Attachment C: LCFS Fuels and Credit Market Modeling

Overview

Staff have relied upon technoeconomic modeling of the transportation fuels sector to inform proposed changes to the compliance targets in the Low Carbon Fuel Standard (LCFS) regulation. The primary modeling tool for this analysis is the California Transportation Supply (CATS) model.[1] The CATS model is a cost and compliance optimization model developed by the California Air Resources Board (CARB) to help estimate fuel supply that may be delivered to California under different policy scenarios. The model determines the least-cost path to compliance with the regulation using currently available fuels and crediting opportunities and produces estimates of the LCFS credit price that may result from that particular compliance path. The model was not designed to predict the future, nor was it designed to simulate the complexities of the broader California transportation fuel market, which includes a wide diversity of transportation fuel producers, marketers, and retailers. The model is not designed to predict future credit prices or any cost pass-through by compliance entities. No model currently available can accurately predict future credit prices for the LCFS, future transportation fuel prices, or pass-through cost for retail gasoline or diesel costs.

Like all other models, the CATS model cannot account for all of the potential factors that may influence the California transportation fuels market. The transportation fuels landscape is complex and affected by many factors outside of the State's control, such as federal regulations and incentives, global economic forces, rate of technology adoption, regulatory compliance and planning internal to any regulated entity, and personal choices related to transportation, among others. These variables can have a large impact on the mix of transportation fuels used in California. Although the model is able to produce some estimates of LCFS credit prices associated with given scenarios and modeling assumptions, the reality is that the actual cost pass-through from LCFS to retail gasoline or diesel prices is uncertain, that there is no correlation between historical LCFS credit prices and gasoline prices,[2] and that the LCFS is not a major driver of overall retail fuel prices in California. Recent analyses show that retail fossil fuel prices are strongly influenced by many factors (e.g., global events, holiday weekends, seasonal fluctuations, refinery disruptions and decisions about production that affect supply, refinery pricing decisions, seasonal fuel blends, and taxes) and fossil fuel producer pricing strategies are complex, reflecting local and regional market conditions.[3] Few of these factors are determined by government entities, including the State of California. Between 2017 and 2023, the average retail price of gasoline in California fell as low as $3.08 and rose as high as $5.41, and the

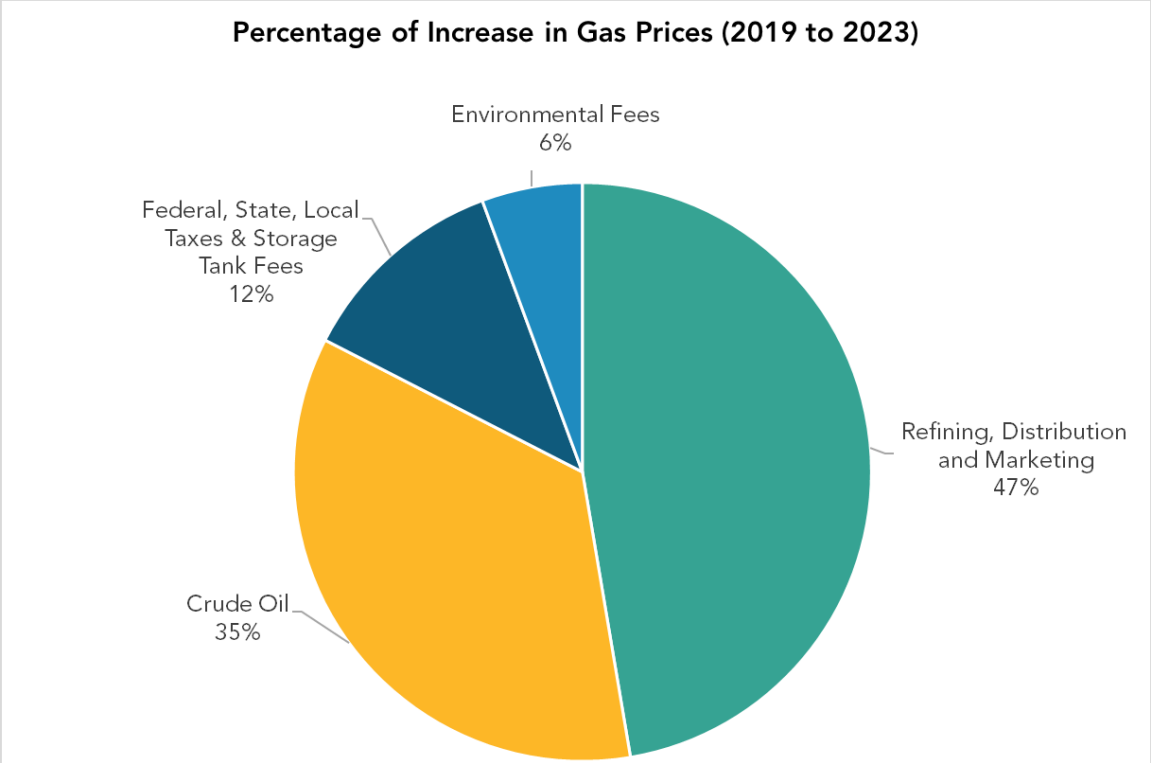
[1] CARB. CATS Model v0.2 Technical Documentation. Aug 16, 2023. https://ww2.arb.ca.gov/sites/default/files/2023-08/CATS%20Technical_1.pdf

[2] Bates and White. LCFS Market Impacts and Evidence for Retail fuel Price Effects (April 2022). https://www.bateswhite.com/media/publication/226_BW LCF Report - April 2022.pdf

[3] CEC, Staff Report: Draft Transportation Fuels Assessment (May 2024) and CEC Division of Petroleum Market Oversight, Planned Maintenance and Gasoline Prices (June 2024).

average retail price of diesel ranged between $3.07 and $6.02.[4] Retail gas prices in California are not fully explained by the current regulatory environment and are being evaluated further pursuant to SBX1-2 (Skinner, Chapter 1, Statutes of 2023). The California Energy Commission's (CEC) data have shown that the cost of crude oil and costs associated with refining, distribution, and marketing were the main drivers of the rising costs of gasoline prices and together have contributed 82% to the increase between 2019 and 2023 retail prices.

