

Analyzing Future Low Carbon Fuel Targets in California

*Response to LCFS Public Workshop
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Table of Contents

Executive Summary.....	1
1 Introduction	4
ICF Commentary on the CATS model.....	5
2 ICF Analysis of Information Presented at April Workshop.....	6
Incorrect Application of CI Changes to Biomass-Based Diesel	6
2025 CI Step Down.....	7
Automatic Acceleration Mechanism	9
Appendix	16
Background on ICF modeling	16
Stakeholder Outreach	17

Executive Summary

The California Air Resources Board staff released the Staff Report: Initial Statement of Reasons outlining many proposed amendments to the Low Carbon Fuel Standard program in December 2023. The Staff Report identified three key areas of change with respect to carbon intensity targets: 1) increased stringency by 2030 (from 20% to 30% carbon intensity reduction), 2) a step down of 5% in the carbon intensity reduction required in 2025 (yielding an 18.75% carbon intensity reduction requirement compared to the 13.75% reduction scheduled), and 3) the introduction of an Automatic Acceleration Mechanism. California Air Resources Board staff provided additional documentation during a Low Carbon Fuel Standard Public Workshop on April 10, 2024.

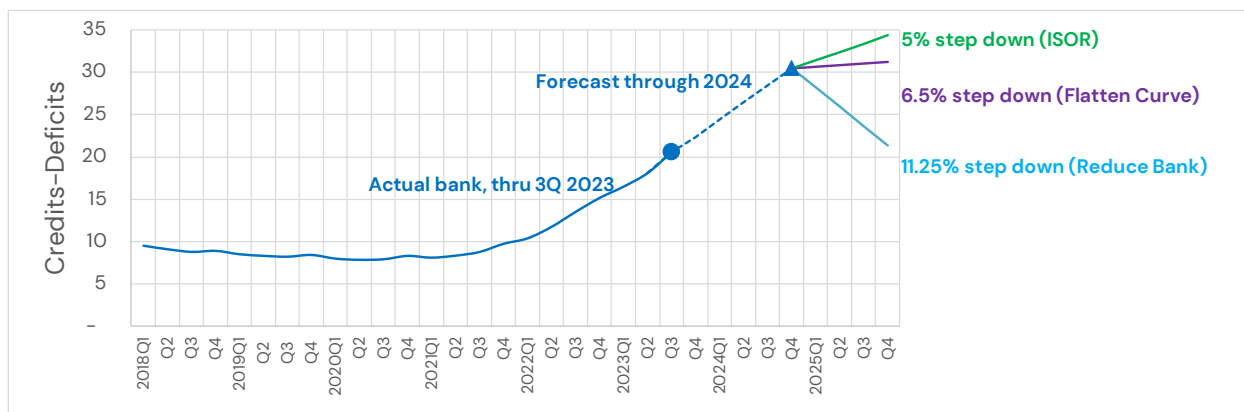
ICF previously reported that in an Accelerated Decarbonization *Central Case* a carbon intensity reduction target of 41–44% for 2030 is achievable for California's Low Carbon Fuel Standard program. ICF reached this conclusion based on expected fuel volumes and carbon intensity reductions for a wide array of low carbon fuel pathways. The work presented here, however, was prepared in direct response to the Staff Report, accompanying documentation published in December 2023, and new information made available during the Low Carbon Fuel Standard Public Workshop in April 2024. ICF's updated commentary focuses on a) California Air Resources Board staff's incorrect application of carbon intensity changes to biomass-based diesel fuels, b) the carbon intensity step down in 2025, and c) the Automatic Acceleration Mechanism.

The carbon intensity for biomass-based diesel has been incorrectly adjusted by California Air Resources Board staff in the CATS modeling.

California Air Resources Board staff published data indicating that the carbon intensity of ultra-low sulfur diesel will increase from 100.45 g/MJ to 105.76 g/MJ when the amended regulation becomes effective. ICF (and presumably stakeholders) notified the California Air Resources Board of the fact that part of the carbon intensity change that applies to diesel also needs to be applied to biomass-based diesel, notably the tailpipe greenhouse gas emissions. However, California Air Resources Board staff applied the carbon intensity adjustment incorrectly. This error by California Air Resources Board staff means that the biomass-based diesel deployed in the scenarios using the CATS model should have generated at least another 3.2 million credits during the period 2025–2030. This has significant impacts on the carbon intensity step down analysis for 2025 (and reinforces the need for a modified approach to the Automatic Acceleration Mechanism).

ICF continues to recommend a step down of 10.5% to 11.5% in 2025 to achieve a target credit bank equivalent of 2–3 quarters' worth of deficits.

This level of stringency is likely what is needed to achieve the stated intent of correcting for the "near-term over-performance" of the program. ICF's analysis indicates that the credit bank will likely continue to build significantly in 2025 if the step down is limited to 5%. ICF analysis suggests that a 6.5% step down is needed to ensure that the credit bank build is flattened in 2025.



ICF recommends that the Automatic Acceleration Mechanism be considered for implementation as soon as 2026, rather than waiting until 2028.

Delaying the implementation of the Automatic Acceleration Mechanism is unnecessary. The risk of a continuous credit bank building through 2027, thereby depressing credit prices for another 3–4 years, outweighs the risk of triggering the mechanism sooner.

