As described in the 2022 Scoping Plan Update, near-term action is critical to achieving the Statewide 2030 GHG emissions reductions target, and this scenario does not support this goal. Alternative 1 also relies more heavily on fossil fuels and carbon dioxide removal technology than the proposed amendments. As a result, this Alternative does not achieve the same level of NO_x and PM_{2.5} emissions reductions as the proposed amendments and potentially exacerbates existing air quality challenges in the State.

2. Alternative 2

Alternative 2 has more stringent CI reduction targets from 2025 to 2030, then smaller increments until reaching 90% reduction in 2045, as compared to the proposed amendments (Table 18). As a result of the more stringent near-term CI targets, Alternative 2 results in higher credit prices and greater credit generation.

Increasing the pace of CI reductions in early years would require additional policies for credit generation to incentivize near-term investment. Alternative 2 does not include several of the credit limitations in the proposed amendments in order to free up supplies of low-carbon fuels to balance the market. Alternative 2 keeps the existing requirements for forklifts that are now commonplace and allows electric forklifts to continue to generate more credits into the future. In addition, Alternative 2 does not include a deliverability requirement for biomethane pathways that break ground after 2030. Lastly, Alternative 2 does not phase out crediting for biomethane pathways that break ground after 2030 – allowing those credits to continue to be generated for transportation use when the State is moving away from combustion technologies in the sector. Figure 16 and Figure 17 depict the alternative fuel volume and total fuel mix for Alternative 2.

Figure 16: Low-CI Fuel Volumes in the Alternative 2 Scenario

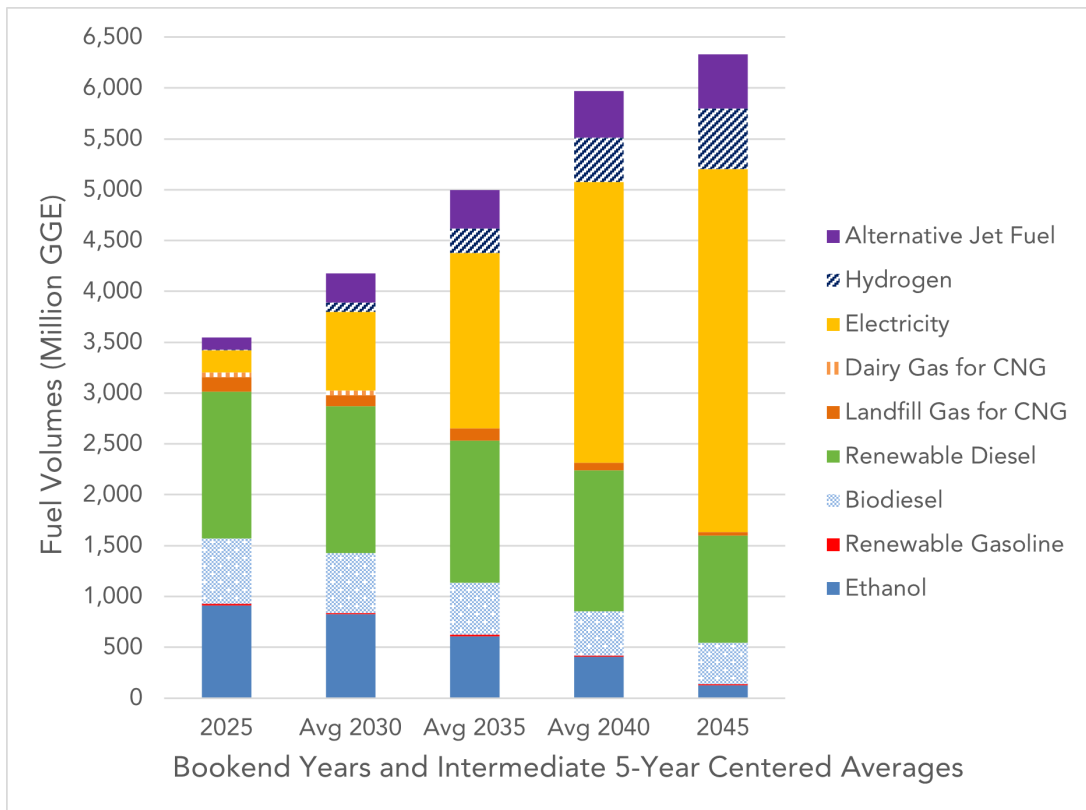
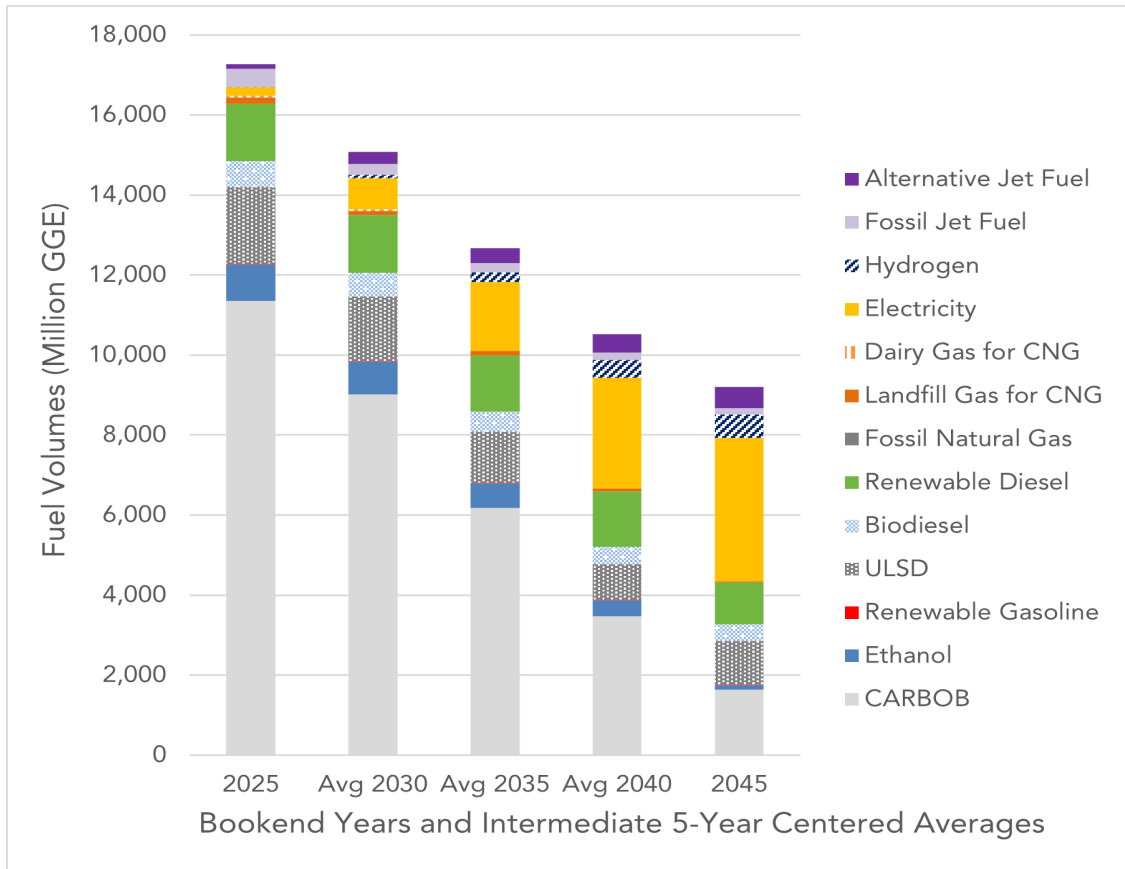


Figure 17: Fuel Mix – Alternative 2 Scenario



a) Costs

Alternative 2 costs approximately \$204 billion as compared to the baseline and 126% the cost of the proposed amendments. Credit prices in Alternative 2 are expected to be at the maximum allowable level for many years under this scenario. Credit revenues in California are \$190.8 billion as compared to the baseline and approximately 130% of the benefit of the proposed amendments, due to the increased stringency of the Alternative and the additional credits needed for compliance.

Table 24: Estimated Total Direct Costs to California of Alternative 2 to Deficit Generators and on Statewide Fuel Expenditures Relative to Baseline (million 2021\$)

Year	Verification Cost	Purchasing Credits	Statewide Fuel Expenditures	Total Cost	Credit Revenues	Net Cost
2024	18	1	-1	18	(54)	72
2025	24	4,601	119	4,745	3,487	1,257
2026	33	6,477	200	6,710	4,600	2,110

Year	Verification Cost	Purchasing Credits	Statewide Fuel Expenditures	Total Cost	Credit Revenues	Net Cost
2027	45	7,161	289	7,495	5,302	2,193
2028	60	9,380	382	9,822	7,081	2,741
2029	78	9,933	383	10,394	7,737	2,656
2030	98	10,353	387	10,838	8,408	2,429
2031	122	10,865	391	11,379	9,031	2,347
2032	145	11,235	396	11,776	9,510	2,266
2033	171	11,485	398	12,054	9,905	2,149
2034	199	11,675	401	12,275	10,423	1,852
2035	229	10,607	403	11,240	9,740	1,500
2036	259	9,975	397	10,631	9,260	1,371
2037	288	9,816	394	10,498	9,213	1,286
2038	318	9,397	402	10,117	8,981	1,135
2039	346	10,425	404	11,176	10,106	1,070
2040	373	10,094	403	10,870	9,574	1,296
2041	399	9,486	398	10,283	9,179	1,104
2042	424	7,962	377	8,763	7,500	1,264
2043	445	6,468	377	7,290	5,993	1,297
2044	465	5,131	377	5,973	4,608	1,366
2045	484	4,321	66	4,871	3,616	1,255
2046	503	4,021	66	4,591	3,436	1,155
Total	5,525	190,870	7,413	203,809	166,638	37,170

b) Benefits

i) Emissions

Social cost of carbon benefits of Alternative 2 from the scenario's 643 MMTCO₂e reduction (Figure 18) range from approximately \$17B to \$71B, as compared to the baseline. This is an average 16% greater valuation than the proposed amendments, since GHG reductions occur earlier and are valued more highly in the near term, as shown by the discount values in Table 3. As shown in Table 25, Alternative 2 results in decreased cumulative NO_x emissions by 28,030 tons and a decrease in PM_{2.5} emissions by 4,367 tons. As compared to the proposed amendments, Alternative 2 results in additional reductions of 2,445 tons of NO_x and 86 tons of PM_{2.5}. NO_x and PM_{2.5} emissions decrease further than the proposed amendments before 2040 since more renewable diesel enters the market.

