Comments of

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Regarding

Proposed Amendments to the Low Carbon Fuel Standard

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I. Introduction

We write to provide comments on the modeling assumptions underlying the California Air Resources Board's (CARB) Initial Statement of Reasons (ISOR) for the proposed Low Carbon Fuel Standard (LCFS) regulatory amendment package, along with more recent scenarios discussed at CARB's April 10, 2024 LCFS Workshop (the April Workshop). We are researchers and graduate students from Stanford University with special expertise in the development of climate and energy policy. Some of us have been active participants in CARB processes since the advent of the LCFS as an early action measure in the early days of AB32 implementation.

We write in our personal capacity. None of the views expressed below can or should be attributed in any way to the Climate and Energy Policy Program, the Woods Institute for the Environment, the Doerr School of Sustainability, or Stanford University.

First and foremost, we wish to express our appreciation to the Board for providing this opportunity for public input and to ARB staff for providing the input files necessary to meaningfully comment on the ISOR and the April Workshop. The LCFS amendment proceedings have generated substantial feedback from various stakeholders. The Board's decision to pause the proceedings—enabling additional discussion and re-evaluation—reflects its dual commitments to promoting public participation and making regulatory decisions informed by rigorous data and analysis.

To this end, we are grateful that CARB staff responded to requests related to the December 2023 ISOR, including our own, by making CATS model input and output files for each ISOR scenario publicly available, along with several new scenarios discussed at the April Workshop. In so doing, CARB encouraged transparency, public input, and engagement in the LCFS amendment process.

Additionally, we commend CARB for its continued commitment to the policy goals of the LCFS, which align with our shared objectives of shifting California's fuel mix to sustainable supplies while prioritizing decarbonization and innovation.

The purpose of this comment letter is twofold:

(1) highlight what we believe to be important updates that should be made to key assumptions in CARB's ISOR and the April Workshop scenarios to reflect the on-the-ground realities and potential trajectories of the ICE-to-ZEV transition for Medium and Heavy Duty Vehicles and real-world growth of renewable diesel supply; and

(2) share our own illustrative modeling results, based on the posted CATS input files for the ISOR and the April Workshop scenarios, that demonstrate how limiting certain renewable diesel and biodiesel production pathways does not necessitate an increase in fossil-based diesel use and credit prices, as presented in the ISOR EJAC scenario.

Based on the data CARB has made publicly available, we conclude that there is substantially more flexibility than considered in the ISOR or the April Workshop scenarios to incorporate key features of the EJAC's September 2023 resolution without the undesirable cost and emissions impacts CARB staff presented in their ISOR EJAC scenario. We hope that this letter, along with those submitted by other public stakeholders, encourages CARB to consider a revised EJAC scenario that more accurately reflects pathways to achieving EJ priorities. We emphasize that we do not present such a scenario in this comment and related modeling. Rather, we present a sensitivity analysis based on CARB's existing modeling results to demonstrate that a fundamentally different EJAC scenario can be constructed using CARB's modeling tools. In our opinion, CARB staff should work with the EJAC to consider such a scenario in this rulemaking.

We respect and value CARB's LCFS modeling efforts to date. However, we also recognize that this modeling is attempting to represent a rapidly evolving transportation fuels landscape, where even short term changes can and have quickly diverged from model assumptions and lead to skewed or misleading results. The ISOR and April Workshop scenarios are anchored to assumptions in the 2022 Scoping Plan, but two years have passed since those assumptions were made. For example, the scenarios assume that there were zero Medium and Heavy Duty Zero Emission Vehicles on the road in 2022 and 797 in 2023, while the California Energy Commission reports that there were 2,320 on the road at the end of 2022 and 3,784 at the end of 2023 (see Table 1 below).[1] We view this difference as clear evidence that the efforts of CARB to accelerate a transition to zero emission vehicles (ZEV) are already beginning to bear fruit - even more rapidly than anticipated during the scenario development for the Scoping Plan.

The assumed rates of internal combustion engine (ICE)-to-ZEV transitions are a fundamental driver of modeled demand for diesel (and gasoline). These rates are treated as fixed inputs with no uncertainty in the ISOR across scenarios that vary widely in other respects. One important implication of this approach is that the ISOR claims that its EJAC scenario would

[1] https://www.energy.ca.gov/data-reports/energy-almanac/zero-emission-vehicle-and-infrastructure-statistics/medium-and-heavy

result in an increase in fossil diesel consumption. As we explain in this letter, this outcome is far from prescribed.