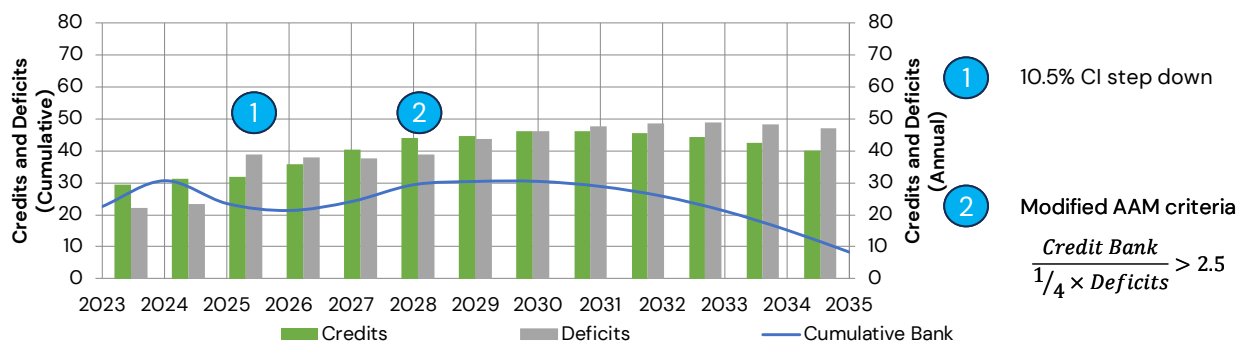
ICF recommends that the Automatic Acceleration Mechanism be implemented on a four-quarter rolling basis.

At the very least, the policy interventions proposed by the California Air Resources Board should be evaluated in the context of the current market to determine if they would have had an impact. As proposed, the Automatic Acceleration Mechanism would not have been triggered based on a review of annual data from 2022, thereby allowing the credit bank to grow during 2023 and again through 2024 with no market correction. If the Automatic Acceleration Mechanism were implemented on a four-quarter rolling basis, then the mechanism would have been triggered sooner and the credit bank build in this hypothetical scenario would have been constrained.

ICF recommends that the first criteria for the Automatic Acceleration Mechanism be modified such that the mechanism is enacted when the credit bank is more than 2.5 times greater than the quarterly deficits generated on a four-quarter rolling basis.

The threshold for the first trigger proposed should be reduced from 3.0 to 2.5 (or lower). ICF disagrees with the underlying presumption that the AAM should be triggered at the proposed threshold i.e., when there are three quarters' worth of deficits in the bank.

The figure below shows the results of ICF's modeling using the *ISOR* Case and focuses on the recommended carbon intensity step down in 2025 (at least 10.5%) and the revised Automatic Acceleration Mechanism recommended based on our analysis.



The figure above has a shape and curve that ICF thinks is more in line with a successful Low Carbon Fuel Standard program i.e., one that maintains a tighter credit-deficit balance and is flexible enough to respond to market conditions in the near-term future (pre-2030), while enabling California to achieve its long-term greenhouse gas emission reduction targets. ICF's view of the market suggests that a focus on an "ideal" credit bank from pre-2021, quantified using a threshold of three quarters worth of deficits, is misguided and may lead to a market that "swings" up and down (as measured by the credit bank) more than necessary, thereby creating market uncertainty for active and would-be participants. Major investments by regulated parties in the last several years have likely improved their respective line of sight on credit generation, thereby reducing the need to carry such a large credit bank.

1 Introduction

The California Air Resources Board (CARB) proposed more ambitious carbon intensity (CI) targets to increase the stringency of the Low Carbon Fuel Standard (LCFS), with the intent of achieving more significant greenhouse gas (GHG) emission reductions in support of California's pursuit of economy-wide carbon neutrality no later than 2045. With respect to CI targets, CARB has proposed three key areas for change:

1. Increased CI stringency by 2030, increasing the target from 20% to 30% by 2030.
2. Additional 5% CI reduction in 2025 from the current CI target, also referred to as the step down. This step down in 2025 will yield an 18.75% CI target in 2025. The step down in 2025 is "in response to the near-term over-performance."
3. Introduction of an Automatic Acceleration Mechanism (AAM) that is designed to trigger a more stringent CI standard in the event of the market over-performing in the future (with over-performance measured by two criteria).

ICF is supporting a coalition of interested parties representing a diverse mix of low carbon fuel producers seeking to understand the potential carbon intensity reduction that could be achieved assuming the likely aggregate deployment of low carbon fuels and supporting technologies. Previously, in an Accelerated Decarbonization *Central Case*, ICF found that a carbon intensity target of 41–44% for 2030 is achievable based on expected fuel volumes and carbon intensity reductions for a wide array of fuel pathways.¹

The initial stages of this project were focused on defining an ambitious CI target for 2030. However, the work presented here builds on previous analysis that ICF presented in response to the Staff Report: Initial Statement of Reasons,² and is focused on information presented at the LCFS Public Workshop on April 10, 2024 ("the April Workshop") and supplemental documentation provided by CARB staff.³ The work presented here focuses on a) commentary on CI changes to ultra-low sulfur diesel (ULSD) and how these changes impacted the CI of biomass-based diesel fuels in the California Transportation Supply (CATS) model, b) commentary on the CI step down in 2025 supported by ICF analysis and

¹ In a *High Case* reflecting updated science and analysis, additional cost effective GHG reduction opportunities, and alignment with proposed federal policies, ICF reported that a carbon intensity reduction of 43% to about 57% could be achieved by 2030.

² Available online at <https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2024/lcfs2024/isor.pdf>.

³ Supplemental 2023 LCFS ISOR Documentation.
<https://ww2.arb.ca.gov/resources/documents/supplemental-2023-lcfs-isor-documentation>

c) review of the AAM in light of likely low carbon fuel deployment to California out to 2030 (and beyond).