Figure 18: Alternative 2 - GHG Emissions

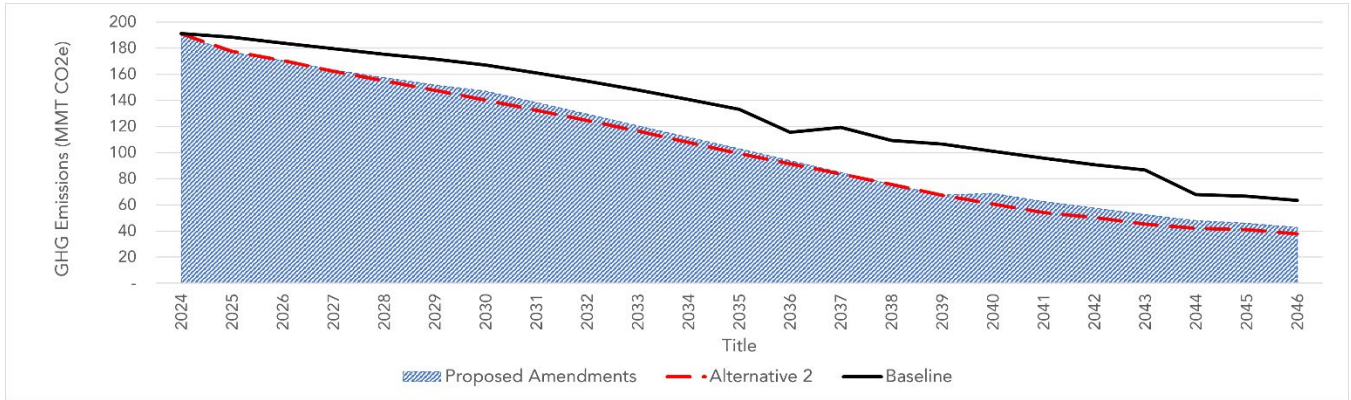


Table 25: Alternative 2 - NOx and PM2.5 Emission Changes (tons per day)

Year	NOx (tpd)	PM2.5 (tpd)
2024	-0.1	0.0
2025	-1.7	-0.2
2026	-2.2	-0.3
2027	-3.0	-0.4
2028	-3.5	-0.5
2029	-3.4	-0.5
2030	-3.7	-0.5
2031	-3.8	-0.5
2032	-3.7	-0.5
2033	-3.7	-0.5
2034	-3.7	-0.6
2035	-3.8	-0.6
2036	-3.6	-0.5
2037	-3.5	-0.5
2038	-3.8	-0.6
2039	-3.9	-0.6
2040	-3.9	-0.7
2041	-3.9	-0.7
2042	-3.5	-0.6
2043	-3.6	-0.6
2044	-3.6	-0.7
2045	-3.5	-0.6
2046	-3.6	-0.7

ii) Health Benefits

Staff used the methods described in Section IV to estimate avoided cardiopulmonary mortality, hospitalizations for cardiovascular illness and respiratory illness, and emergency room visits for respiratory illness and asthma that would be expected to result from implementing Alternative 2 when compared to the Baseline scenario. The results are presented in Table 26.

Alternative 2 has approximately a 11% higher valuation of health benefits at \$5.5 billion more than the baseline (Table 27), as compared to the proposed amendment at \$4.98 billion. The greater avoided health impacts of Alternative 2 are associated with additional decreases in both NO_x and PM_{2.5} over the baseline.

Table 26: Alternative 2 - Avoided Mortality and Morbidity Incidents from 2024 to 2046

Air Basins	SC	SCC	SJV	SFB	SD	Statewide
Cardiopulmonary Mortality	236 (131 - 337)	9 (5 - 13)	56 (31 - 80)	42 (23 - 60)	20 (11 - 29)	405 (224 - 578)
Hospitalizations for Cardiovascular Disease	48 (35 - 61)	2 (1 - 2)	11 (8 - 14)	9 (7 - 11)	5 (4 - 6)	83 (60 - 104)
Cardiovascular ED Visits	64 (-25 - 150)	2 (-1 - 5)	13 (-5 - 31)	12 (-5 - 29)	5 (-2 - 13)	109 (-42 - 253)
Acute Myocardial Infarction	27 (10 - 72)	1 (0 - 2)	6 (2 - 16)	5 (2 - 14)	2 (1 - 6)	46 (17 - 122)
Hospitalizations for Respiratory Disease	7 (0 - 14)	0 (0 - 0)	2 (0 - 3)	1 (0 - 2)	1 (0 - 1)	12 (0 - 24)
Respiratory ED Visits	135 (27 - 281)	5 (1 - 9)	36 (7 - 75)	31 (6 - 65)	10 (2 - 21)	244 (48 - 509)
Lung Cancer Incidence	17 (5 - 28)	1 (0 - 1)	4 (1 - 6)	4 (1 - 7)	2 (1 - 3)	30 (9 - 50)
Asthma Onset	538 (517 - 558)	22 (21 - 23)	104 (100 - 108)	149 (143 - 155)	49 (47 - 51)	954 (917 - 990)
Asthma Symptoms	46,196 (-22,537 - 112,061)	1,950 (-952 - 4,727)	9,287 (-4,534 - 22,511)	12,529 (-6,103 - 30,438)	4,165 (-2,029 - 10,118)	82,175 (-40,074 - 199,409)
Work Loss Days	33,357 (28,132 - 38,385)	1,326 (1,119 - 1,526)	7,118 (6,004 - 8,189)	8,554 (7,211 - 9,847)	3,408 (2,873 - 3,923)	59,701 (50,345 - 68,704)
Hospitalizations for Alzheimer's Disease	116 (89 - 140)	3 (2 - 4)	27 (20 - 32)	20 (15 - 24)	16 (12 - 19)	194 (148 - 236)
Hospitalizations for Parkinson's Disease	16 (8 - 22)	1 (0 - 1)	3 (2 - 5)	4 (2 - 5)	2 (1 - 2)	28 (15 - 40)

Table 26 continued

Air Basins	SS	SV	NP	NC	NCC	Statewide
Cardiopulmonary Mortality	7 (4 - 10)	12 (6 - 17)	0 (0 - 1)	1 (0 - 1)	3 (2 - 5)	405 (224 - 578)
Hospitalizations for Cardiovascular Disease	1 (1 - 2)	2 (2 - 3)	0 (0 - 0)	0 (0 - 0)	1 (0 - 1)	83 (60 - 104)
Cardiovascular ED Visits	2 (-1 - 5)	3 (-1 - 7)	0 (0 - 0)	0 (0 - 1)	1 (0 - 2)	109 (-42 - 253)
Acute Myocardial Infarction	1 (0 - 2)	1 (1 - 4)	0 (0 - 0)	0 (0 - 0)	0 (0 - 1)	46 (17 - 122)
Hospitalizations for Respiratory Disease	0 (0 - 0)	0 (0 - 1)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	12 (0 - 24)
Respiratory ED Visits	6 (1 - 13)	7 (1 - 15)	0 (0 - 1)	1 (0 - 2)	3 (1 - 5)	244 (48 - 509)
Lung Cancer Incidence	1 (0 - 1)	1 (0 - 1)	0 (0 - 0)	0 (0 - 0)	0 (0 - 1)	30 (9 - 50)
Asthma Onset	18 (17 - 18)	26 (25 - 27)	1 (1 - 1)	2 (2 - 3)	10 (10 - 11)	954 (917 - 990)
Asthma Symptoms	1,576 (-767 - 3,830)	2,269 (-1,105 - 5,512)	122 (-59 - 297)	195 (-95 - 475)	899 (-438 - 2,186)	82,175 (-40,074 - 199,409)
Work Loss Days	1,181 (995 - 1,359)	1,764 (1,487 - 2,031)	74 (63 - 86)	149 (125 - 171)	626 (528 - 721)	59,701 (50,345 - 68,704)
Hospitalizations for Alzheimer's Disease	2 (2 - 3)	3 (2 - 4)	0 (0 - 0)	0 (0 - 0)	1 (1 - 1)	194 (148 - 236)
Hospitalizations for Parkinson's Disease	1 (0 - 1)	1 (0 - 1)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	28 (15 - 40)