We evaluate and illustrate a different approach. Given the pace of the energy transition, driven in substantial part by California's innovative transportation policies, estimates of future demand and fuels supply must contend with substantial uncertainty. However, facing that uncertainty means that demand scenarios should not be treated as static. Critical but outdated assumptions should be updated when new information becomes available. That is, we believe it is essential to account for uncertainty but also to be rigorous about the aspects we do know now to ensure a model's accuracy and effectiveness. As new information becomes available, CARB needs to update its assumptions and planning to reflect new information when this information has important impacts on what California's climate policies can achieve.

II. ISOR / April Workshop assumptions and our alternative, illustrative scenario

In this section, we comment on several of the ISOR's key assumptions, particularly those that led CARB staff to conclude that their EJAC scenario, as implemented by staff in the CATS model, necessarily leads to an increase in fossil diesel consumption. We compare these assumptions to recent evidence. We then present an illustrative scenario that demonstrates the sensitivity of modeling results to those assumptions and how updating them creates flexibility that CARB may not have understood existed when they constructed the ISOR, relying on the Scoping Plan.

A. New data from actual ZEV deployment indicates that ISOR and April Workshop assumptions are unduly pessimistic about fleet transition

The ISOR's EJAC scenario rests on a hypothetical causal chain. Limiting LCFS credits for renewable diesel, the reasoning goes, will reduce renewable fuel production. That, in turn, will necessarily result in more fossil diesel consumption, because diesel demand will remain the same and the only available supply to meet that demand is fossil diesel. But the core assumption propelling this deterministic sequence—that fuel demand must be held fixed while other model assumptions are adjusted—fails to account for the uncertainty in future diesel demand, as well as the impact of battery electric and hydrogen vehicles on that demand. In addition, this conclusion fails to consider that assumptions about future fuels demand (including diesel) have shifted substantially across the versions of CATS modeling related to this rulemaking that CARB staff has released over the past year, as staff have incorporated estimated impacts of CARB's vehicle programs and made other adjustments (see Figure 1).

The initial example CATS modeling inputs released by CARB staff in March 2023 were updated in August 2023 to reflect modeling associated with the 2022 Scoping Plan, including the effects of ACF. After the April 2024 release of CATS model input files, it is now clear that these August 2023 inputs were those used in the ISOR. The additional scenarios released with the April Workshop contain further updates to demand, as described by CARB staff, to account

for MDV updates and PHEV gas miles. We note that all of these adjustments in assumptions are driven in part by the rapid pace of technological innovation in the sector and in part by CARB's own successful track record of rulemaking in the space.

Figure 1: Energy Demand Updates for Diesel, HDV-H2 and HDV-e. Energy demands in the CATS model have changed substantially, as CARB has incorporated the estimated effects of vehicle programs such as ACF (2022), ACCII (2019), and ACT (2019) and made other adjustments.