ICF Commentary on the CATS model

As noted elsewhere, ICF's modeling differs from the modeling conducted by CARB staff using the California Transportation Supply (CATS) model. More specifically, CATS is described as a "transportation fuel supply optimization model" that "minimizes the cost of supplying fuel to meet demand in each year." In other words, given certain modeling constraints, namely a specific CI reduction trajectory and associated policy constraints, the CATS model optimizes compliance accordingly. The CATS model is designed to answer the question: *What is the least-cost compliance pathway associated with a CI target of X in year Y?* ICF notes that CARB has used scenario modeling in previous analyses supporting amendments to the LCFS program and has provided no rationale for switching to an optimization model during the current regulatory amendment process. ICF maintains that an optimization model is not the right approach for target setting because it puts an out-sized impact on the modeling inputs that are used to solve for what is more likely to be a preconceived outcome. Scenario modeling, when done correctly, is more useful to understand market outcomes as they might be, rather than how the author(s) wants them to be.

ICF's reservations about using the CATS model's optimization construct were reinforced by two aspects presented at the April Workshop or in supplementary documentation posted online, as summarized here:

- The CATS model is constrained whereby the number of credits generated in any given year is equal to the number of deficits generated in that same year. Since 2011, the LCFS program has had a single year when annual credits generated nearly equaled annual deficits generated (2017) and a second year (2020) when they were within 1% of each other. In other words, it is unlikely that the credit-deficit balance will be in equilibrium every year as reflected in the CATS model. Regulated parties have varying compliance strategies in the LCFS program, and not a single LCFS compliance strategy employed to date suggests that regulated parties would adopt a position whereby their credit position perfectly matches their deficit position. The CATS model construct is a poor representation of likely LCFS compliance today and into the future.
- CARB staff indicated that the CATS model is incapable of modeling the impacts of the AAM and that their analysis required them to "force" a change in the CATS model framework.

2 ICF Analysis of Information Presented at April Workshop

Incorrect Application of CI Changes to Biomass-Based Diesel

CARB staff published data indicating that the CI of ULSD will increase from 100.45 g/MJ to 105.76 g/MJ⁴ when the amended regulation becomes effective. ICF (and presumably stakeholders) notified CARB of the fact that part of the CI change that applies to ULSD also needs to be applied to biomass-based diesel, notably the tailpipe GHG emissions. However, CARB staff applied the CI adjustment incorrectly. The table below is a condensed version of what is presented in Table B.4 of the reference document.⁵

Lifecycle Stage	CA-GREET 3	CA-GREET 4	Delta	Applies to BBD?
Crude recovery	11.78	12.61	0.83	n
Crude refining	13.57	13.24	-0.33	n
Transport	0.24	0.27	0.03	n
Tailpipe	74.86	79.64	4.78	
CH ₄	0.03	0.01	-0.02	y
N ₂ O	0.72	3.49	2.77	y
CO ₂	74.10	76.14	2.04	n
Total	100.45	105.76	+5.31	+2.74

The tailpipe CH₄ and N₂O emission factors should be applied to tailpipe biomass-based diesel but not CO₂ because it is considered biogenic. That means one should add 2.74 g/MJ to the previous CI values that were being used in the CATS model for biomass-based diesel fuels. However, when CARB updated its modeling, staff modified the CI of “Renewable Diesel” and “Biodiesel” by adding 4.78 g/MJ.⁶ During the April Workshop, CARB staff indicated that they “fixed” the CI value for biomass-based diesel in the CATS modeling and that the result was that it was “about a wash.” After accounting for the 2.04 g/MJ difference in what the CI adjustment for biomass-based diesel should have been, the biomass-based diesel volumes in CARB’s CATS output files for the 5%, 7%, and 9% 2025 CI step down scenarios would have generated an additional 3.21 million, 3.32 million, and 3.35 million cumulative credits between 2025 and 2030 (see table below).

⁴ Technical Support Documentation for Lookup Table Pathways, December 19, 2023. Available online at https://ww2.arb.ca.gov/sites/default/files/classic/fuels/lcfs/ca-greet/lut_update_v12192023.pdf.

⁵ *Ibid.*

⁶⁶ For instance, see cells J6, J7, J176, and J177 on the *Fuel Production* tab of the input files e.g., *scenario_inputs_15Day_Proposed_5percent_step_down.xls*, available online [here](#).

Scenario	2025	2026	2027	2028	2029	2030	Cumulative 2025–2030
5% step down							
BD, Mgal	281	281	281	281	281	281	
RD, Mgal	1,990	1,979	1,769	1,707	1,633	1,457	
+ credits, millions	0.60	0.60	0.54	0.52	0.50	0.46	3.22
7% step down							
BD, Mgal	281	281	281	281	281	281	
RD, Mgal	1,995	1,979	1,962	1,824	1,699	1,457	
+ credits, millions	0.60	0.60	0.59	0.55	0.52	0.46	3.32
9% step down							
BD, Mgal	281	281	281	281	281	281	
RD, Mgal	1,995	1,979	1,962	1,945	1,699	1,457	
+ credits, millions	0.60	0.60	0.59	0.59	0.52	0.46	3.35

This is a substantial difference in credit generation from 2025 to 2030. By way of comparison, CARB modeling shows credit “Bank Drawdowns” of 8.8 million credits and 19.4 million credits between 2025 and 2030 in the 7% CI step down and 9% CI step down scenarios, respectively.

2025 CI Step Down

To ICF’s knowledge, CARB staff has not defined the objective of the CI step down in 2025. The Staff Report notes that it is “in response to the near-term over-performance” in the LCFS market and that it will “further support ambition.” However, there is no clear objective. Without a clear objective, stakeholders are left to choose from the CI step down menu provided by CARB staff at the April Workshop: 5%, 7%, or 9% CI step down in 2025. However, without a clear objective to evaluate the CI step down against, stakeholders are left with a false choice.