Figure 1: Over 80% of Recent Gasoline Cost Increases Are Due to Oil Companies



The LCFS creates price-mitigating effects by inducing diversification and expansion of fuel supply.[5] For example, electricity, renewable diesel, and ethanol currently provide affordable alternatives to petroleum diesel and gasoline. Just as importantly, the LCFS provides a market for a significantly greater number[6] of clean fuel producers, allowing for greater competition and lower fuel rates when compared to the significantly smaller number of petroleum fuel producers today, thus increasing competition and putting downward pressure on prices.[7]

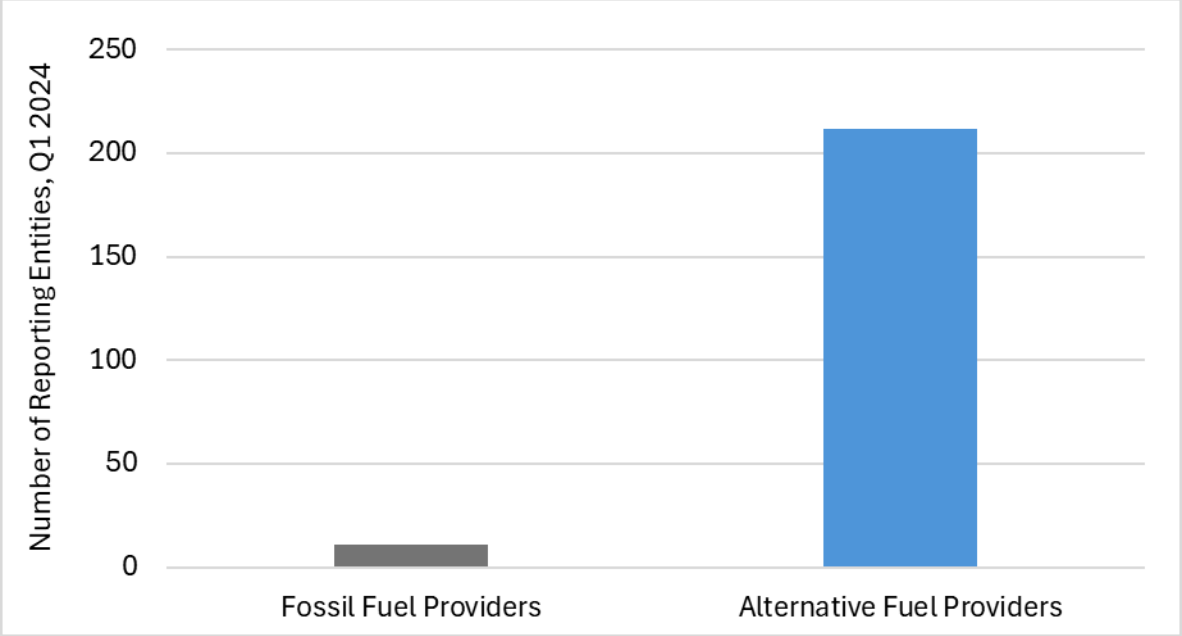
[4] *See* U.S. Energy Information Administration, Annual Retail Gasoline and Diesel Prices

[5] Bates and White, LCFS Market Impacts and Evidence for Retail Fuel Price Effects: Executive Summary (April 2022), with updates by CARB for recent quarterly LCFS data.

[6] As of 2024, just 6 companies operate the 9 remaining fossil fuel refineries in California. The non-fossil fuel supply is much more diverse, with over 1,300 individual low carbon fuel pathways certified by CARB to supply alternative fuels to California.

[7] Natural Resources Defense Council. Increasing Market Competition to Reduce the Level and Variability of Transportation Fuel Prices (March, 2014). NRDC DocumentBank: ene_14041501a.pdf

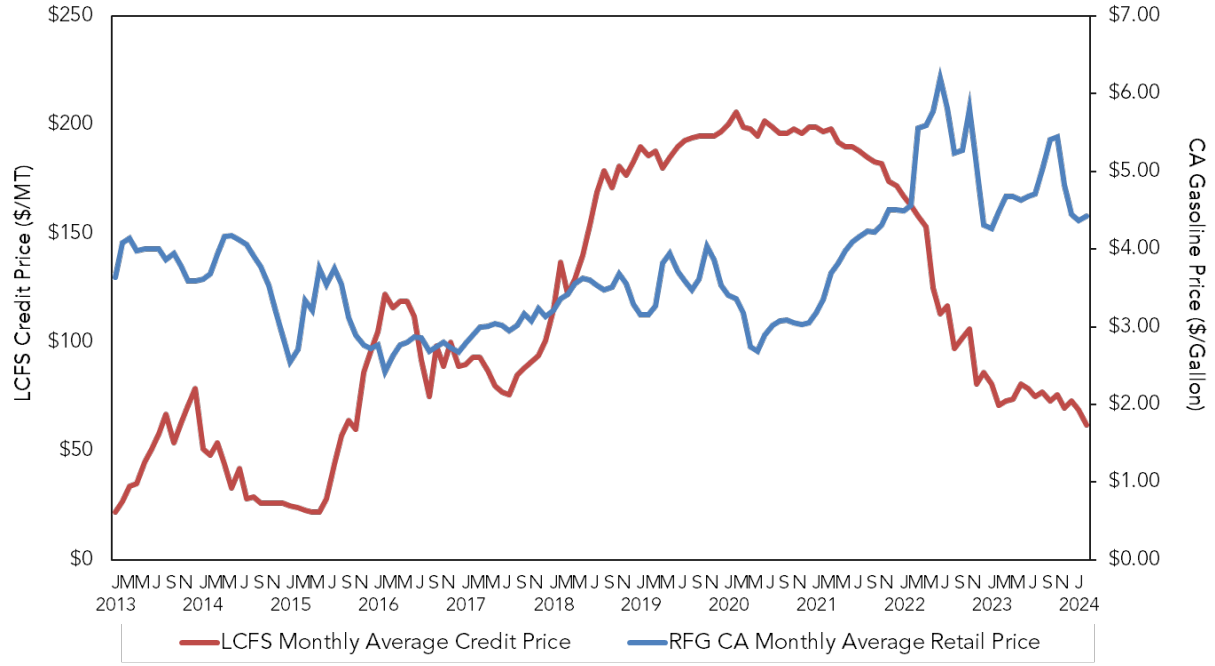
Figure 2: Increased Competition Means Lower Prices



Additionally, the CEC found in 2019 that retail margins for higher-priced retail brands compared to lower-priced brands were nearly twice the California average retail margin.[8] These high retail margins are unrelated to the LCFS program, because the LCFS program has no differential effect based on brand or fuel grade. Data reveal the LCFS credit prices are not a major driver of retail fuel prices in California. As shown in Figure 3, LCFS credit prices and the retail price of gasoline in California have no apparent relationship.

[8] CEC, Additional Analysis on Gasoline Prices in California (October 2019).

Figure 3: No Relationship Between Gasoline Retail Prices and LCFS Monthly Average Credit Price



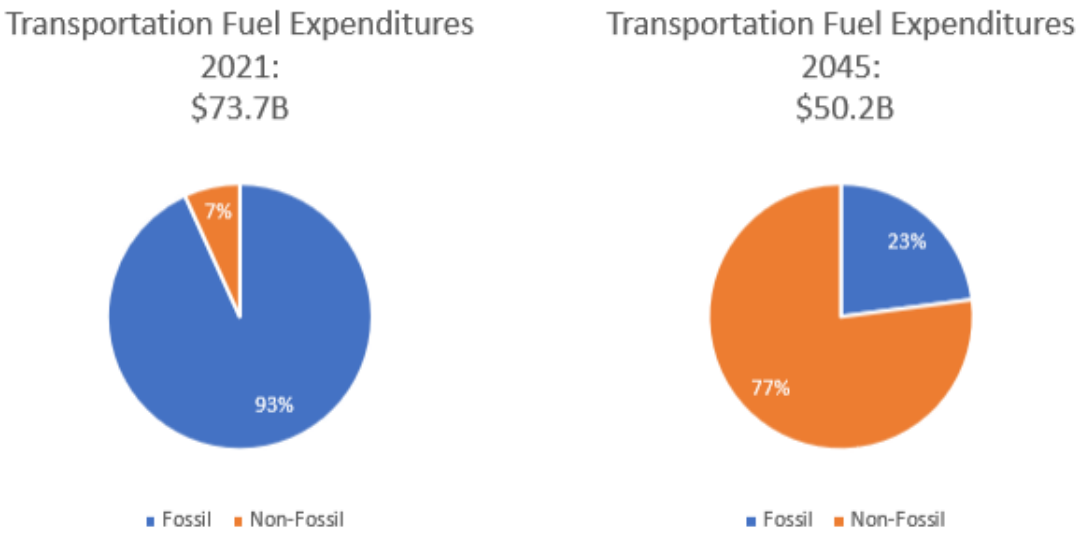
Just as importantly, data show that Californians are using less fuel as zero-emission vehicle (ZEV) sales increase.