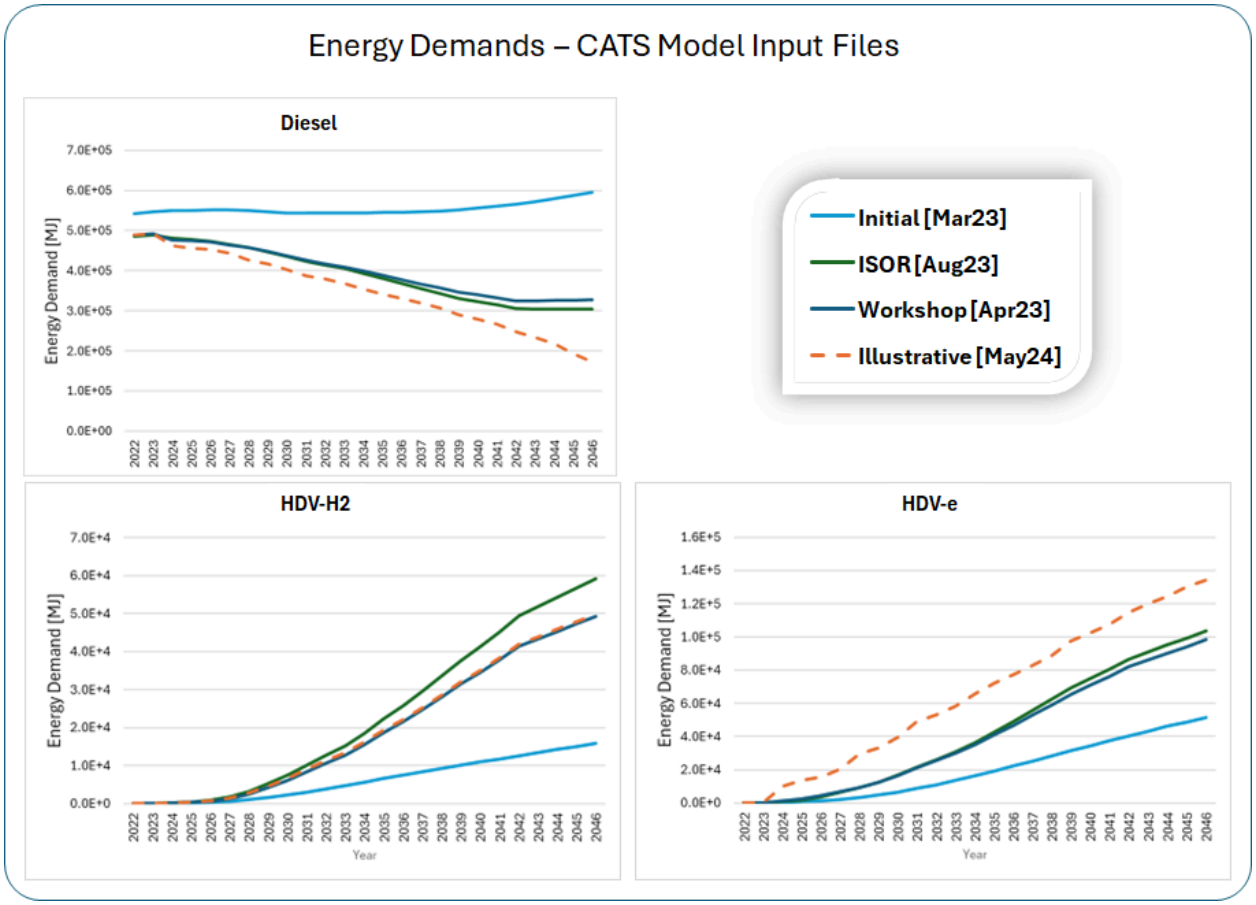


Table 1 compares the actual rate of adoption of Medium and Heavy Duty ZEV vehicles to the energy demands used in the ISOR and April Workshop CATS model scenarios. The assumptions that underlie the ISOR assume zero ZEV deployment in 2022 and fewer than 800 vehicles in 2023. Instead, in 2022, more than 2300 were in service and in 2023, that number had increased to over 3700 vehicles. Table 1 also compares the assumed and actual proportion of hydrogen and battery electric ZEVs. As mentioned above, we view the greater real-world deployment of ZEVs over the last two years with optimism, observing that the rate of transition from diesel-to-ZEV vehicles is actually more rapid than assumed in the Scoping Plan, ISOR, or the April Workshop scenarios.

Table 1. Actual Medium and Heavy Duty ZEV deployment versus what was assumed in the ISOR and April Workshop scenarios.

	ISOR and April Workshop CATS modeling[2]		Data reported by CEC[3]	
	Size of fleet	**Share of ZEV**	**Size of fleet**	**Share of ZEV**
2022				
- Hydrogen	0	-	134	6%
- Electricity	0	-	2186	94%
2023				
- Hydrogen	372	47%	203	5%
- Electricity	425	53%	3581	95%

Taking into account this early evidence, we construct a new illustrative scenario for fuel demand based on more rapid adoption of Medium and Heavy Duty ZEV vehicles that replace diesel vehicles. This illustrative scenario, with reduced diesel demand and increased ZEV demand, enables a sensitivity analysis of this key assumption - the rate of medium and heavy duty ZEV adoption. We use actual 2022 and 2023 ZEV deployment as our starting point, and limit the year-over-year percentage increase in Medium and Heavy Duty ZEV vehicles to the observed increase between 2022 and 2023 (~60%). Further, we assume that battery electric ZEVs meet this increased demand, given their overwhelming share of the currently deployed ZEV stock. We note that the ISOR and April Workshop scenarios assume a higher percentage of hydrogen ZEVs than actual deployment to date.

The delay in uptake of hydrogen fueled HDVs may change as hydrogen fueling stations become more available and vehicle choice increases, with the cumulative effect being even faster deployment than observed from 2021 to 2023 since battery electric deployment is already on a much faster growth curve than projected just a few years ago and hydrogen vehicles will reinforce that success. Throughout all of this, it is crucial to remember that adoption of ZEVs is an assumption and input to the CATS model, not something that the model simulates. This means that the assumption, to the degree that it differs from reality on the ground, should be updated as soon as better information becomes available. This is particularly true when model results depend heavily on the assumption in question.