As noted previously, the incorrect CI adjustment for biomass-base diesel fuels discounted 3.3 million credits that should have been generated.⁷ After one increases LCFS credit generation accordingly, then the 7% and 9% CI step down scenarios presented by CARB staff are likely to yield a credit bank drawdown of about 6 million and about 16 million

⁷ ICF notes that because the CATS model is an optimization model, that even after CARB staff correct for the CI of biomass-based diesel fuels in their modeling, the net credit-deficit generation will likely be unchanged in the model outputs. The model will either a) decrease biomass-based diesel volumes to account for increased credit generation or b) decrease credit generation from another source to offset the additional credit generation from the lower CI for biomass-based diesel. This highlights the deficiency of using an optimization approach for this type of rulemaking.

credits out of the system, respectively. The former (in the 7% CI stepdown scenario) is not enough of a credit bank drawdown to stabilize the market and the latter (in the 9% CI step down scenario) is more appropriate based on criteria that ICF has established in our consideration of a CI step down in 2025 i.e., that at the end of 2025, the bank drawdown should leave about two quarters worth of deficits in the credit bank.

ICF continues to recommend a step down of 10.5%–11.5% to reduce the cumulative bank of credits to the range of 2–3 quarters' worth of deficits by the end of 2025.

ICF views the 2025 CI step down as a critical juncture for the program. In our modeling, we first evaluated the following:

1. What is the impact of the 5% CI reduction step down proposed in the Staff Report, yielding an 18.75% CI target in 2025?

As of the end of 4Q 2023, the credit bank has exceeded 23.5 million credits, with a record bank build of nearly 3 million credits in the most recent quarter for which data are available. ICF forecasts that the program will have a bank of about 29–30 million credits by the end of 2024. ICF analysis suggests that the 5% CI step down will slow the bank build by about 50% compared to previous years; however, the credit bank is still likely to grow by nearly 4 million credits by the end of 2025.

ICF then sought to determine two things with our analysis:

2. What CI step down is necessary to flatten the credit bank in 2025?
3. What CI step down is necessary to decrease the bank of credits to two quarters' worth of deficits?

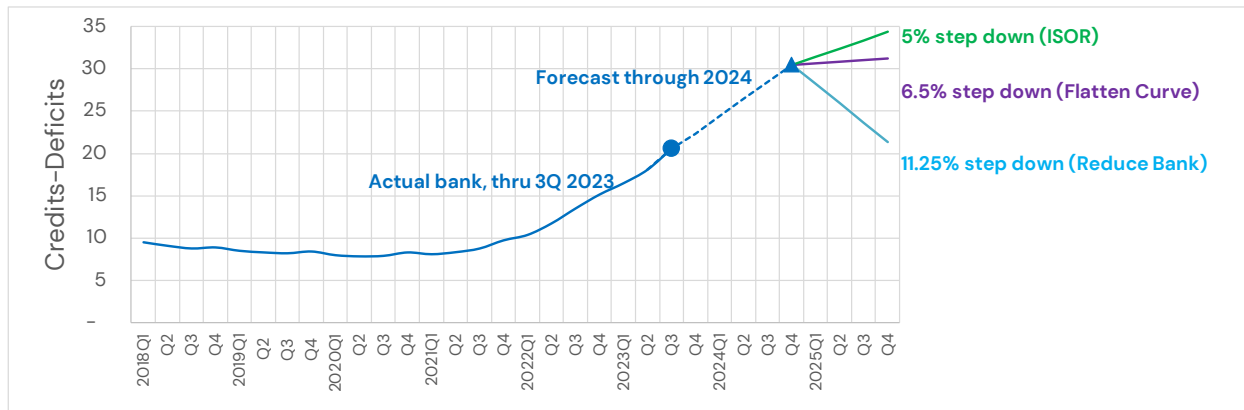
With respect to the former, ICF modeling sought to identify the level of CI reduction that would be needed for the step down to *at least* flatten the curve of growing credits. ICF analysis shows that a CI step down of 6.25–7.25% (i.e., a CI reduction of 20% to 21% in 2025) is likely needed to ensure that the credit bank does not continue to build.

With respect to the latter, ICF sought to identify the level of CI reduction that would be needed for the 2025 CI step down to reduce the bank of credits to about two quarters' worth of deficits by the end of 2025. ICF analysis shows that a CI step down of 10.5% to 11.5% (i.e., a CI reduction of 24.25% to 25.25% in 2025) is likely needed to ensure that the credit bank reverses and that the bank is drawn down to a level that is in line with a credit bank of only two quarters' worth of deficits. This level of stringency, while seemingly high, is likely what is needed to achieve CARB's stated intent of correcting for the "near-term over-performance" of the program.

The figure below illustrates the three aspects of the 2025 CI step down evaluated by ICF: the blue line shows the current credit bank inventory (20 million credits), the dotted blue

line shows ICF forecasted credit bank by the end of 2024 (30 million credits), the green line shows the likely growth of the credit bank using CARB's proposed step down in 2025 (5% step down to 18.75% CI reduction), the purple line shows what ICF analysis indicates is needed to flatten the credit bank (6.5% step down to 20.25% CI reduction), and the light blue line shows that a CI step down of 11.25% to a 25% CI step down is needed to restore the program to an appropriate credit bank balance.

Figure 1. ICF analysis of the CI step down in 2025



Automatic Acceleration Mechanism

The AAM is designed to accelerate the stringency of the LCFS program when certain criteria are met. CARB defined two criteria in the Staff Report: 1) when the credit bank at the end of a calendar year is more than 3 times greater than the quarterly deficits generated in the same calendar year and 2) when credit generation in a calendar year exceeds deficit generation in that same calendar year. The Staff Report also indicates that the first year during which the CI reduction schedule can be impacted is in 2028, based on a review of annual data from 2026 that would occur in 2027.