Ultimately, energy affordability for Californians is not solely predicted by retail gasoline prices. A recent analysis found that California had the 41st lowest energy use per person out of the 50 states in average monthly energy expenditures.[9] Transportation fuel expenditures will also continue to decline over time. CARB staff estimate that the amount of money Californians spend on transportation across all vehicle classes could be up to 42% lower in 2045 compared to the amount of money spent on transportation in 2021. This translates into annual savings of over $20 billion 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 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 regulations 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 Californians will be paying $0.12 per mile traveled, for an overall 42% savings in fuel costs per mile statewide (see Figure 4). 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, a reduction of over 50%, as the light-duty sector

[9] Visual Capitalist. *Mapped: Energy Costs by State in 2024.* July 10, 2024. Mapped: Energy Costs by State in 2024 (visualcapitalist.com)

transitions away from fossil fuels and becomes mostly ZEVs supplied by electricity and hydrogen.

Figure 4: California's Fuel Expenditures by Type



As part of this LCFS amendments rulemaking processes, CARB released a Standardized Regulatory Impact Assessment (SRIA),[10] which included 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 metrics in the Initial Statement of Reasons (ISOR) incorporate the costs for all transportation fuels into one metric and provides a more comprehensive and accurate demonstration of potential future transport costs to California consumers.[11]

While this appendix and the LCFS SRIA include estimated LCFS credit prices based on various scenarios modeled via CATS, these should not be misconstrued as a prediction of the future credit price nor as a direct impact on prices at the pump. As noted above, 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, and taxes) and fossil fuel producer pricing strategies are complex and reflect local and regional market conditions. The LCFS SRIA, which was developed to satisfy Department of Finance requirements for analyzing regulatory impacts,[12] evaluated potential costs of program compliance on fossil fuels and did

[10] CARB, *Staff Report: Initial Statement of Reasons: Public Hearing to Consider the Proposed Amendments to the Low Carbon Fuel Standard, Appendix C-1: Standard Regulatory Impact Assessment Submitted to the Department of Finance.* December 19, 2023. https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2024/lcfs2024/appc-1.pdf
[11] CARB, *Staff Report: Initial Statement of Reasons: Public Hearing to Consider the Proposed Amendments to the Low Carbon Fuel Standard*. December 19, 2023. https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2024/lcfs2024/isor.pdf
[12] Department of Finance. Major Regulations. https://dof.ca.gov/forecasting/economics/major-regulations/

not assume all benefits of program credits for competing fuels would be passed through to the end user. Importantly, the SRIA does not represent the actual price at the pump that would happen in the real world because the CATS model and the analysis are not intended to comprehensively model California's complex retail fuel market. Actual compliance cost pass-through depends on factors including the quantity of fossil fuel still in use, the supply of clean fuel, and the number of LCFS credits in the market, among other private business decisions. In addition to having a narrow and incomplete evaluation of potential fossil fuel price impacts, the SRIA was a point-in-time analysis that represented policy options that were updated in some cases with the proposal released along with the ISOR. As such, the SRIA does not fully reflect the current proposed changes to the program. Fossil fuel combustion and associated deficits generated under the program will decrease over time as the ZEV population increases. Clean fuels will increase as the program becomes more stringent and a stronger market signal is supported, while the costs of some of the lowest-carbon fuels will fall over time due to innovation as the technology to produce and use these fuels is widely 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 costs of the program to consumers are managed.

Given the uncertainty associated with projecting future transportation fuel mixes in California, staff assessed three uncertainty scenarios in addition to the Proposed Scenario (regulatory proposal released along with the ISOR and updated for this 15-day regulatory package), which quantify the impact of changes to three key modeling inputs: triggering of the automatic acceleration mechanism (AAM); ZEV adoption; and renewable diesel (RD) consumption. This document shows the fuel mix and potential credit price trajectories of each uncertainty scenario as compared to the Proposed Scenario. The uncertainty associated with these key variables supports staff's proposal to establish a compliance target of 30% carbon intensity (CI) reduction in 2030. Uncertainty also increases past 2030, but CARB anticipates re-evaluating any post-2030 program design as part of its normal process once the 2027 Climate Change Scoping Plan update[13] is completed.

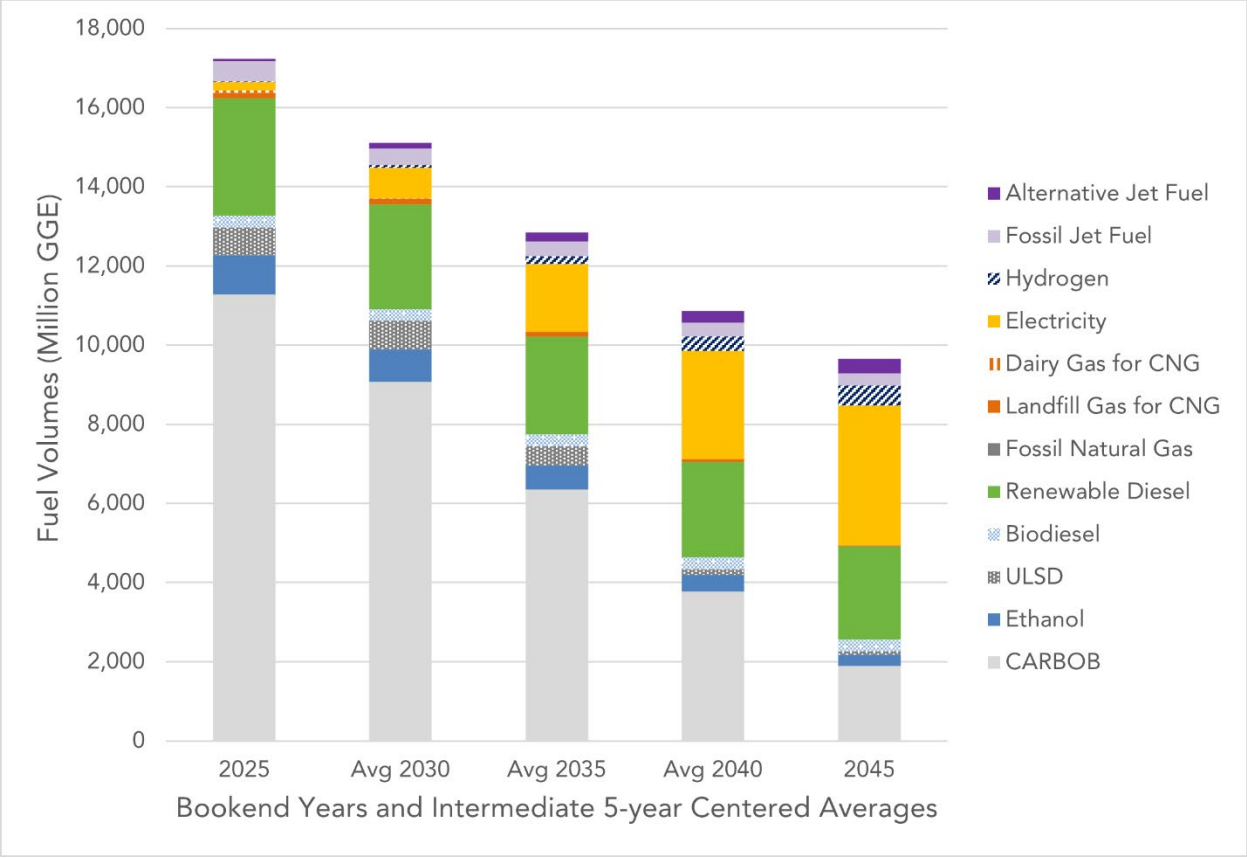
Proposed and Uncertainty Scenario Modeling