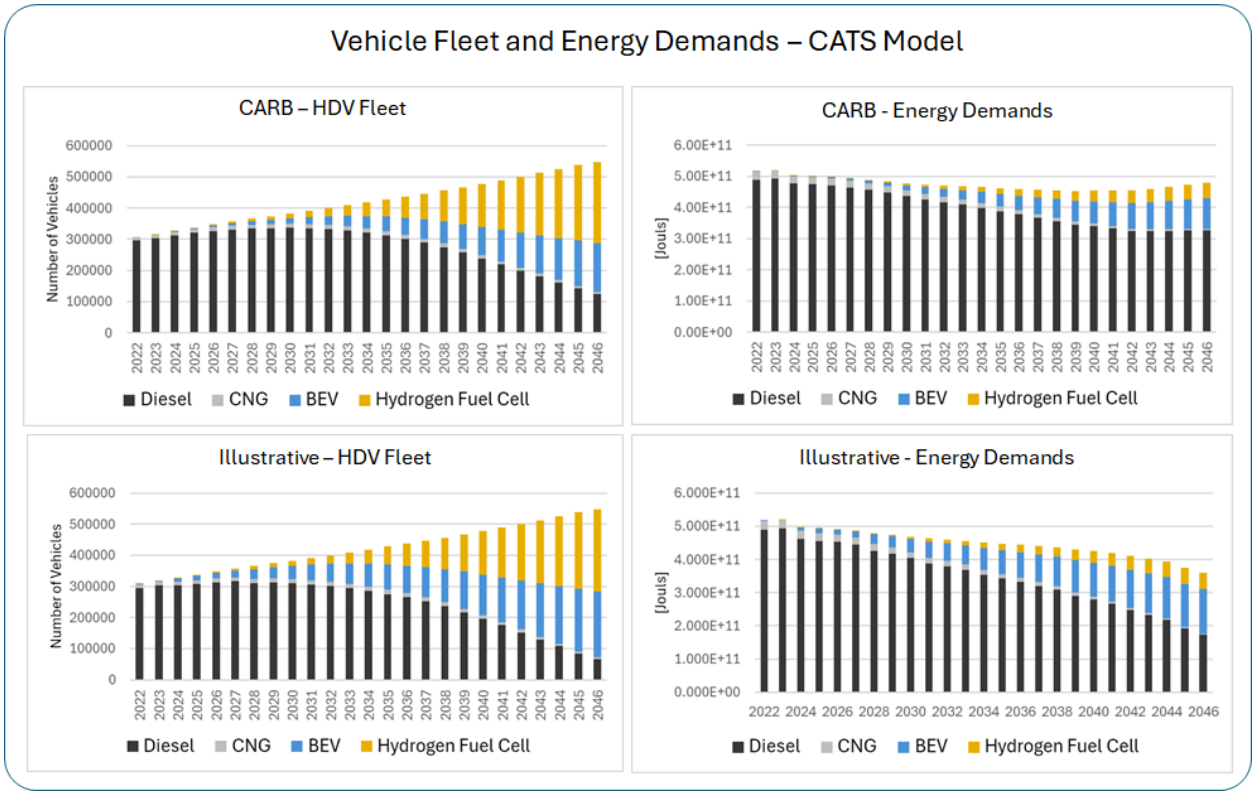
Figure 2 compares Medium and Heavy Duty vehicles on the road and energy demand by fuel type for the most recent April Workshop scenarios released by CARB staff and our illustrative scenario. Our illustrative scenario assumes that the overall number of vehicles on the

[2] https://ww2.arb.ca.gov/resources/documents/supplemental-2023-lcfs-isor-documentation

[3] https://www.energy.ca.gov/data-reports/energy-almanac/zero-emission-vehicle-and-infrastructure-statistics/medium-and-heavy

road in any year matches the number assumed in the April Workshop scenarios, but that the type of vehicle can vary (with more ZEV than diesel vehicles). Because battery electric vehicles are more energy efficient than diesel vehicles, this shift reduces overall energy demand for the same number of vehicles on the road. Overall, this results in a modest acceleration - to 2038 from 2040 - of reaching 50/50% fossil diesel and compressed natural gas (CNG) vehicles vs. ZEV

Figure 2: Vehicle fleet and energy demands for Medium and Heavy Duty vehicles in the CARB April Workshop scenarios and our illustrative scenario presented in this comment.