Evaluating LCFS program data from the end of 2022 indicates that the AAM would NOT have been triggered as currently constructed. The first trigger is defined as follows in the proposed regulation:

$$\text{Trigger 1, } \frac{\text{Credit Bank}_{20xx}}{(0.25 \times \sum \text{Deficits}_{20xx})} > 3$$

The cumulative credit bank ($\text{Credit Bank}_{20xx}$) is divided by the product of 0.25 and the sum of deficits generated in the year of interest ($\sum \text{Deficits}_{20xx}$). In May 2023, an evaluation of data from 2022 would have yielded a value of 2.9, and the AAM would not have been enacted, thereby allowing the credit bank build that occurred during 2023 to continue unabated until an adjustment could have been made based on analysis today (i.e., in May 2024), with the AAM being triggered and taking effect on January 1, 2025 in this

hypothetical scenario. This is as clear as an analysis that the AAM as proposed is inadequate.

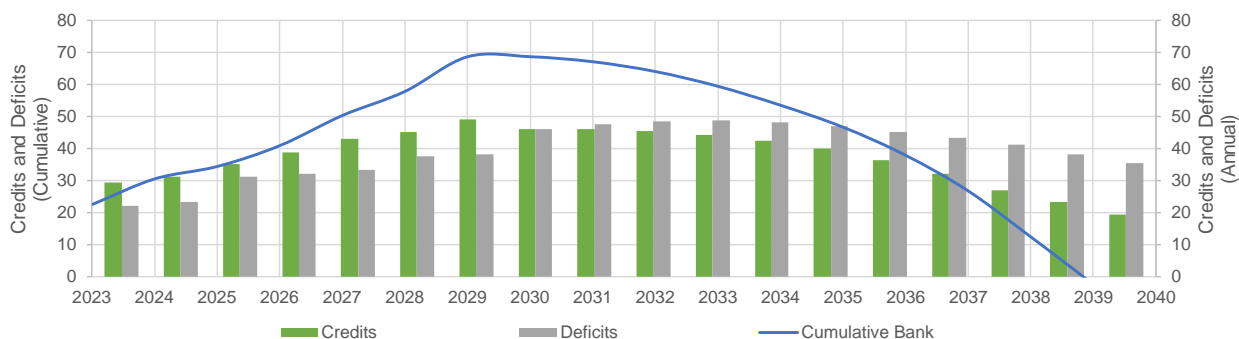
ICF recommends that a) the AAM be considered for implementation as soon as 2026, rather than waiting until 2028, regardless of the 2025 CI step down, b) the AAM be implemented on a four-quarter rolling basis, and c) that the value in Trigger 1 (in Section 95484(b)(2)(A) be decreased from 3.0 to 2.5.

Implement the AAM Immediately

There is no need to delay AAM implementation. The risk of the 2025 CI step down “missing” and not correcting the current over-performance of the program (and leading to credit bank builds in 2026 and 2027) outweighs any downside risks to implementing the AAM immediately.

Building on commentary regarding the CI step down in 2025, ICF’s analysis indicates that if CARB keeps the 5% CI step down in 2025, that the credit bank will build in 2025, 2026, and 2027. In fact, by the end of 2027, ICF analysis suggests that the credit bank will reach 45–50 million credits. This will trigger the AAM in 2028 (based on 2026 data). ICF analysis suggests that the bank will be triggered again in 2029 or 2030 (based on data for 2028 or 2029)—getting the program to a 39% CI standard by 2030. The figure below shows the credit and deficit generation annually (green and grey bars, respectively) and the associated credit bank (blue line) using CARB’s CI trajectory, including the CI step down in 2025, and the AAM as proposed.

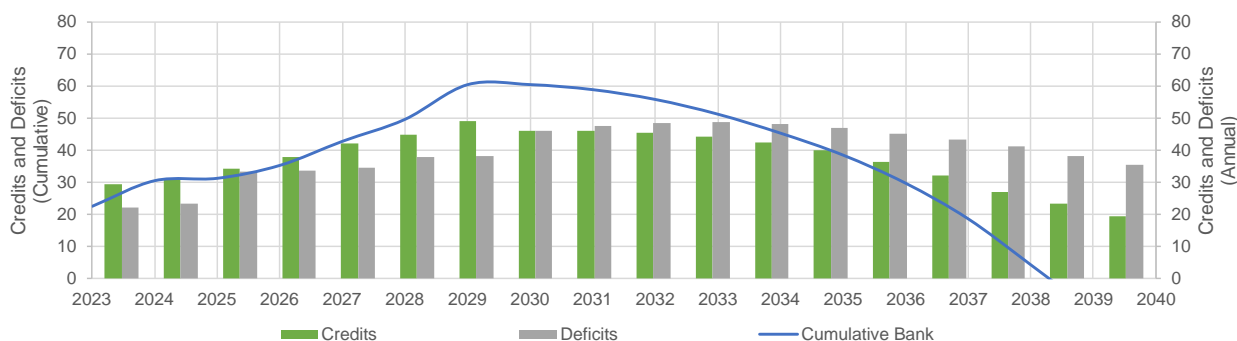
Figure 2. Credit-Deficit Balance in the ICF ISOR Case



In the long-term future, the AAM modifies the trajectory of the program post-2030. However, the short-term impact is muted and the CI step down does not achieve the objective of reversing the credit bank, and delaying the AAM until 2028 slows credit growth, but does not reverse the credit bank build until 2031. The shape of the curve in the figure above is appropriate, but the magnitude of the credit bank is too high to drive higher credit prices.

Implementing a more stringent CI step down in 2025 will reduce credit generation but will still likely lead to credit generation post-2025, and the AAM will be inadequate to reverse the credit bank build until 2030.