Air Basins	MC	MD	LT	LC	GBV	Statewide
Cardiopulmonary Mortality	2 (1 - 2)	16 (9 - 22)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	405 (224 - 578)
Hospitalizations for Cardiovascular Disease	0 (0 - 0)	3 (2 - 4)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	83 (60 - 104)
Cardiovascular ED Visits	0 (0 - 1)	4 (-2 - 10)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	109 (-42 - 253)
Acute Myocardial Infarction	0 (0 - 0)	2 (1 - 5)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	46 (17 - 122)
Hospitalizations for Respiratory Disease	0 (0 - 0)	0 (0 - 1)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	12 (0 - 24)
Respiratory ED Visits	1 (0 - 3)	9 (2 - 18)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	244 (48 - 509)
Lung Cancer Incidence	0 (0 - 0)	1 (0 - 2)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	30 (9 - 50)
Asthma Onset	5 (5 - 5)	27 (26 - 28)	1 (1 - 1)	0 (0 - 0)	1 (1 - 1)	954 (917 - 990)
Asthma Symptoms	457 (-222 - 1110)	2,387 (-1,162 – 5,800)	47 (-23 - 115)	36 (-17 - 86)	59 (-29 - 145)	82,175 (-40,074 – 199,409)
Work Loss Days	333 (281 - 384)	1,703 (1,436 – 1,960)	44 (37 - 51)	22 (18 - 25)	41 (35 - 48)	59,701 (50,345 – 68,704)
Hospitalizations for Alzheimer's Disease	0 (0 - 1)	6 (5 - 8)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	194 (148 - 236)
Hospitalizations for Parkinson's Disease	0 (0 - 0)	1 (0 - 1)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	28 (15 - 40)

Table 27: Alternative 2 - Number of Avoided Health Outcomes and Valuation in Million 2021\$

Avoided Health Incident	2026	2030	2034	2038	2042	2046	Total
Cardiopulmonary Mortality	139	250	261	274	256	262	5,429
Hospitalizations for Parkinson's Disease	<1	<1	<1	<1	<1	<1	0
Respiratory ED Visits	<1	<1	<1	<1	<1	<1	0
Hospitalizations for Alzheimer's Disease	<1	<1	<1	<1	<1	<1	3
Hospitalizations for Cardiovascular Disease	<1	<1	<1	<1	<1	<1	2
Cardiovascular ED Visits	<1	<1	<1	<1	<1	<1	0
ER visits, respiratory	<1	<1	<1	<1	<1	<1	0
Asthma Onset	2	3	2	3	2	2	51
Asthma Symptoms	<1	1.04	<1	1	<1	<1	21
Lung Cancer Incidence	<1	<1	<1	<1	<1	<1	1
Acute Myocardial Infarction	<1	<1	<1	<1	<1	<1	4
Work Loss Days	<1	<1	<1	<1	<1	<1	12
Valuation (Million 2021\$)	142	255	266	279	260	267	5,524

c) Economic Impacts

Alternative 2 is more stringent than the proposed amendments since Alternative 2 includes more stringent CI targets, which in turn result in a larger credit market overall and greater deficit generation, leading to higher compliance costs. Higher compliance costs would lead to a larger overall effect on the California economy.

The macroeconomic impact analysis results shown in Table 28 indicate that Alternative 2 would result in more negative impacts on GSP, personal income, employment (Figure 19), output (Figure 20), and private investment growth when compared to the proposed amendments and the baseline due to the more stringent requirements.

Table 28: Summary of Economic Impact Indicators for Alternative 2

	GSP	GSP	Personal Income	Personal Income	Employment	Employment	Output	Output	Private Investment	Private Investment
Year	Change (2023M\$)	% Change	Change (2023M\$)	% Change	Change (2023M\$)	% Change	Change (2023M\$)	% Change	Change (2023M\$)	% Change
2026	-799	-0.02%	-1,271	-0.04%	-1,362	-0.01%	-2,875	-0.04%	-368	-0.06%
2030	-3,223	-0.08%	-1,095	-0.03%	-7,908	-0.03%	-9,184	-0.13%	-483	-0.07%
2034	-4,381	-0.10%	-98	0.00%	-8,669	-0.03%	-12,857	-0.18%	18	0.00%
2038	-5,586	-0.12%	-981	-0.02%	-13,369	-0.05%	-15,375	-0.19%	-234	-0.03%
2042	-6,531	-0.13%	-2,505	-0.05%	-16,840	-0.06%	-17,120	-0.20%	-620	-0.07%
2046	-6,232	-0.11%	-4,652	-0.09%	-17,867	-0.06%	-15,237	-0.16%	-1,279	-0.13%
Average	-4,251	-0.09%	-1,495	-0.03%	-10,405	-0.04%	-11,654	-0.15%	-429	-0.05%

Figure 19: Alternative 2 - Employment Impacts by Major Sector (jobs)

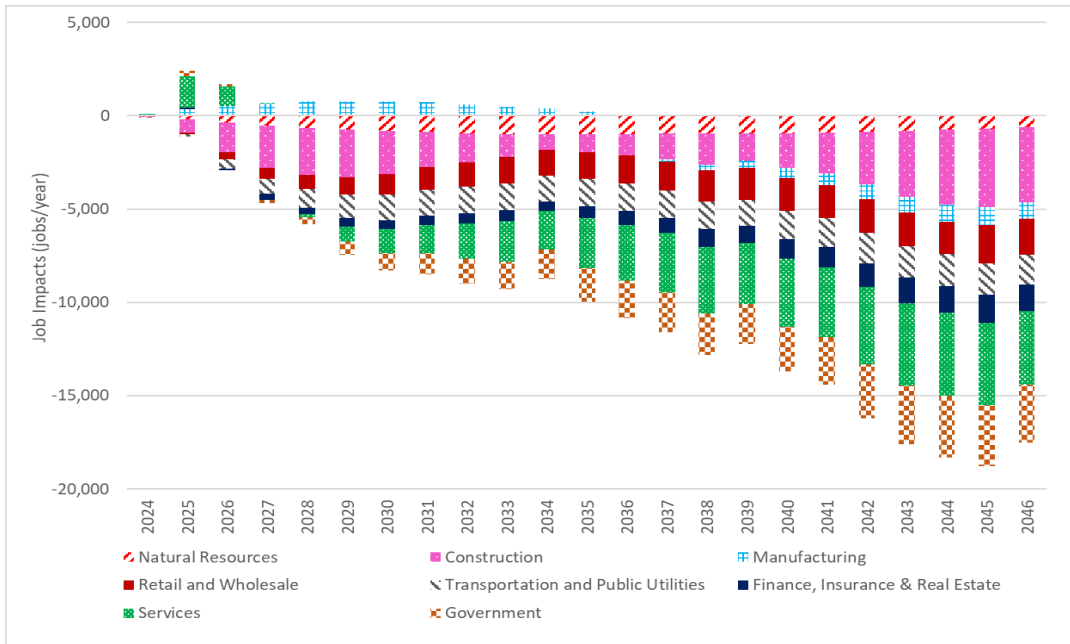
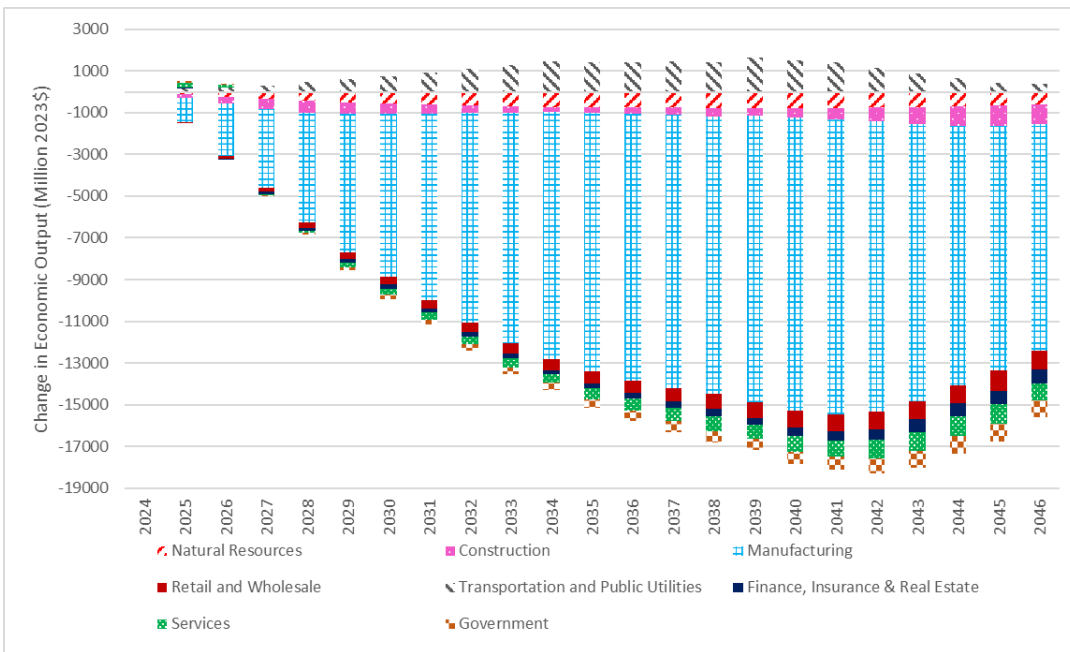


Figure 20: Alternative 2 - Change in Output by Major Sector (2023M\$)



d) Cost-Effectiveness

Alternative 2 has a cost effectiveness of \$58 per metric ton CO_{2e}. This is similar to the proposed amendments due to higher GHG reductions balanced against higher overall cost.

e) Reason for Rejecting

Alternative 2 was rejected for several reasons. First, the scenario is less feasible to achieve than the proposed amendments due to the more stringent near-term CI targets through 2030. Credit prices in this scenario are projected to be at or near the maximum and would quickly trigger advanced crediting requirements if low-carbon fuels are not produced at projected volumes. To achieve these near-term emission reductions, Alternative 2 also necessitates removing several important policy inputs in the proposed amendments, such as updates to the forklift crediting methodology and changing requirements for biomethane. Pursuing faster CI target reductions at the expense of these and other provisions would counteract the broader energy transition that is identified in the approved 2022 Scoping Plan Update. Lastly, the credit prices in Alternative 2 are higher than the proposed amendments and may place additional near-term burden on consumers of fossil fuels at the retail level.