Staff updated the CATS modeling for the Proposed Scenario in response to public feedback received on the regulatory proposal released along with the ISOR to match the currently proposed modifications to the initial regulatory proposal.[14] The most important update to the Proposed Scenario CATS modeling was increasing the stringency of the 2025 compliance target to reflect a 9% step-down, an increase from the previously-proposed 5% step-down. Staff proposed to increase the near-term ambition of the compliance targets in consideration of the

[13] Health and Safety Code section 38561 requires CARB to California's "scoping plan" for achieving the maximum technologically feasible and cost-effective reductions of greenhouse gas emissions at least once every five years.
[14] CARB, *Staff Report: Initial Statement of Reasons: Proposed Amendments to the Low Carbon Fuel Standard*. December 19, 2023. https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2024/lcfs2024/isor.pdf

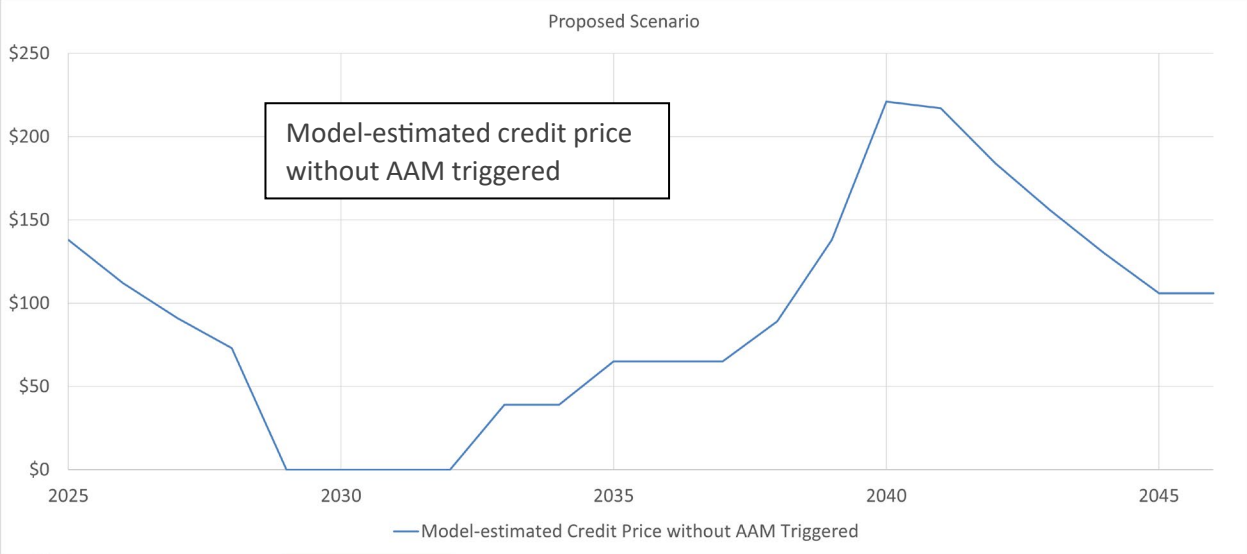
continued growth in the credit bank in recent quarters, as well as public feedback stating that a 5% step-down would not be adequate to balance credits and deficits in the market or reduce the size of the credit bank, which continues to increase over time. Staff maintained the stringency of the 2030 compliance target for this scenario, due to the high levels of uncertainty in key modeling inputs, which is discussed in more detail later in this appendix. It is important to note that no model can fully reflect all real-world nuances, and that the specific purpose of CATS is to compare scenarios against each other. Figure 5 below depicts the fuel mix projected by the CATS model under the updated Proposed Scenario.

Figure 5: Proposed Scenario – Model-Estimated Fuel Mix for the Purpose of Comparing Scenarios



The credit price outputs from the CATS model for the updated Proposed Scenario are summarized in Figure 6. The model projects a near-term increase in the credit price, but also suggests a drop in credit price in the 2030 time frame before rebounding as the pace of CI reduction increases post-2030. Staff is relying on the credit price estimates solely to compare potential differences in credit market behavior under different scenarios.

Figure 6: Proposed Scenario – Model-Estimated Prices for the Purpose of Comparing Scenarios



These results should be considered in light of several key input variables. First, the scenario does not model triggering of the AAM described in section 95484 of the proposed amendments to the LCFS regulation (Proposed Amendments). If market conditions were present that could reduce the LCFS credit price, it is likely that the AAM would be triggered, and the compliance target schedule brought forward. Conditions for when the AAM would be triggered are clearly defined in the Proposed Amendments. Market participants would likely anticipate the triggering of the AAM and would factor this into their valuation of LCFS credits in the marketplace. In addition, the actual change in compliance targets from triggering the AAM would increase the CI reduction benchmark of the program in the near-term and reduce the supply of credits. The CATS modeling for the Proposed Scenario cannot account for these factors, and staff expect that the modeled drop in credit price in the 2030 time frame is an outcome of the model's design and not an accurate representation of what will be likely to happen. Staff developed Uncertainty Scenario 1 to assess the potential market effects of the AAM being triggered once after the adoption of the Proposed Scenario. Figure 7 depicts the fuel mix that could result from the AAM being triggered in 2027 based on 2026 data and implemented in 2028, and Figure 8 shows the resulting modeling credit prices for comparison purposes.