Figure 3. Credit-Deficit Balance in the ICF ISOR Case, with 6.5% CI stepdown in 2025

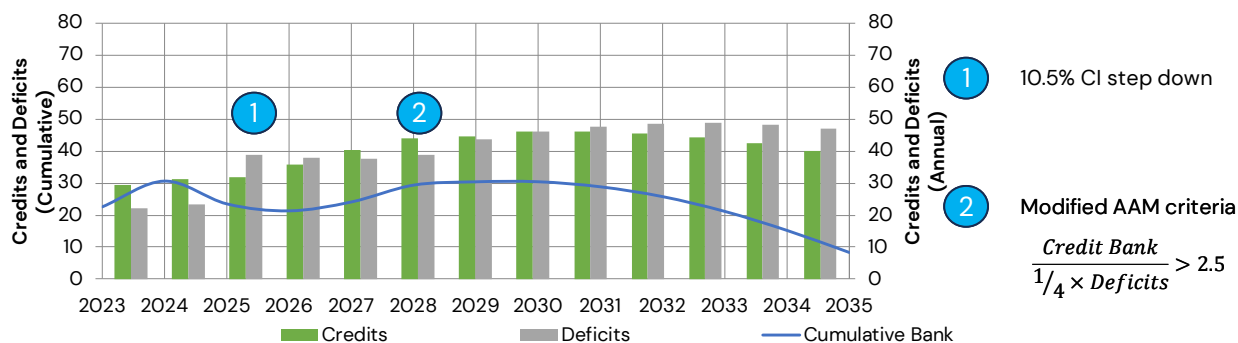


ICF analyzed the ISOR Case using the following assumptions:

- A CI stepdown of 10.5% in 2025 that would require a CI reduction of 24.25%. We adjusted the targets between 2026 and 2030 linearly while maintaining the 30% CI reduction in 2030 and post-2030 CI reduction schedule included in the Staff Report.
- An AAM that is implemented similarly as to what is used in the Staff Report, but adjusting the threshold to being triggered when the credit bank is more than 2.5 times greater than the quarterly deficits generated in a given year.

The figure below shows the results of the ISOR Case using the parameters described above.

Figure 4. ICF ISOR Case with larger CI step down and modified AAM



The figure above has a shape and curve that ICF thinks is more in line with a successful LCFS program i.e., one that maintains a tighter credit-deficit balance and is flexible enough to respond to market conditions in the near-term future (pre-2030), while enabling California to achieve its long-term GHG reduction targets. A similar trajectory can be achieved with a shallower step down in 2025, but with an AAM that comes into place in

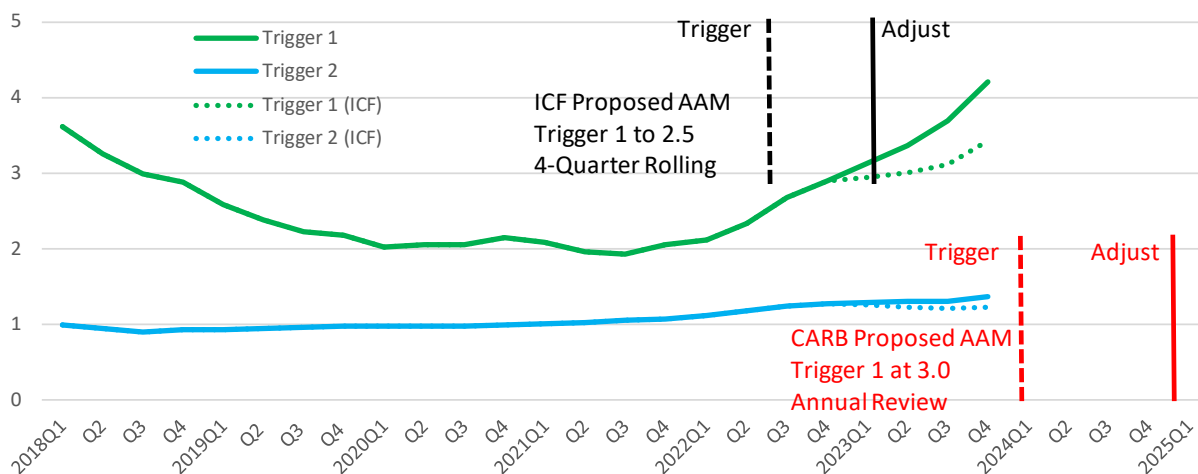
2026 and an even lower threshold of the first criteria that would trigger the AAM (e.g., lowering the value from 2.5 to 2.0).

AAM on a Four-Quarter Rolling Basis

•ICF recommends that the AAM be considered on a four-quarter rolling basis, rather than on an annual basis. If the criteria for the AAM are met on a four-quarter rolling basis, then the change in the CI would be implemented on January 1st of the next calendar year after the criteria are met.

Evaluating the AAM triggers annually risks missing a credit bank build and not allowing for a correction for a full two years. The example provided above for 2022 is shocking: The first trigger would not have been met evaluating data from 2022. That means the credit bank build in 2023 occurred as it has, depressing the market, and the AAM trigger occurs in May 2024, making any changes effective Jan 1, 2025 (see figure below). That means the proposed policy correction would have been inadequate to prevent the specific over-performance in the market that CARB staff references in the Staff Report. However, if the AAM analysis was done on a four-quarter rolling basis, and the more sensitive criteria for the AAM were employed (see below), then the AAM trigger would have been identified based on 3Q 2022 data and the change would have occurred January 1, 2023. ICF estimates that this proposed approach would have reduced the bank build in 2023 by about one third or 2.6 million credits (see figure below).