3. Comparison of Costs and Benefit

Table 29: Comparison of Costs and Benefits of Proposed Amendments and Alternatives

	Revenue from LCFS Credit Sales (Million 2021\$)	Health Benefits*	Total Benefits	Total Costs (Million 2021\$)	Net Costs* (Million 2021\$)	Total GHG Reduction (MMT CO2e)	CE* (\$/MT CO2e)
Proposed Amendments	128,416	4,977	133,393	160,531	32,115	558	58
Alternative 1	126,035	1,583	127,618	162,118	36,083	461	78
Alternative 2	166,638	5,524	172,162	203,809	37,171	643	58

*Health benefits are not included in the net cost, nor in the cost-effectiveness metrics

B. Other Concepts

1. Comprehensive Environmental Justice Scenario

This scenario narrows LCFS crediting opportunities to reduce impacts from the production of lipid-based biofuels and manure-based fuels as well as prioritize direct greenhouse gas emissions in California. The scenario was proposed by CARB’s Environmental Justice

Advisory Committee⁹⁵ and includes concepts recommended by environmental justice, environmental, health, animal rights, science-based advocacy, and political organizations.⁹⁶ Under this alternative, the following modifications would be made to the proposed LCFS regulation:

1. Eliminate avoided methane credits effective January 1, 2024.
2. Eliminate credit generation for pathways relying on the production of fuel from livestock and dairy manure for emissions reductions that otherwise would have occurred or were legally or contractually required to occur.
3. Cap the use of lipid biofuels (commonly known as crop-based fuels) at 2020 levels, about 855 million gallons, pending an updated risk assessment to determine phase out timelines for high-risk, crop-based feedstocks.
4. Prohibit enhanced oil recovery as an eligible sequestration method.
5. Do not issue LCFS credits for carbon removal projects such as Direct Air Capture.
6. Include intrastate jet fuel.

This scenario matches the proposed amendments with regard to the 2030 carbon intensity target. The provision to include intrastate jet fuel as a deficit generator is also aligned, though the proposed amendments provision begins in 2028 instead of 2025.

The 30% carbon intensity target in 2030, and the carbon intensity schedule generally, is not viable in this scenario due to the removal of substantial crediting pathways for both lipid biofuels and dairy biogas (both which are low-CI fuels). Due to limitations on lipid biofuels and dairy biogas, the Comprehensive EJ Scenario results in higher volumes of fossil diesel being used than any of the other scenarios evaluated. The limits on lipid biofuels, biomethane, and DAC also resulted in credit prices immediately reaching the maximum credit price in 2025 and remaining at the maximum levels for every year analyzed. Because credit generation is limited in this scenario, the modeling suggests that there would not be enough credits available for deficit holders to comply with the CI benchmarks. To resolve this modeling and compliance issue, CARB staff manually included additional banked credit supply into the modelling. Ultimately, this increase in banked credits is outside the bounds of the LCFS regulation as

⁹⁵ Environmental Justice Advisory Committee, *Draft Recommendations to the California Air Resources Board (CARB) on the Low Carbon Fuel Standard Regulation Updates*. August 27, 2023. <https://ww2.arb.ca.gov/sites/default/files/2023-08/EJAC%20DRAFT%20Low%20Carbon%20Fuel%20Standard%20Recommendations%20Version%20%200820823.pdf>

⁹⁶ Leadership Counsel for Justice and Accountability, Earthjustice, Animal Legal Defense Fund, Center on Race, Poverty & the Environment, Union of Concerned Scientists, Defensores Del Valle Central Para El Aire Y Agua Limpia, Santa Cruz Climate Action Network, Food & Water Watch, Center for Food Safety, Clean Water Action, California Environmental Voters, Asian Pacific Environmental Network, CleanEarth4Kids.org, 350 Ventura County Climate Hub, Communities for a Better Environment, Progressives for Democracy in America, Center for Community Action and Environmental Justice, Climate Action California, San Joaquin Valley Democratic Club, 350 Bay Area Action, Center for Biological Diversity, Central California Asthma Collaborative, Central Valley Air Quality Coalition, Center for Community Action Environmental Justice, Central California Environmental Justice Network, Physicians for Social Responsibility - Los Angeles, Valley Improvement Projects, and 350 Humboldt (may not be a comprehensive list).

there are no current or proposed regulatory mechanisms in the LCFS Regulation that would provide this level of additional banked credits. Figure 21 and Figure 22 depict the fuel volume and fuel mix for the Comprehensive EJ Scenario.

Figure 21: Low-CI Fuel Volumes in the Comprehensive EJ Scenario

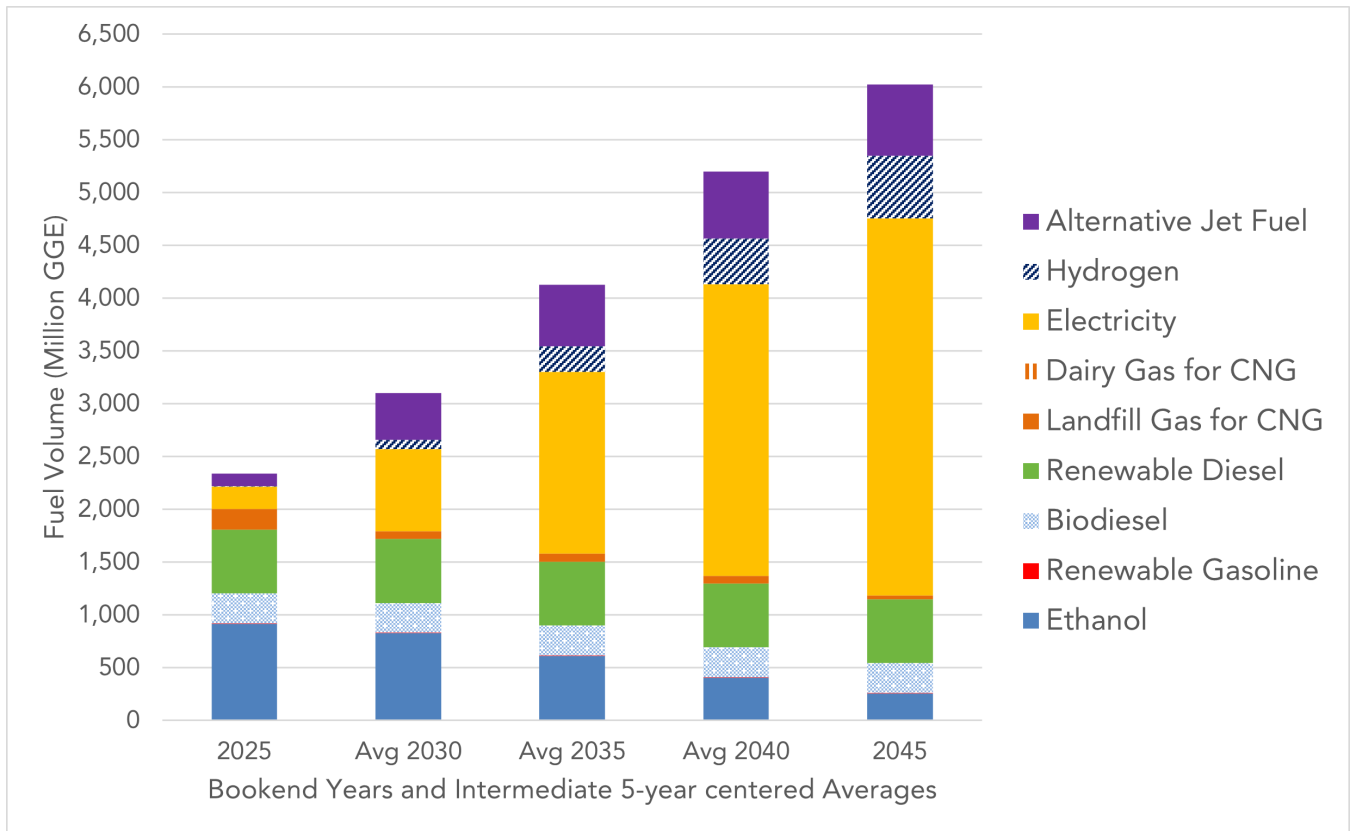
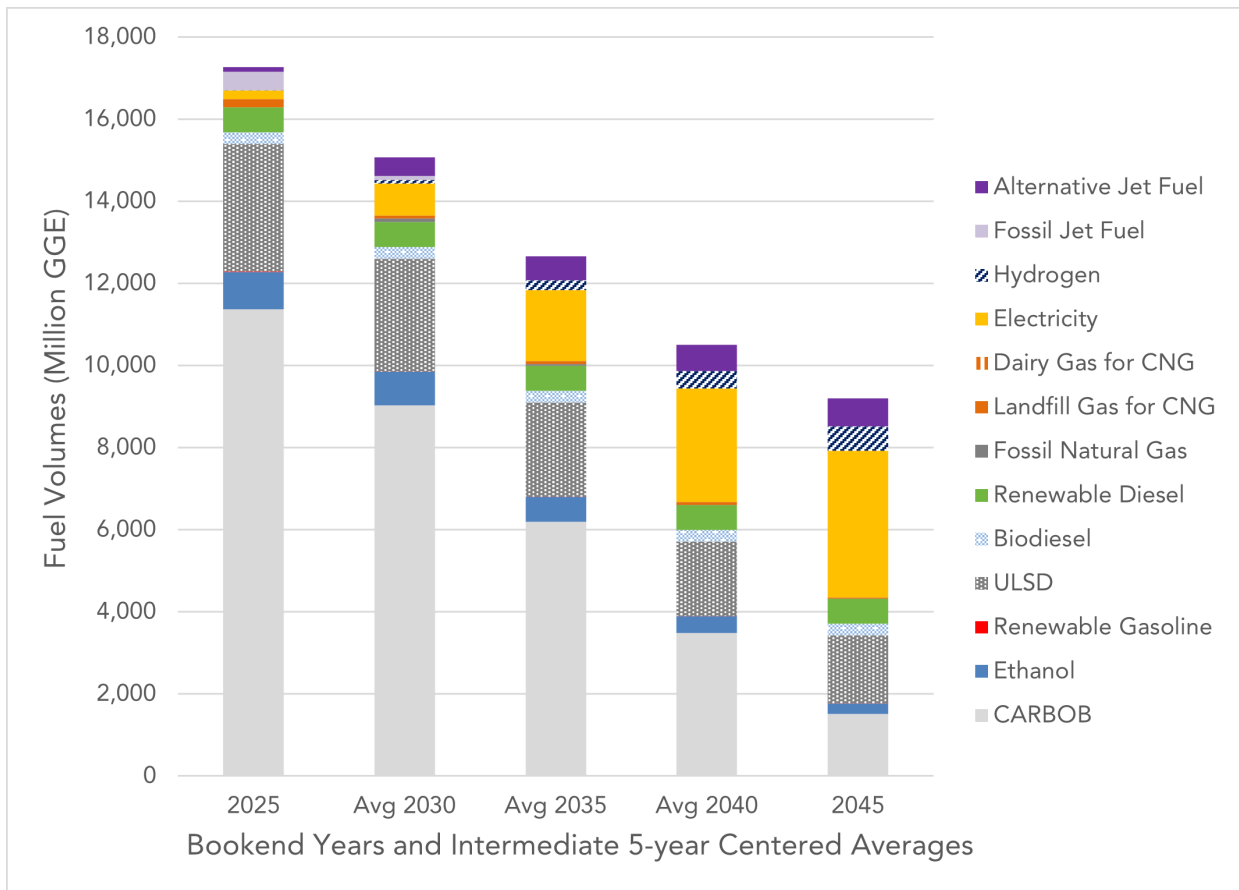