Figure 7: Uncertainty Scenario 1- Proposed with 2028 AAM – Model-Estimated Fuel Mix for the Purpose of Comparing Scenarios

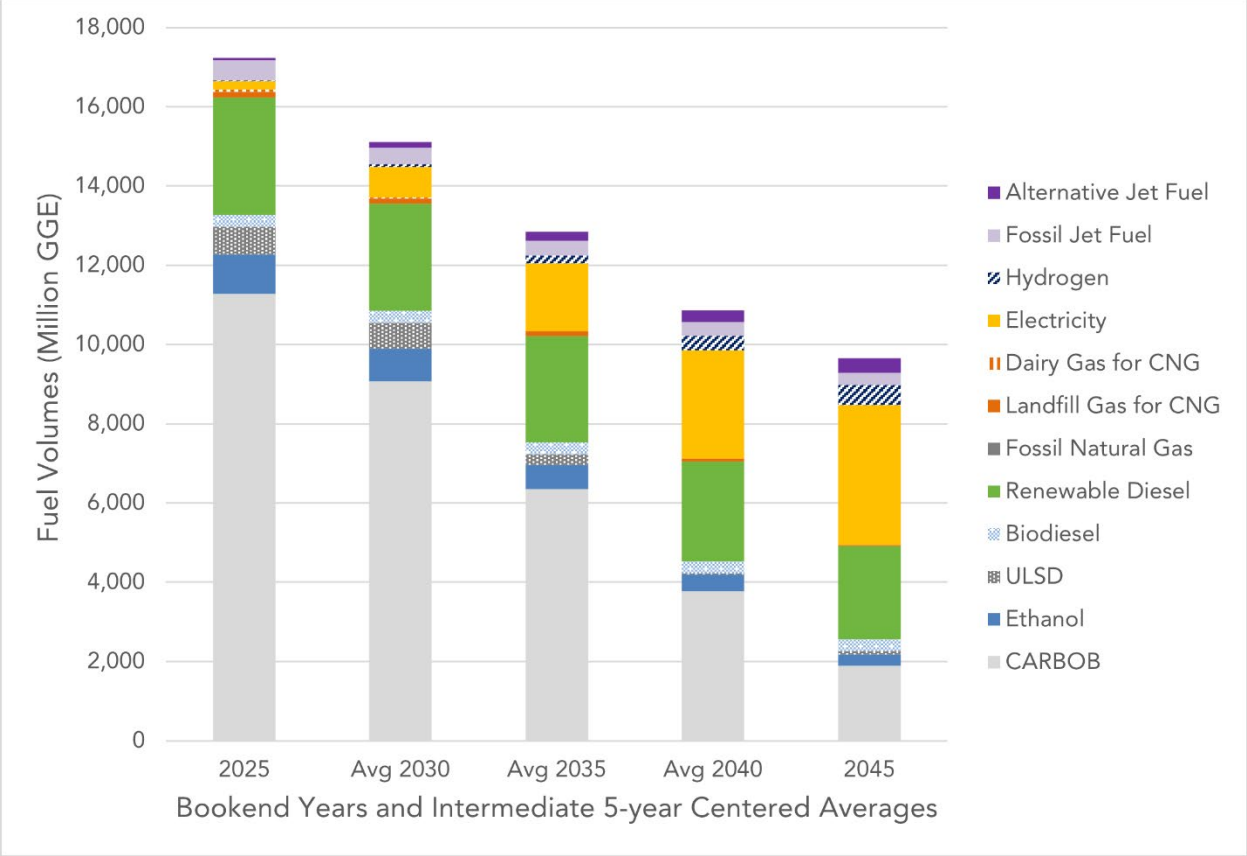
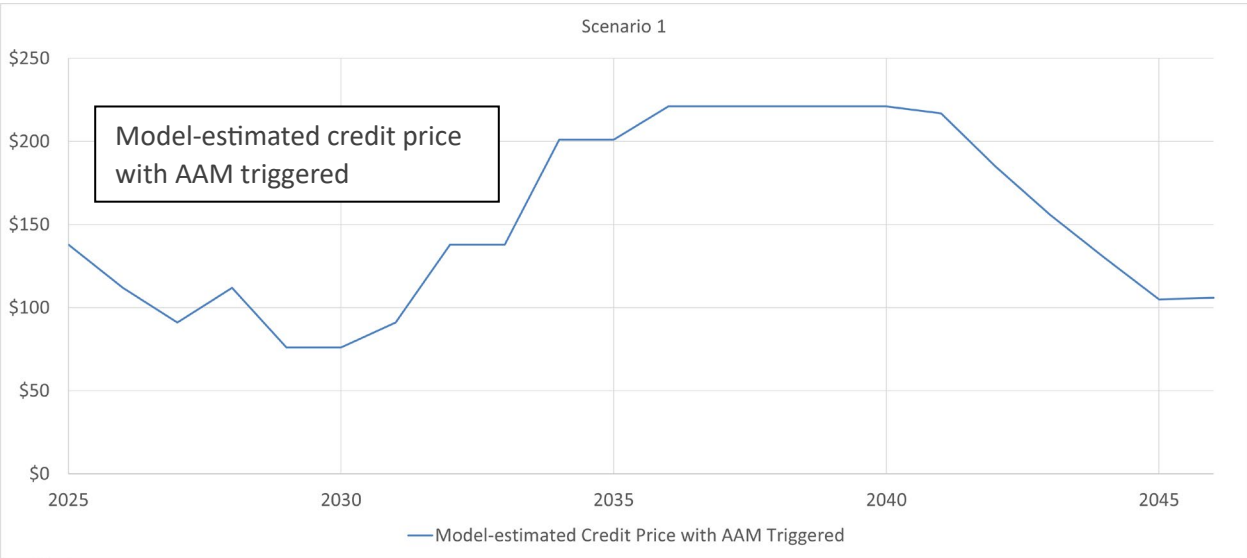


Figure 8: Uncertainty Scenario 1- Proposed with 2028 AAM – Model-Estimated Price for the Purpose of Comparing Scenarios



The Proposed Scenario modeling assumes full implementation of California's ZEV regulations, including Advanced Clean Cars II (ACC II), Advanced Clean Trucks (ACT) and Advanced Clean Fleets (ACF). Staff's modeling shows that electricity and hydrogen used in ZEVs become

dominant sources of credits in the program in the future. However, if ZEV adoption in California is slower than anticipated under these regulations, LCFS credit generation from ZEVs will lag. This would reduce the supply of credits and potentially increase deficits as gasoline and diesel fleets remain on the road longer, which could lead to higher LCFS credit prices than projected by the model in the Proposed Scenario. Delays in ZEV adoption could be due to a number of potential barriers, such as permitting delays for infrastructure, high prices for vehicles or lower-than-expected sales. Regardless of the cause, delayed ZEV adoption would impact the credit market. Staff modeled a potential lag in ZEV adoption for on-road vehicles (light-, medium-, and heavy-duty) in Uncertainty Scenario 2. The scenario assumes that the State achieves only 75% of the ZEV adoption targets by 2030. Figure 9 depicts the fuel mix that could result from this lag in ZEV adoption, and Figure 10 shows estimates of the credit prices projected by the model as a result. Credit prices could be higher than in the Proposed Scenario due to a reduction in the supply of credits from electricity- and hydrogen-powered vehicles. This uncertainty must be considered when establishing CI targets based on modeling.