Figure 5. Illustrative Results of Different Approaches to the Automatic Acceleration Mechanism



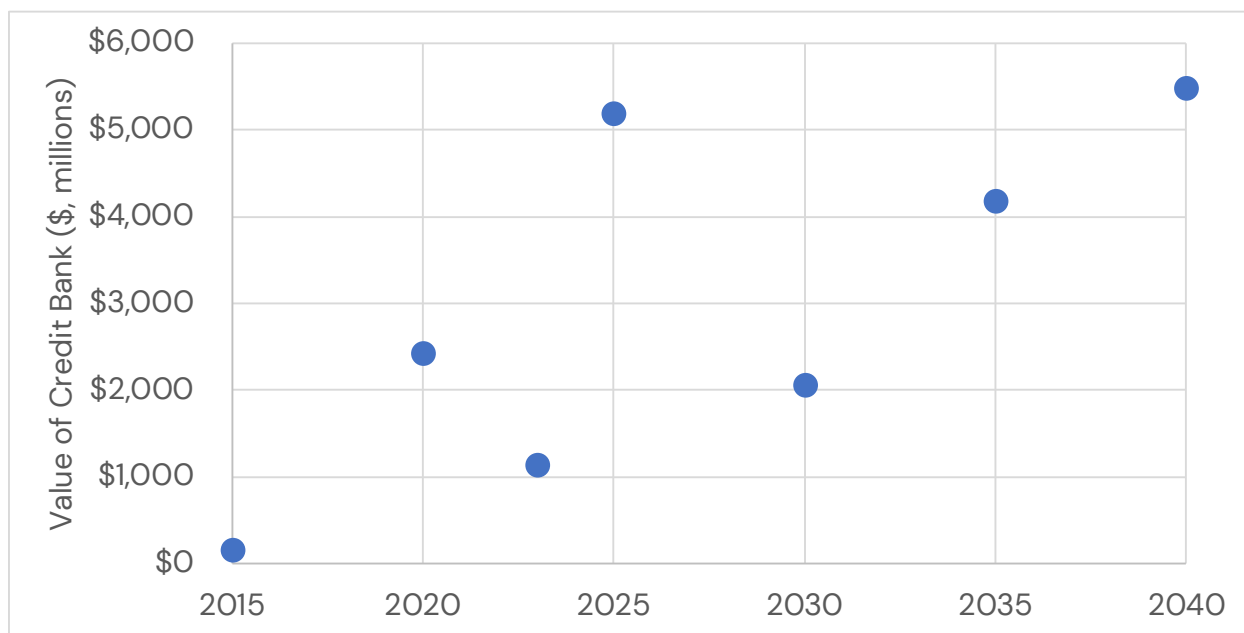
The credit bank would still have increased substantially in 2023 based on ICF’s proposed AAM, but that reinforced the need for a more aggressive CI step down, rather than further adjustments to the AAM.

ICF's proposed approach reduces the potential for a future credit bank build in a more efficient manner than CARB's proposed intervention. CARB is proposing policy interventions that are too slow to provide a market correction needed to ensure more predictable credit-deficit supply dynamics.

Implement More Sensitive Criteria in the first AAM Trigger

The threshold for the first trigger proposed should be reduced from 3.0 to 2.5. ICF disagrees with the underlying presumption that the AAM should be triggered at the proposed threshold i.e., when there are three quarters' worth of deficits in the bank. Based on information presented at the May 23, 2023 modeling discussion, the AAM design is looking to program data from prior to 2021 as an indicator of an "ideal" bank of credits. ICF views this as a critical mistake with respect to how the market is likely to unfold in the future. From a market perspective, if we consider the credit bank as a measure of the risk that regulated parties (i.e., refiners) bear in order to do business in California, then the credit bank should be measured in dollars, not credits/deficits. The figure below shows the estimated value of the credit bank in five-year increments from 2015 to 2040. The data for 2015 and 2020 are based on data reported by CARB for both deficits and credits; whereas the data for 2025 to 2040 is based on the deficit generation in ICF's analysis of the proposed CI reduction trajectory and the credit price reported by CARB in the Staff Report. All values are reported in real dollars using 2021 as the basis year (\$2021).

Figure 6. Estimated value of LCFS credit bank as a proxy for refiner risk tolerance



A target credit bank of three quarters worth of deficits in 2015 would have been valued at \$140 million; by 2020, the value of the bank grew to \$2.4 billion. In 2023, ICF estimates that

a credit bank with three quarters worth of deficits is valued at \$1.1 billion. Based on CARB's forecasted credit price, the value of a credit bank of three quarters worth of deficits in 2025 would rise to \$5.2 billion before collapsing back to \$2.1 billion in 2030. The higher pricing reported by CARB in 2035 and 2040 yields an "ideal bank" valued at \$4.2 billion and \$5.5 billion. When viewed from the lens of dollars tied to risk, rather than risk tied to a specific credit bank, the target bank of three quarters worth of deficits does not make sense. By 2035, for instance, petroleum products will have decreased substantially due to efficiency gains, increased liquid biofuel blending, and transportation electrification. ICF estimates that gasoline consumption may decrease by up to 50% by 2035, while ULSD consumption could decrease by as much as 85% by 2035 (compared to 2022 consumption). Why would an industry that has lost so much market share increase the value of its risk burden by nearly a factor of four over that same time frame?

In line with ICF's hypothesis that the AAM should consider the "ideal credit bank" in terms of managed risk (as measured in dollars' worth of exposure), we also believe that the proposed AAM fails to recognize the evolution of the market post-2020. Consider that in 2018:

- The average CI of ethanol was nearly 70 g/MJ
- Biodiesel volumes were averaging around 5% blend rates in California
- There were 2-3 renewable diesel producers delivering product to California
- The first fuel pathway for RNG from animal manure was submitted and approved by CARB
- EVs represented just 7% of new light-duty vehicle sales
- Off-road electrification applications generated about 500,000 credits

Most of the refiners in the LCFS program had limited visibility with respect to LCFS credit generation and were forced into a position of purchasing LCFS credits from a limited market. As a result, refiners generally opted to build substantial credit banks as part of their compliance strategy. This strategy enabled other market participants to benefit via an increased credit price. However, in the interim years, refiners have made substantial investments that give them a clearer line of sight in their credit generation. The table below highlights the key investments that six refiners have made since 2018; these refiners represent what ICF estimates to be more than 90% of the obligation in the LCFS program. This is not meant to be an exhaustive list, rather it illustrates key investments that will impact LCFS credit generation moving forward.