Figure 22: Fuel Mix - Comprehensive EJ Scenario



a) Costs

The scenario costs approximately \$240 billion and brings in revenues of about \$155 billion, as compared to the Proposed scenario’s cost of \$160 billion and revenues of \$128 billion. The net cost is \$85 billion, while the proposed amendment’s net cost is \$32 billion. The large net cost of this scenario is associated with higher credit prices and the demand for 76 billion banked credits by 2030 and 288 million banked credits between 2024 and 2046, which far exceeds the available quantity even under the credit clearance market.

b) Benefits

This scenario results in NOx reductions of approximately 27,341 tons, PM2.5 increases of 1,350 tons, and GHG reductions of 386 MMT. The criteria pollutant emission changes are primarily due to lower amounts of biofuels entering the market; PM2.5 increases are due to fossil diesel being used instead of renewable diesel. NOx decreases as compared to the proposed amendments are primarily due to smaller volumes of biofuel consumed which leads to lower emissions from biofuel production and biofuel transportation. This scenario results in greater GHG emissions than the proposed amendments due to a combination of fossil fuels

replacing biofuels, and zero-CI hydrogen and electricity replacing carbon negative hydrogen and electricity produced using dairy biomethane.

i) Health Benefits

Staff used the methods described in Appendix C-1 to estimate avoided cardiopulmonary mortality, hospitalizations for cardiovascular illness and respiratory illness, and emergency room visits for respiratory illness and asthma that would be expected to result from implementing the Comprehensive EJ Scenario when compared to the Baseline scenario. The results are presented in Table 30.

The Comprehensive EJ Scenario has approximately a 140% lower valuation of health benefits at \$1,970 million less than the baseline, as compared to the proposed amendment at \$4.98 billion more than baseline. The greater health impacts of Comprehensive EJ Scenario are associated with additional increases in both NO_x and PM_{2.5} over the baseline.

Table 30: Comprehensive EJ Scenario - Avoided Mortality and Morbidity Incidents from 2024 to 2046

Air Basin	SC	SCC	SJV	SFB	SD	Statewide
Cardiopulmonary Mortality	-128 (-70 - -185)	3 (2 - 4)	13 (7 - 18)	-23 (-13 - -33)	5 (3 - 7)	-151 (-82 - -219)
Hospitalizations for Cardiovascular Disease	-24 (-17 - -30)	1 (1 - 1)	3 (2 - 4)	-5 (-3 - -6)	1 (1 - 2)	-27 (-19 - -34)
Cardiovascular ED Visits	-35 (13 - -81)	1 (0 - 2)	3 (-1 - 7)	-7 (3 - -17)	1 (0 - 3)	-42 (16 - -98)
Acute Myocardial Infarction	-14 (-5 - -39)	0 (0 - 1)	1 (0 - 3)	-3 (-1 - -8)	1 (0 - 1)	-17 (-6 - -47)
Hospitalizations for Respiratory Disease	-4 (0 - -7)	0 (0 - 0)	0 (0 - 1)	-1 (0 - -1)	0 (0 - 0)	-4 (0 - -8)
Respiratory ED Visits	-73 (-14 - -152)	2 (0 - 3)	8 (2 - 17)	-18 (-4 - -37)	2 (0 - 5)	-93 (-18 - -194)
Lung Cancer Incidence	-10 (-3 - -17)	0 (0 - 0)	1 (0 - 1)	-2 (-1 - -4)	0 (0 - 1)	-12 (-4 - -21)
Asthma Onset	-324 (-311 - -338)	6 (6 - 7)	17 (16 - 17)	-94 (-90 - -98)	9 (9 - 9)	-440 (-421 - -458)
Asthma Symptoms	-26,300 (12,750 - -64,178)	629 (-309 - 1,512)	1,851 (-921 - 4,404)	-7,827 (3,806 - -19,046)	744 (-364 - 1,797)	-35,551 (17,222 - -86,818)
Work Loss Days	-18,345 (-15,447 - -21,141)	413 (349 - 474)	1,546 (1,310 - 1,772)	-5077 (-4,278 - -5,846)	721 (608 - 829)	-24,066 (-20,260 - -27,740)
Hospitalizations for Alzheimer's Disease	-75 (-54 - -95)	1 (1 - 1)	3 (3 - 2)	-11 (-8 - -14)	4 (3 - 4)	-84 (-60 - -108)
Hospitalizations for Parkinson's Disease	-9 (-4 - -14)	0 (0 - 0)	1 (0 - 1)	-2 (-1 - -3)	0 (0 - 1)	-11 (-5 - -17)

Table 30 continued

Air Basins	SS	SV	NP	NC	NCC	Statewide
Cardiopulmonary Mortality	0 (0 - 0)	-12 (-7 - -18)	-1 (-1 - -1)	-2 (-1 - -2)	0 (0 - 0)	-151 (-82 - -219)
Hospitalizations for Cardiovascular Disease	0 (0 - 0)	-2 (-2 - -3)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	-27 (-19 - -34)
Cardiovascular ED Visits	0 (0 - 0)	-3 (1 - -7)	0 (0 - 0)	0 (0 - -1)	0 (0 - 0)	-42 (16 - -98)
Acute Myocardial Infarction	0 (0 - 0)	-2 (-1 - -4)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	-17 (-6 - -47)
Hospitalizations for Respiratory Disease	0 (0 - 0)	0 (0 - -1)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	-4 (0 - -8)
Respiratory ED Visits	0 (0 - 0)	-8 (-1 - -16)	-1 (0 - -2)	-1 (0 - -3)	0 (0 - 0)	-93 (-18 - -194)
Lung Cancer Incidence	0 (0 - 0)	-1 (0 - -1)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	-12 (-4 - -21)
Asthma Onset	-1 (-1 - -2)	-29 (-28 - -30)	-3 (-3 - -3)	-5 (-5 - -5)	-1 (-1 - -1)	-440 (-421 - -458)
Asthma Symptoms	-136 (66 - -332)	-2,463 (1,198 - -5,992)	-242 (118 - -588)	-373 (182 - -908)	-82 (40 - -201)	-35,551 (17,222 - -86,818)
Work Loss Days	-69 (-58 - -79)	-1,855 (-1,563 - -2,136)	-146 (-123 - -168)	-285 (-241 - -329)	-43 (-36 - -50)	-24,066 (-20,260 - -27,740)
Hospitalizations for Alzheimer's Disease	0 (0 - 0)	-3 (-2 - -4)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	-84 (-60 - -108)
Hospitalizations for Parkinson's Disease	0 (0 - 0)	-1 (0 - -1)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	-11 (-5 - -17)