Figure 9: Uncertainty Scenario 2- 75% ZEV Deployment – Model-Estimated Fuel Mix for the Purpose of Comparing Scenarios

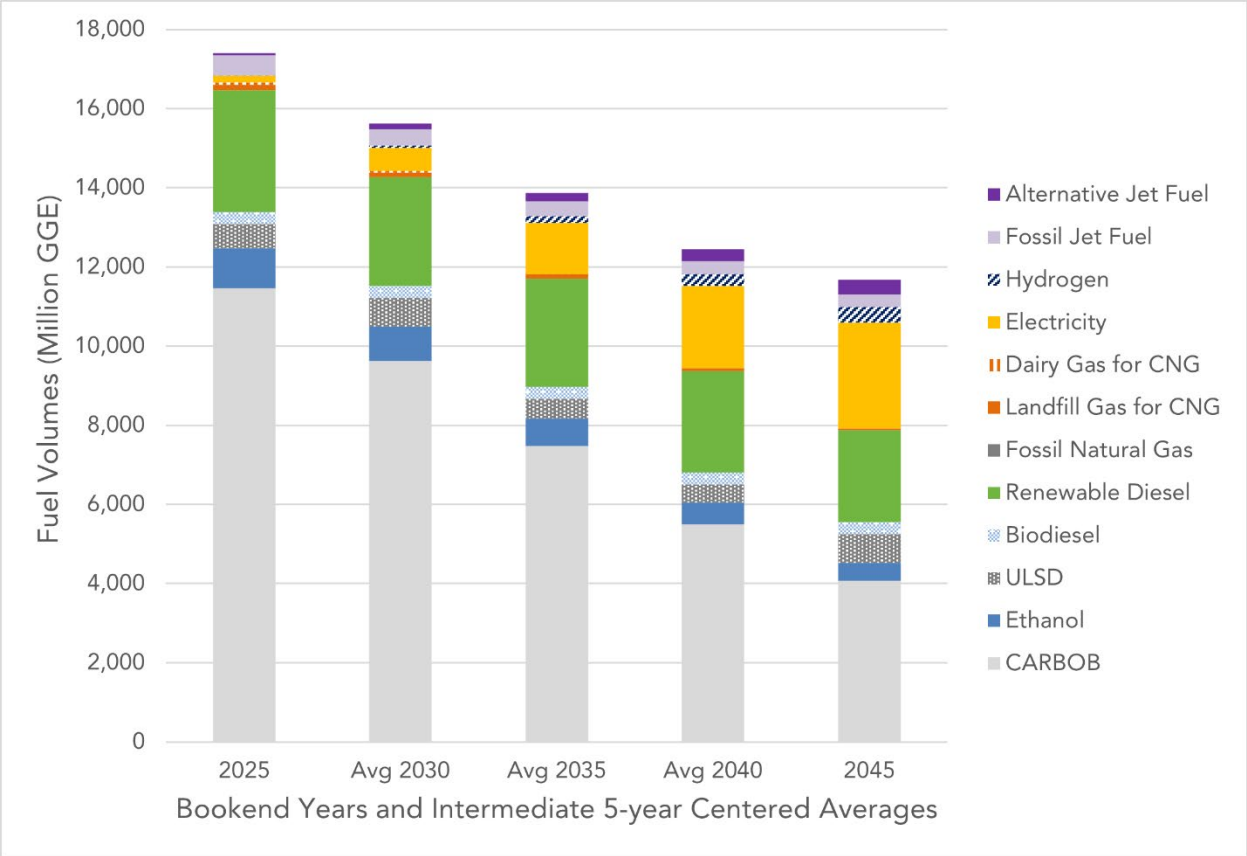
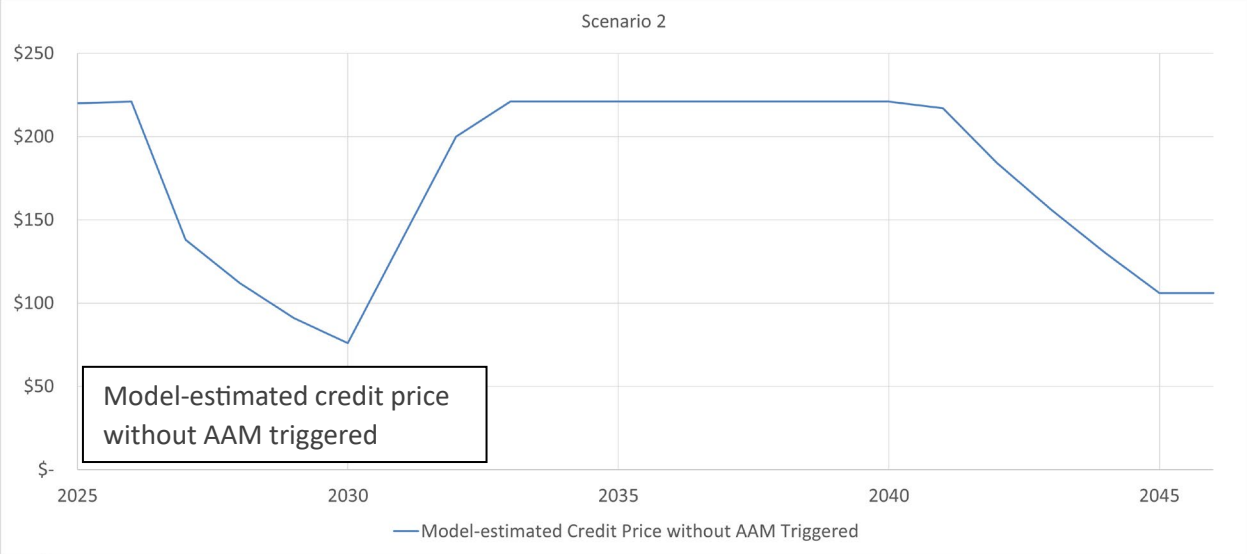


Figure 10: Uncertainty Scenario 2- 75% ZEV Deployment – Model-Estimated Prices for the Purpose of Comparing Scenarios



The other major uncertainty factor regarding future fuels market projections is the quantity of RD that will come to California. Renewable diesel consumption in California increased by 240% from 2018 to 2023,[15] and California currently makes up over 66% of total domestic RD consumption.[16] However, it only accounts for 65% of the State's diesel fuel demand in the medium- and heavy-duty sectors. Staff's modeling in the Proposed Scenario assumes that RD consumption will continue to grow through 2030, and therefore continues to generate credits. However, there is a high degree of uncertainty in projecting future volumes of RD. One source of this uncertainty is the fact that California's diesel pool is larger than the nationwide biomass-based diesel Renewable Volume Obligation (RVO) established by the U.S. Environmental Protection Agency (EPA) for the years 2023, 2024, and 2025, and the announced domestic production capacity for RD is even larger. Traditionally, the RVO has established a soft upper limit on total nationwide volumes of biofuels, and there is uncertainty about how fuel producers will respond to overshooting the RVO. In addition, while California has historically attracted a disproportionately large amount of renewable diesel to the State likely as a result of the LCFS price signal, this may not always be the case. Other states and provinces with clean fuel standards similar to California's LCFS have begun to report increases in renewable diesel consumption, including Oregon, Washington and British Columbia. New Mexico is creating an LCFS program of its own, and several other states are strongly considering similar programs, including large markets like New York. The Canadian federal government also introduced a clean fuels regulation in 2023 and that will likely increase competition for volumes of RD. Due to these and other factors, staff must consider a future in which RD volumes in California do not continue to increase at the current rapid pace. Uncertainty Scenario 3 examines the effects of

[15] CARB. *LCFS Quarterly Data Summary Spreadsheet*. https://ww2.arb.ca.gov/sites/default/files/2024-04/quarterlysummary_Q42023.xlsx

[16] USDA. U.S. Renewable Diesel Consumption. June 11, 2024. https://fas.usda.gov/data/us-renewable-diesel-production-growth-drastically-impacts-global-feedstock-trade

freezing renewable diesel volumes at a maximum of 2023 levels as a proxy for a slowdown in the RD market. Figure 11 and Figure 12 depict the fuel mix and potential credit prices that could result, respectively.