Obligated Party	Key Investment since 2018
Marathon	<ul style="list-style-type: none"> • Retrofitted Dickinson facility for RD production • Martinez Renewables joint venture with Neste in California • Acquired RNG platform (LF Bioenergy)
Chevron	<ul style="list-style-type: none"> • Acquired REG, largest biodiesel producer in US • Converting diesel hydrotreating unit for renewable diesel / renewable jet fuel production at El Segundo • Investments in RNG platforms including California Bioenergy, Brightmark Energy • Acquired natural gas fueling assets via deal with Mercuria
PBF ⁸	<ul style="list-style-type: none"> • St. Bernard Renewables project in Louisiana producing RD
Valero	<ul style="list-style-type: none"> • Expanded Diamond Green Diesel (a joint venture with Darling Ingredients) at Norco, Louisiana • Commissioned Port Arthur project with expected completion in 2025
Phillips 66	<ul style="list-style-type: none"> • On the verge of completing Rodeo Renewed project at San Francisco Bay Area refining complex, converting to renewable fuels entirely
BP	<ul style="list-style-type: none"> • Expanded co-processing capabilities at Cherry Point • Purchased RNG platform via Archaea acquisition

It is clear from this table that there is a much clearer line of sight to LCFS credit generation for regulated parties today in 2024 than there was in 2018. The view of the credit-deficit balance from pre-2021 will not be a good indicator of how the market will evolve moving in 2025 and beyond.

⁸ Shell sold its Martinez Refinery and related logistics assets to PBF in 2021.

Appendix

Background on ICF modeling

ICF models the CI reductions that could be achieved using the structure of the LCFS program. The modeling is driven by the demand for transportation fuel in California, which is a function of many variables including but not limited to economic growth, vehicle miles traveled (VMT), vehicle fleet turnover, and the expected compliance with complementary policies that impact transportation fuel demand. ICF's modeling is initiated using documentation associated with the Emissions FACTor model (EMFAC)⁹ that is publicly available for download. The EMFAC model is "developed and used by CARB to assess emissions from on-road vehicles including cars, trucks, and buses in California." The EMFAC model enables ICF to characterize top-level transportation fuel demand in California given baseline consideration of the aforementioned key factors, like VMT and fleet turnover. Although EMFAC2021 incorporates expected compliance with several regulations that decrease fossil fuel demand, like the Advanced Clean Truck (ACT) Rule and the Innovative Clean Transit (ICT) Rule, it does not include expected compliance with Advanced Clean Cars II (ACC2) or Advanced Clean Fleet, which were adopted by the Board in 2022 and 2023, respectively. ICF has modified EMFAC2021 to ensure compliance with ACC2 and ACF. ICF then pairs the fleet turnover and fuel demand functions of EMFAC with supply-cost curves for low carbon fuels, including ethanol, biodiesel, renewable diesel, and renewable natural gas (RNG).

ICF previously modeled multiple scenarios for this project and framed each as *Accelerating Decarbonization* in the transportation sector using a diverse array of low carbon fuel strategies that are viable in the timeframe contemplated. Within this framework, ICF presented a Central Case and High Case(s).

- *Accelerating Decarbonization, Central Case*: ICF's primary focus is this case, whereby we limited our consideration of low carbon fuel strategies that require expanded deployment, reasonable technological advancement, and limited, if any, substantive policy changes.
- *Accelerating Decarbonization, High Case(s)*: In these cases, ICF considered additional strategies and/or policy changes that would lead to higher deployment of low carbon fuels and/or greater CI reductions over the course of the analysis. These included but were not limited to reductions in indirect land use change (ILUC) accounting, resumption of FFV manufacturing by OEMs, and relaxation of

⁹ ICF is using the most recent version of EMFAC, EMFAC2021 (v1.0.2) as a starting point for our modeling. The EMFAC model is available for download [online](#).

deliverability requirements for electricity used as a transportation fuel and as a processing fuel. Together, these represent a more expansive market and aggressive outlook for decarbonizing the transportation sector.

Stakeholder Outreach

ICF retains exclusive decision-making with respect to the parameters that are included in (or excluded from) the modeling in this project. However, as part of the development of our modeling, we sought (and will continue to seek) input and feedback from stakeholders that are uniquely positioned to characterize trends, constraints, and opportunities across various low carbon fuels. ICF conducted interviews with stakeholders from various low carbon fuel providers. Through these conversations, ICF introduced the broader project objectives and ICF's modeling approach to help stakeholders understand the key drivers for our analysis. ICF then led a discussion guided by the following questions:

- **Deployment.** What are expected changes in the industry that will increase or decrease the deployment of a particular fuel or fuel/vehicle combination? These generally include supply and demand considerations and should account for opportunities and barriers to the extent feasible. What is the timeframe associated with any changes?
- **Carbon intensity.** What is the current and projected carbon intensity of the fuel under consideration? Are there any California-specific policy or regulatory changes that can be accommodated to help achieve these reductions? What is the rate at which these carbon intensity changes are likely to occur?
- **Demand from Other Markets.** Where are the developments likely to occur? Are there any specific advantages or disadvantages associated with delivering these solutions to California that ICF needs to consider? To what extent will other (existing or potential) low carbon fuel markets be advantaged or disadvantaged as it relates to these solutions as a function of their corresponding geography?

Lastly, it is important to note that ICF developed the modeling framework used in this study based on publicly available tools and data—we have purposefully excluded any proprietary data or considerations as part of this analysis.



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