Table 30 continued

Air Basins	MC	MD	LT	LC	GBV	Statewide
Cardiopulmonary Mortality	-3 (-2 - -4)	-2 (-1 - -3)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	-151 (-82 - -219)
Hospitalizations for Cardiovascular Disease	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	-27 (-19 - -34)
Cardiovascular ED Visits	-1 (0 - -2)	-1 (0 - -1)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	-42 (16 - -98)
Acute Myocardial Infarction	0 (0 - 0)	0 (0 - -1)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	-17 (-6 - -47)
Hospitalizations for Respiratory Disease	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	-4 (0 - -8)
Respiratory ED Visits	-2 (0 - -5)	-1 (0 - -3)	0 (0 - 0)	0 (0 - 0)	0 (0 - -1)	-93 (-18 - -194)
Lung Cancer Incidence	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	-12 (-4 - -21)
Asthma Onset	-9 (-9 - -10)	-5 (-4 - -5)	0 (0 - 0)	-1 (-1 - -1)	-1 (-1 - -1)	-440 (-421 - -458)
Asthma Symptoms	-815 (397 - -1,982)	-424 (206 - -1,032)	23 (-11 - 55)	-52 (25 - -126)	-83 (40 - -201)	-35,551 (17,222 - -86,818)
Work Loss Days	-590 (-497 - -679)	-270 (-227 - -311)	22 (19 - 25)	-32 (-27 - -37)	-56 (-47 - -65)	-24,066 (-20,260 - -27,740)
Hospitalizations for Alzheimer's Disease	-1 (-1 - -1)	-1 (-1 - -1)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	-84 (-60 - -108)
Hospitalizations for Parkinson's Disease	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	-11 (-5 - -17)

Table 31: Comprehensive EJ Scenario - Number of Avoided Health Outcomes and Valuation in Million 2021\$

Avoided Health Incident	2026	2030	2034	2038	2042	2046	Total
Cardiopulmonary Mortality	-411	-151	-96	-27	38	86	-1,928
Hospitalizations for Parkinson's Disease	0	0	0	0	0	0	<-1
Respiratory ED Visits	0	0	0	0	0	0	<-1
Hospitalizations for Alzheimer's Disease	0	0	0	0	0	0	-1
Hospitalizations for Cardiovascular Disease	0	0	0	0	0	0	<-1
Cardiovascular ED Visits	0	0	0	0	0	0	<-1
ER visits, respiratory	0	0	0	0	0	0	<-1
Asthma Onset	-5	-2	-1	0	0	1	-24
Asthma Symptoms	-2	-1	0	0	0	0	-9
Lung Cancer Incidence	0	0	0	0	0	0	<-1
Acute Myocardial Infarction	0	0	0	0	0	0	-2
Work Loss Days	-1	0	0	0	0	0	-5
Total Valuation	-419	-154	-98	-27	38	87	-1,970

c) Cost Effectiveness

The cost effectiveness is \$220/MT GHG reduction, approximately \$162/MT more expensive than the proposed amendments.

d) Reason for Rejecting

This scenario is rejected because, relative to the proposed amendments, it would produce fewer GHG emissions reductions, have worse health outcomes, have the highest costs of any scenario, and create significant LCFS regulatory non-compliance risks.

Additionally, the Comprehensive EJ Scenario is also not responsive to the direction in the 2022 Scoping Plan Update, as capturing methane from dairies is one of the primary measures for achieving the state's 2045 greenhouse gas reduction targets⁹⁷ and SB 1383 methane reduction target.⁹⁸ Ending avoided methane crediting in 2025 could stop the development of new anaerobic digester projects and also cause operating digestors to shut down if the operational expense is greater than the value of the gas and other incentives received by the dairies. Without anaerobic digesters, California would not be able to meet its SB 1383 methane reduction goals. Additionally, eliminating biomethane pathways used to produce hydrogen may unduly restrict the development of low-CI hydrogen supply that California needs in order to displace fossil fuels. Increasing the supply of low-CI renewable hydrogen is a key strategy identified in the 2022 Scoping Plan Update and supports MDV and HDV ZEVs.

And finally, Direct Air Capture (DAC) is a key component of CARB's plan to reduce greenhouse gas emissions and meet carbon neutrality by 2045.⁹⁹ Eliminating credits for DAC projects would eliminate one of the key incentives to deploy this technology, and jeopardizes the feasibility of achieving California's long-term decarbonization targets and the 2045 carbon intensity target proposed under this project.

2. Accelerated Decarbonization Scenario - More Stringent

This alternative is based on a scenario proposed by a coalition of stakeholders that accelerates decarbonization by increasing the stringency of the 2030 CI target and excluding proposed project amendments that limit or phase out credit generation opportunities for certain

⁹⁷ California Air Resources Board, *2022 Scoping Plan for Achieving Carbon Neutrality*. November 16, 2022. <https://ww2.arb.ca.gov/sites/default/files/2023-04/2022-sp.pdf>

⁹⁸ California Air Resources Board, *Analysis of Progress toward Achieving the 2030 Dairy and Livestock Sector Methane Emissions Target*. (Accessed on September 19, 2023). <https://ww2.arb.ca.gov/resources/documents/dairy-livestock-sb1383-analysis>

⁹⁹ California Air Resources Board, *2022 Scoping Plan for Achieving Carbon Neutrality*. 91-97. November 16, 2022. https://ww2.arb.ca.gov/sites/default/files/2022-12/2022-sp_1.pdf

pathways.¹⁰⁰ The coalition proposed a CI target in the range of 40% by 2030, whereas the Proposed Project has a 30% by 2030 CI target. To meet this accelerated target, the coalition proposed no limitations on the volume of crop-based fuels in LCFS, increasing the use of ethanol in gasoline to 15% by volume, no phaseout of avoided methane and no deliverability requirements for biomethane. In addition, the coalition proposed inclusion and crediting of new credit generation opportunities for climate-smart agricultural practices to incentivize lower-CI fuel production. Under this alternative, the following changes would be made to the proposed LCFS amendments:

1. Increase CI reduction target to 40% in 2030 (from the 30% proposed);
2. Eliminate sustainability criteria for crop-based biofuels; and
3. No limitations on forklift crediting
4. No phase out of avoided methane crediting for biomethane pathways; and
5. No deliverability requirements for book-and-claim of biomethane generated outside of California.

The recommended credit generation opportunities for agricultural practices were not included in this alternative because there is not yet a mechanism within the LCFS for quantifying, verifying, and including greenhouse gas emissions reductions or soil-carbon sequestration from changes in individual farm-level management practices in LCFS fuel pathways. The recommended increase in ethanol volume to E15 was also not included because separate California fuel regulations currently limit ethanol use in gasoline to 10% by volume and changing these fuel regulations is outside the scope of this LCFS rulemaking.

¹⁰⁰ ICF Resources LLC, *Analyzing Future Low Carbon Fuel Targets in California: Initial Results for Accelerated Decarbonization, Central Case*. Submitted to Auto-Acceleration Mechanism for the Low Carbon Fuel Standard Public Comment Docket. June 30, 2023. <https://ww2.arb.ca.gov/form/public-comments/submissions/4306>