Figure 11: Uncertainty Scenario 3- Less RD Available to CA – Model-Estimated Fuel Mix for the Purpose of Comparing Scenarios

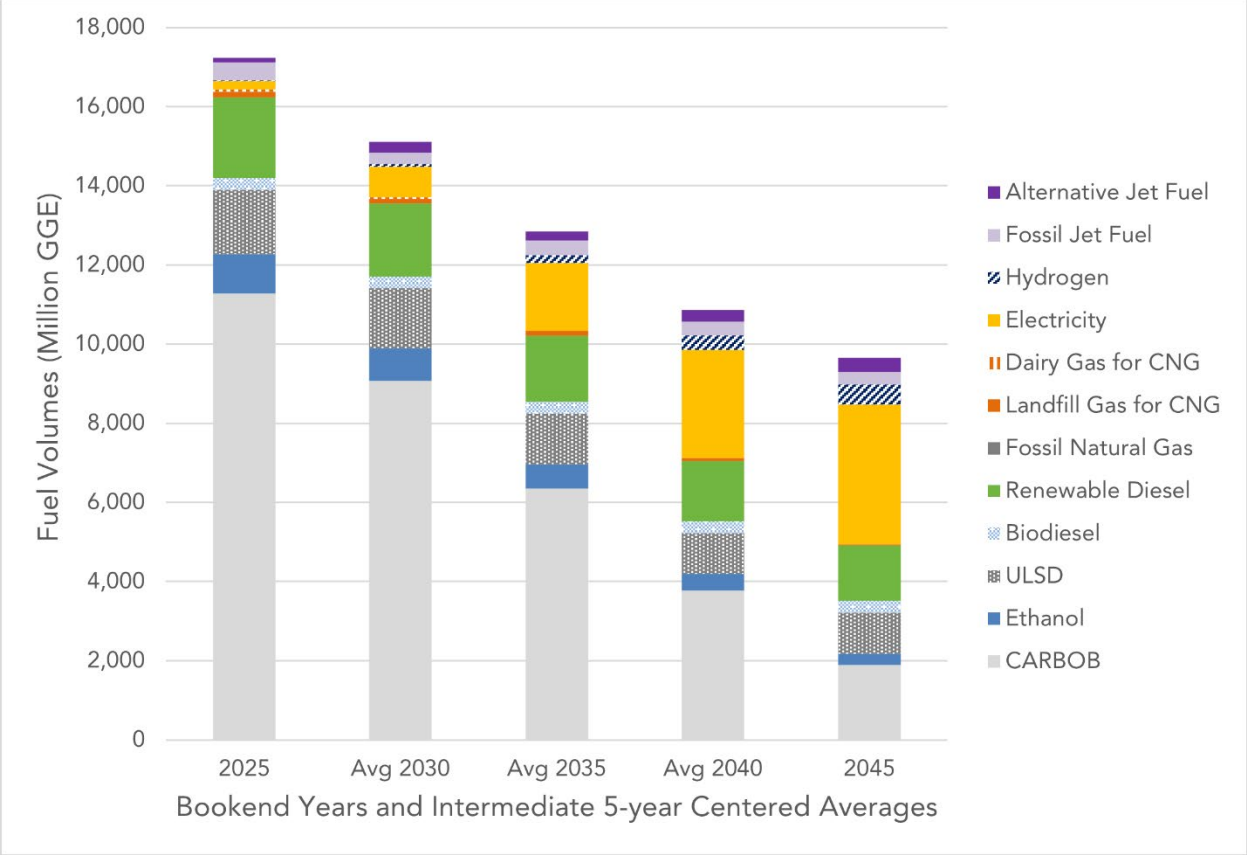
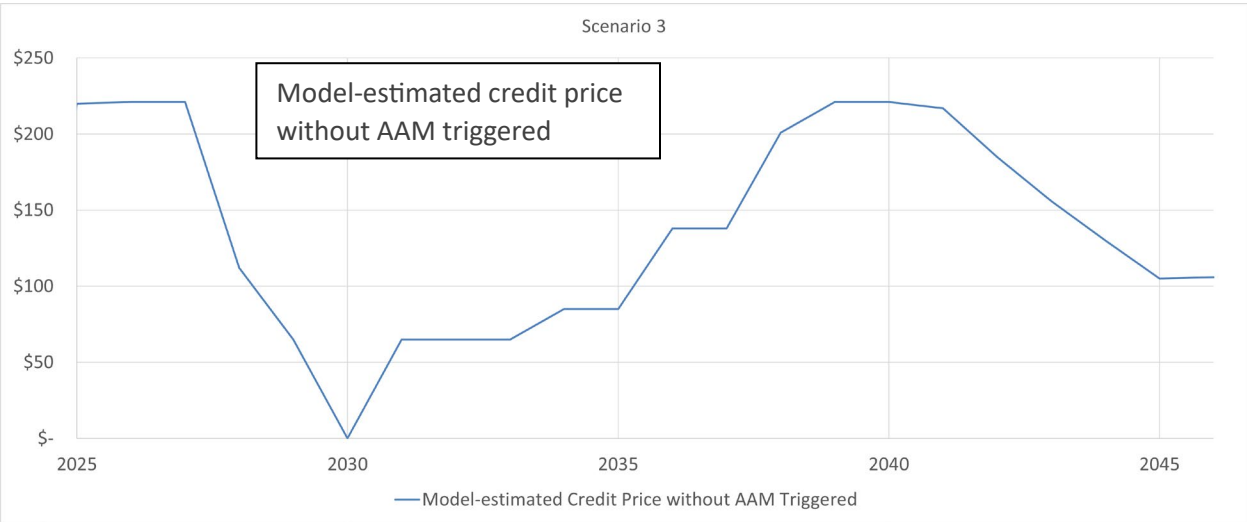


Figure 12: Uncertainty Scenario 3- Less RD available to CA – Model-Estimated Prices for the Purpose of Comparing Scenarios



Lastly, staff assessed the potential for both a lag in ZEV adoption and a slowdown in RD

consumption, in Uncertainty Scenario 4. In this scenario, the fuel mix in Figure 13 and credit price trend in Figure 14 differ from the Proposed Scenario, and highlight the variability in possible futures if the Proposed Amendments are adopted.