Figure 23: Low-CI Fuel Volumes in the Accelerated Decarbonization Scenario

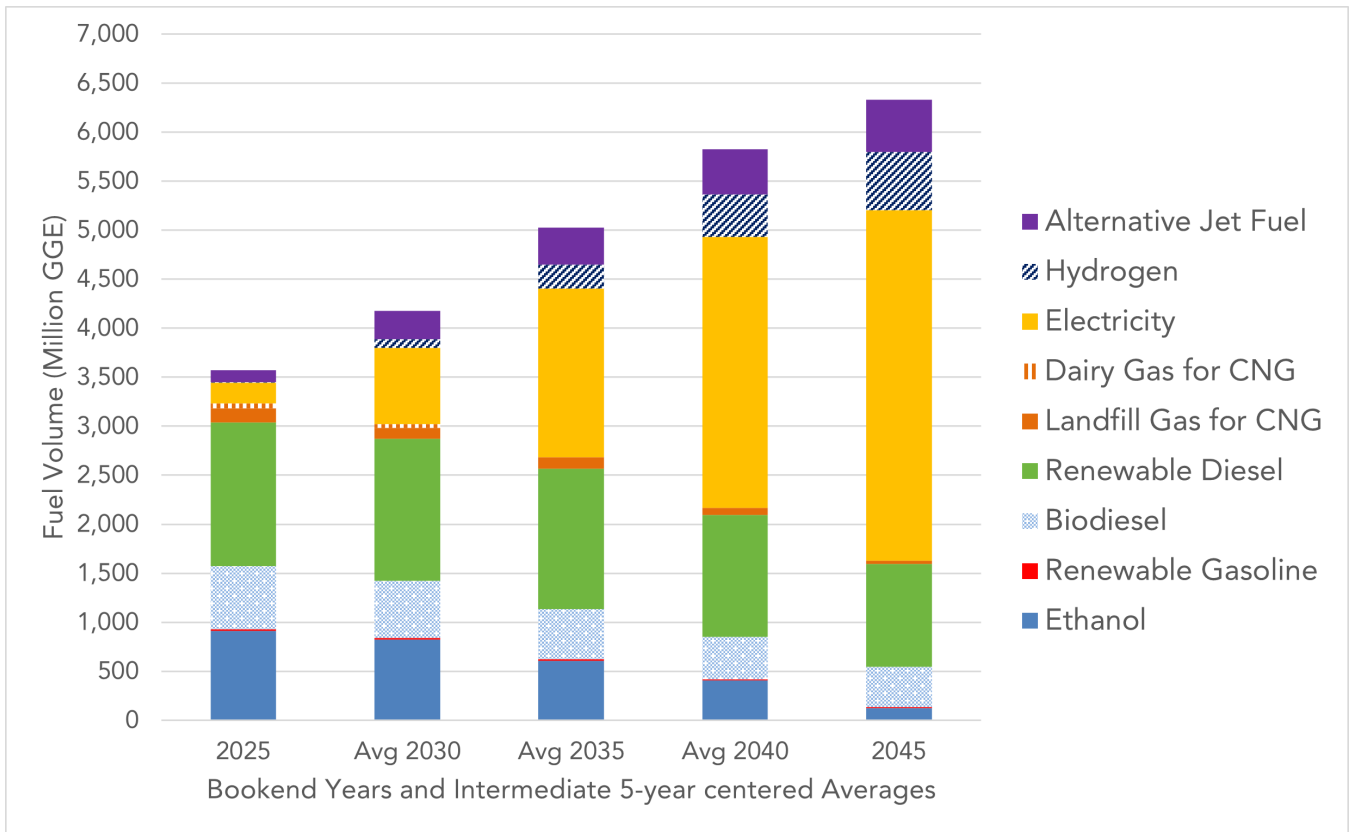
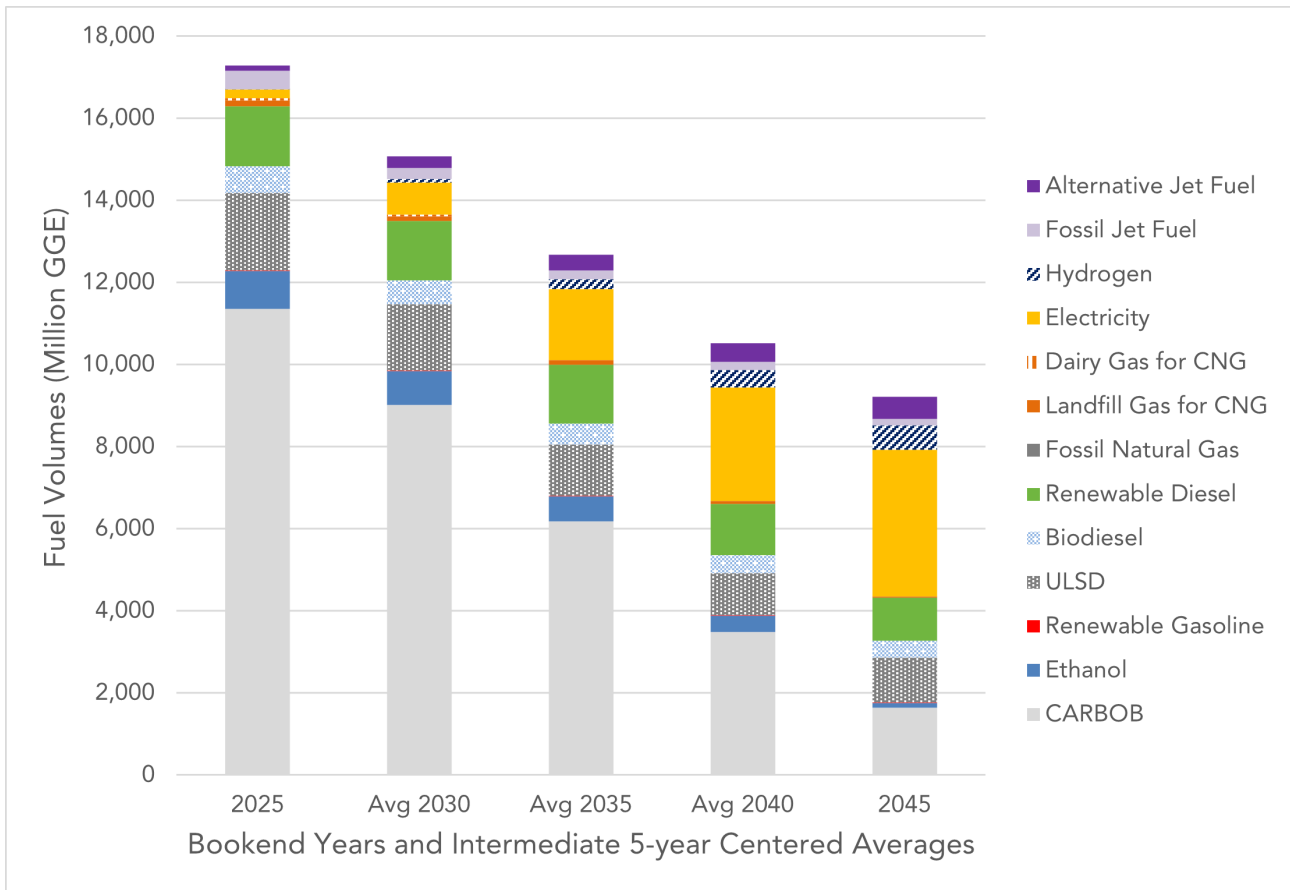


Figure 24: Fuel Mix – Accelerated Decarbonization Scenario



a) Costs

The scenario costs approximately \$194 billion and brings in revenues of about \$149 billion, as compared to the proposed amendment’s cost of \$160 billion and revenues of \$128 billion. The net cost is \$45 billion, while the proposed amendment’s net cost is \$32 billion. The larger net cost of this scenario is associated with higher credit prices and the demand for 40 billion banked credits by 2030 and 76 billion banked credits between 2024 and 2046, which far exceeds the available quantity even under the credit clearance market.

b) Benefits

This scenario results in NOx reductions of approximately 27,531 tons (1,945 more tons reduced than the Proposed), PM2.5 decreases of 4,233 tons (47 more tons reduced than the Proposed), and GHG reductions of 847 MMT (289 MMT greater reductions than the Proposed). The criteria pollutant emission changes as compared to the proposed amendments are primarily due to higher amounts of renewable fuels used. This scenario results in fewer GHG emissions than the proposed amendments due to higher volumes of renewable diesel and low-CI hydrogen and electricity produced using dairy biomethane.

c) Cost-Effectiveness

The cost effectiveness is \$68/MT GHG reduction, approximately \$10/MT higher than the proposed amendments.

d) Reason for Rejecting

This scenario is rejected because it results in higher costs and increases the risk of LCFS regulatory non-compliance. This scenario also does not align with 2022 Scoping Plan's direction to reduce potential risks of crop-based biofuel impacts to forests and food-crops and to phase out pathways for low-CI combustion fuels used in the transportation sector, like biomethane, away from the transportation sector.

C. Small Business Alternative

The Board has not identified any reasonable alternatives that would lessen any adverse impact on small business, since staff do not expect small businesses to be directly impacted.

D. Performance Standards in Place of Prescriptive Standards

Government Code section 11346.2(b)(4)(A) requires that when CARB proposes a regulation that would mandate the use of specific technologies or equipment, or prescribe specific actions or procedures, it must consider performance standards as an alternative. The LCFS is a performance standard, and therefore this requirement is not applicable.

E. Health and Safety Code section 57005 Major Regulation Alternatives

CARB estimates the proposed regulation will have an economic impact on the State's business enterprises of more than \$10 million in one or more years of implementation. CARB will evaluate alternatives submitted to CARB and consider whether there is a less costly alternative or combination of alternatives that would be equally as effective in achieving increments of environmental protection in full compliance with statutory mandates within the same amount of time as the proposed regulatory requirements, as required by Health and Safety Code section 57005.

X. Justification for Adoption of Regulations Different from Federal Regulations Contained in the Code of Federal Regulations

There are no current federal regulations comparable to the LCFS regulation. The U.S. EPA implements a Renewable Fuels Standard (RFS) regulation that mandates the blending of specific volumes of renewable fuels into gasoline and diesel sold in the U.S. to achieve a specified ratio for each year (i.e., the renewable fuel standard). As defined, “renewable fuels” under the RFS superficially resembles the list of transportation fuels subject to the LCFS. However, there are a number of reasons why the RFS is not comparable to the LCFS.

Congress adopted the RFS in 2005 and recently strengthened and expanded it in June 2022. The RFS requires that 36 billion gallons of biofuels be sold annually by 2022, of which 21 billion gallons must be “advanced” biofuels and the other 15 billion gallons can be corn ethanol. The advanced biofuels are those that achieve at least 50% reduction from baseline life cycle GHG emissions, with a subcategory required to meet a 60% reduction target. These reduction targets are based on life cycle emissions, including emissions from land use changes. With the update to the RFS, standards for cellulosic biofuel, biomass-based diesel, advanced biofuel, and total renewable fuel were added for 2020 through 2022. U.S. EPA also established a 250-million-gallon “supplemental obligation” to the volumes finalized for 2022 and stated its intent to add another 250 million gallons in 2023.¹⁰¹ U.S. EPA is currently proposing volume requirements and percentage standards for 2023 through 2025.¹⁰²

The RFS volumetric mandate alone will not achieve the objectives of the LCFS. The RFS targets only biofuels and not other alternatives; therefore, the potential value of electricity, hydrogen, and natural gas are not considered in an overall program to reduce the carbon intensity of transportation fuels and would not align with the overall transition to zero emission technology defined in California’s regulations. In addition, the targets of 50% and 60% GHG reductions only establish minimum requirements for biofuels, without incentivizing continuous improvements. It assigns biofuels to a small number of fixed categories, without incentivizing innovations within categories. Finally, the GHG requirements do not apply to corn ethanol production plants that were existing and planned at the time of RFS adoption, thus providing no incentive for reducing the carbon intensity from these fuels.