Figure 13: Uncertainty Scenario 4- Less RD and 75% ZEV Deployment – Model-Estimated Fuel Mix for the Purpose of Comparing Scenarios

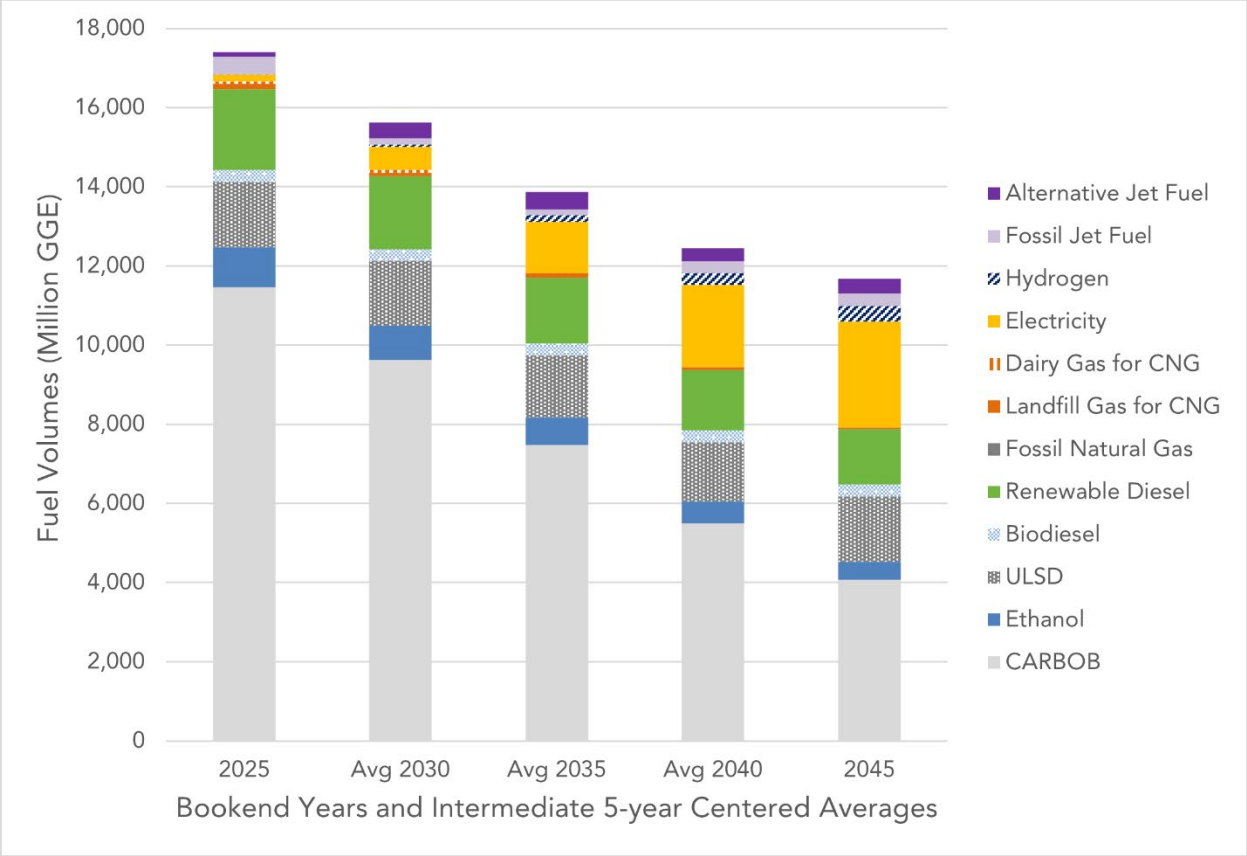
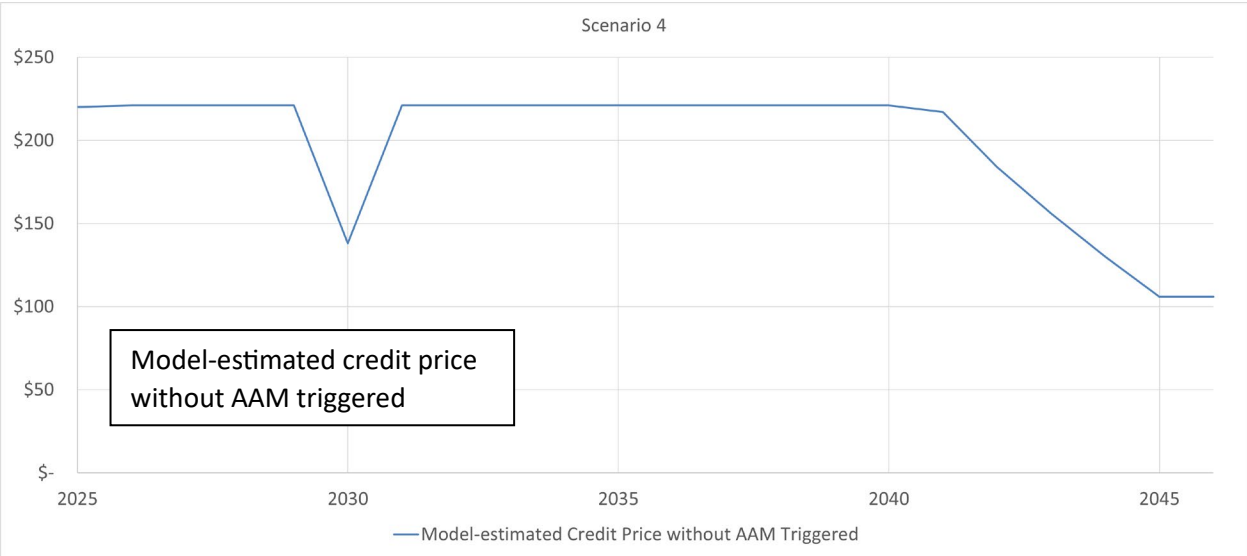


Figure 4: Uncertainty Scenario 4- Less RD and 75% ZEV Deployment – Model Projected Credit Price for the Purpose of Comparing Scenarios



Conclusion

This uncertainty scenario comparison exercise highlights the complexities and challenges of forecasting the California transportation fuel system decades into the future. These complexities and challenges necessitate that following every update to the California's Climate Change Scoping Plan, existing CARB programs must be evaluated for potential modifications to ensure they continue to reflect the most recent science, data, legislative direction, and executive orders. Additional factors not modeled in this exercise could also complicate the analysis, such as changes in vehicle miles traveled, and the state of the economy. Given the uncertainty inherent in these projections, staff is proposing to increase the near-term step-down in CI stringency in 2025 to balance the market in the near-term, and to maintain the 2030 CI target reduction of 30%. If key market factors align and credit generation exceeds what is needed to comply, the AAM may be triggered as designed to improve program efficacy. However, a 30% 2030 target provides a balanced path forward that achieves substantial greenhouse gas reductions while acknowledging the potential for future lags in ZEV adoption and RD consumption.