By contrast, the LCFS regulates all transportation fuels, including biofuels and non-biofuels, with a few narrow and specific exceptions. Thus, non-biofuels such as electricity and hydrogen may play important roles in the LCFS program. In addition, the LCFS encourages greater

¹⁰¹ United States Environmental Protection Agency, *Final Volume Standards for 2020, 2021, and 2022*. (Updated on August 31, 2022). <https://www.epa.gov/renewable-fuel-standard-program/final-volume-standards-2020-2021-and-2022>

¹⁰² United States Environmental Protection Agency, *Proposed Renewable Fuel Standards for 2023, 2024, and 2025*. (Updated on February 2, 2023). <https://www.epa.gov/renewable-fuel-standard-program/proposed-renewable-fuel-standards-2023-2024-and-2025>

innovation than the federal program by recognizing and rewarding incremental improvements to the carbon intensity of biofuel supply chains and deployment of innovative technologies and other fuels with very low-carbon intensities.

If California were to solely rely on the RFS, the State would neither achieve the fuel carbon intensity goal called for in Executive Order S-01-07, nor the 2030 GHG reduction targets of SB 32 and AB 1279, nor support its ZEV regulations as the LCFS does, nor stimulate the innovation needed to support future dramatic GHG reductions from the transportation sector. The lack of infrastructure and clean fuels for medium- and heavy-duty vehicles could also put at risk the state's ability to meet its air quality targets under federal regulations. Because of these differences, the federal RFS regulation is complementary, but not comparable to staff's proposal.

Accordingly, the existing LCFS and proposed amendments are authorized by California law; and as explained in Chapter VIII, the cost of the LCFS regulations is justified by the anticipated and potential benefits to human health, public safety, public welfare, and the environment.

XI. Public Process for Development of the Proposed Action (Pre-Regulatory Information)

Consistent with Government Code sections 11346, subdivision (b), and 11346.45, subdivision (a), and with the Board’s long-standing practice, CARB staff held public workshops and had other meetings with interested persons during the development of the proposed regulation. These informal pre-rulemaking discussions provided staff with useful information that was considered during development of the regulation that is now being proposed for formal public comment.

In this chapter, CARB staff provides a brief overview of the regulatory process and actions taken to develop the proposed amendments to the LCFS regulation.

Staff has been engaging with the public on potential future changes to the LCFS program for several years. Beginning in October 2020 and ending in August 2023 CARB staff conducted nine public workshops and two LCFS community meetings, in addition to numerous meetings with individual stakeholders to discuss concepts for potential amendments to the LCFS regulation and address various concerns. Notices for the workshops were emailed to subscribers of the “Low Carbon Fuel Standard Program” and “Fuels (General)” listservs at least two weeks in advance to give stakeholders ample time to attend and participate in the workshops. About 11,500 individuals or companies were notified for each workshop/hearing through the existing LCFS subscription lists. Details for public workshops and community meetings, including staff presentations were posted to CARB’s LCFS Meetings and Workshop webpage¹⁰³ prior to the workshop. Staff presented concepts for public consideration during the workshops. Staff provided ample opportunity during the workshops for stakeholders to provide oral feedback and additional opportunity for stakeholders to provide written public feedback for at least two weeks following the workshops. This feedback played a key role in informing the proposed amendments and were also posted publicly on the LCFS Meetings and Workshop webpage. All workshops and community meetings were held virtually to allow for remote participation during the COVID-19 pandemic, which also allowed for wider participation. Staff also added community listening sessions, which has not been done before for the LCFS.

Meeting attendees included the following:

- Transportation fuel producers, providers, and importers,
- Environmental justice groups,
- Community members,
- Academia,
- Verification and certification bodies,
- Consultants, and

¹⁰³ California Air Resources Board, *LCFS Meetings and Workshops webpage*. (Accessed on November 30, 2023). <https://ww2.arb.ca.gov/our-work/programs/low-carbon-fuel-standard/lcfs-meetings-and-workshops>

- Other interested persons.

These individuals participated by reviewing written material (i.e., preliminary draft regulations and other supporting documentation), providing data, and participating in workshops and meetings. Public input was used to inform and refine staff proposals, such as developing the acceleration mechanism and expanding the infrastructure crediting provision to the MHD sector. Staff also released the CATS model, which was used to evaluate the California fuel market to assess the technological and economic feasibility of bringing low-carbon fuels to California under various scenarios, with associated technical information for public review and input. Because of public input, the pre-rulemaking public process assisted staff in developing a better proposal. This also provided input on developing alternatives, as required under the Standardized Regulatory Impact Assessment (SRIA) process.

Staff’s approach to public engagement follows the precedent of previous LCFS rulemakings. Following approval of the previous 2017 Scoping Plan Update set the path of meeting California’s 2030 climate goals and was approved in 2017. In 2018, staff updated the LCFS to align with the 2017 Scoping Plan Update and the 2030 climate target. In May 2022, the draft 2022 Scoping Plan Update was released to identify a path and policies to achieve carbon neutrality and was brought to the Board for its first Board Hearing in June 2022. This release provided a concrete goal and initiated a process with which staff could engage to begin considering the pre- and post-2030 targets. Although the 2022 Scoping Plan Update was not complete at the time, staff started exploring what the LCFS could do to support California’s long-term carbon neutrality goal with stakeholders through workshops, while working closely with the Scoping Plan team to ensure the LCFS aligned with policy direction provided by the final Scoping Plan. The 2022 Scoping Plan Update was approved in December 2022, which provided high-level direction on where the LCFS program needs to go into the future. This direction played a role in developing and finalizing the potential amendments discussed with stakeholders during public workshops and community meetings.

Table 32 lists dates for the public workshops that were held to apprise the public about potential future changes to the LCFS program and other related developments.

Table 32: LCFS Public Workshops

Workshop	Date	Location	Time	Number of Feedback Letters Received
Workshop to discuss potential regulation revisions	Day 1: October 14, 2020	Virtual via GoToWebinar	Day 1: 9am – 12pm	135
Day 1: Potential amendments to LCFS and potential revisions to OPGEE model	Day 2: October 15, 2020		Day 2: 9am – 1pm	
Day 2: Stakeholder suggestions				

Workshop	Date	Location	Time	Number of Feedback Letters Received
Workshop to discuss guiding principles for potential future changes to LCFS program, including establishing post-2030 targets, phasing out petroleum projects, adding intrastate jet fuel, supporting hydrogen refueling infrastructure for MHD vehicles, and streamlining implementation	December 7, 2021	Virtual via GoToWebinar	9am – 12:30pm	106
Workshop to discuss potential changes to Crude Oil Carbon Intensity Estimation under the LCFS regulation	April 26, 2022	Virtual via GoToWebinar	9am – 10:30am	7
Workshop to discuss potential changes to the LCFS, including considerations for adjustments to compliance targets	July 7, 2022	Virtual via GoToWebinar	9am – 1pm	131
Workshop to discuss potential opportunities to streamline implementation and potential updates to emission factors, verification, and EV base credit methodology	August 18, 2022	Virtual via GoToWebinar	9am – 12pm	76
Workshop to discuss options for increasing stringency of the carbon intensity targets for 2030 and beyond, design of initial modeling scenarios, describe modeling approach, and soliciting alternatives	November 9, 2022	Virtual via GoToWebinar	9am – 1pm	155
Workshop to discuss potential credit generation opportunities that may affect carbon intensity targets, present preliminary fuel mix and cost outputs from CATS model, and present concepts related to streamlining implementation	February 22, 2023	Virtual via GoToWebinar	9am – 12pm (morning session) 12:30pm – 3pm (afternoon session)	154

Workshop	Date	Location	Time	Number of Feedback Letters Received
Workshop to discuss ways to design a mechanism that would accelerate the carbon intensity benchmarks if certain conditions are met.	May 23, 2023	Virtual via Zoom	9am – 12pm	43
Community meetings for community members to hear an overview of the LCFS program and provide input on potential future LCFS changes with CARB staff	May 31 and June 1, 2023	Virtual via Zoom	6pm – 8pm	16
Workshop to discuss LCFS modeling updates	August 16, 2023	Virtual via Zoom	9am – 11am	N/A

In addition, CARB staff participated in numerous stakeholder meetings sponsored by other parties, presenting information on the implementation of the existing program and exploring potential amendments.

During the original 2009 rulemaking process, staff created the LCFS website,¹⁰⁴ which has since been updated and improved, to increase public participation and enhance the information flow between CARB staff and interested parties. Since that time, staff has consistently made available online materials related to this rulemaking, including meeting presentations, preliminary draft regulatory language, and life cycle analysis models and tools used in assessing fuel and feedstock availability to inform the proposed carbon intensity benchmarks. The website also provides background information on the LCFS, workshop and meeting notices and materials, other GHG-related information, and links to other websites with related information. The website also includes feedback letters from stakeholders in response to staff’s pre-rulemaking public workshops and community meetings that led to the proposed amendments.

¹⁰⁴ California Air Resources Board, *Low Carbon Fuel Standard website*. (Accessed on May 15, 2023). <https://ww2.arb.ca.gov/our-work/programs/low-carbon-fuel-standard>

XII. References

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XIII. Appendices

Appendix A: Proposed Regulation Order

Appendix A-1: Proposed Regulation Order (Proposed Sections for Amendments)

Appendix A-1.1: Alternative Format to Proposed Regulation Order

Appendix A-2: Proposed Regulation Order (Proposed Sections for Adoption)

Appendix B: CA-GREET4.0 Technical Documentation

Appendix C-1: Standard Regulatory Impact Assessment Submitted to the Department of Finance

Appendix C-2: Department of Finance Comment Letter

Appendix C-3: Summary of Department of Finance Comments to the Low Carbon Fuel Standard 2023 Amendments Standardized Regulatory Impact Assessment and CARB Responses

Appendix D: Draft Environmental Impact Analysis

Appendix E: Purpose and Rationale for Low Carbon Fuel Standards Amendments

Appendix F: Estimating Carbon Intensity Values for the Crude Lookup Table

Appendix G: List of References