B. Underestimation of renewable diesel refining capacity threatens to further saturate the LCFS market with RD credits and reduce credit values.

As we discussed in our February 20, 2024 comment letter, growth in renewable diesel (RD) supply "has continued to far outstrip expectations."[4] CARB staff's projections, as of August 2023, estimated that 1.15 billion gallons of RD would be produced in 2023 by facilities participating in the LCFS. But CARB's LCFS Quarterly Data Spreadsheet, updated through Q4 2023 and released on April 30, 2024, reveals that RD production in 2023 totaled 1.97 billion gallons, with consistent quarter-on-quarter growth despite low LCFS prices throughout the year.[5] Further, two new projects expected to come fully online in 2024 (the Phillips 66 refinery in

[4] https://www.arb.ca.gov/lists/com-attach/7057-lcfs2024-AXJRI1c3UWwDY1I9.pdf

[5] https://ww2.arb.ca.gov/sites/default/files/classic/fuels/lcfs/dashboard/quarterlysummary/Q4%202023%20Data%20Summary.pdf

Rodeo and the Marathon refinery in Martinez) are expected to significantly expand RD production further, on their own adding as much as 1.4 billion gallons. Production growth of such magnitude raises numerous environmental and agricultural concerns, from feedstock shortages and increased reliance on crop-based feedstocks to deforestation and indirect land use change emissions. While those consequences are not the focus of this comment letter, we encourage the Board to keep them in mind and for staff to further evaluate them.

In our illustrative scenario, we impose a simple volumetric cap on biodiesel and renewable diesel at the level of reported 2023 volumes. We do not suggest that this is the cap that should be adopted, as it is purely an illustrative choice. We view such a cap as implementable and practical within the LCFS framework, particularly if eligibility to sell LCFS creditable gallons was itself a marketable commodity that could be traded between producers.

We encourage CARB to conduct a full analysis of the implications of different cap levels, to evaluate the ongoing changes in the RD market both inside and outside the LCFS, and to seek additional input from the EJAC and other stakeholders on this issue prior to finalizing an LCFS amendments package. Growth in the supply of RD for reasons that do not appear connected to the LCFS or the incentives that it creates appears poised to upend all expectations and assumptions regarding the incentives for innovation created by the LCFS. Significantly more thinking and engagement is required before the Board should act to lock in a planning framework given that RD supply as soon as the end of this year could easily total 3.4 billion gallons.

C. The dairy methane "cliff" in the ISOR and April Workshop modeling

We raise one additional issue with CARB staff's ISOR EJAC scenario: the dairy methane "cliff." The ISOR EJAC scenario assumes that all pathways for dairy methane crediting are canceled after 2024: that is, the scenario completely eliminates dairy gas pathways beginning on January 1, 2025. This causes the CATS model to add more carbon intensive fuels to the mix to fill this abrupt drop in supply. Further, in the April Workshop, CARB mentioned that the EJAC pathway would have the added negative effect of stranding agricultural assets and forcing CARB to go back on its word regarding pathways it had already approved.

Table 3. Currently approved dairy methane and selected fuel pathway carbon intensities

Fuel Pathway	Carbon Intensity (gCO2e/MJ)
CNG from Dairies	-293
LDV / HDV Hydrogen (Dairy Gas)	-353
LDV-e/HDV-e (Dairy Gas)	-440
LDV-e/HDV-e (0-CI)	0

It is our understanding that the EJAC proposed the immediate elimination of *future* pathway approvals for dairy methane at current carbon intensity (CI) scores.[6] Such an approach would allow already-approved pathways to maintain their LCFS approval for the entirety of their 10-year duration. With this timeline, most current contracts would sunset by 2032. This approach contemplates not a "cliff" but a more gradual transition of dairy methane crediting to higher CI values, honoring CARB commitments to existing LCFS pathways while also increasing the carbon intensity (CI) of dairy methane by 2032. CARB has set the average CI for avoided dairy methane per pathway as reported in Table 3, based on the assumption that dairy methane would otherwise be released to the atmosphere. To illustrate a more gradual transition to a higher dairy methane CI, we assume that the Board decides to stop approval of future pathways with the CI scores in Table 3, and instead adopts a higher CI for dairy methane projects more in line with methane produced from sewage treatment plants (which are assumed flare methane to carbon dioxide rather than simply venting methane to the atmosphere). This gradually increases the average CI score of dairy methane so that it reaches a positive value of ~44 gCO2e/MJ by 2032.

III. Illustrative scenario results and comparison to ISOR and April Workshop scenarios

We present the results of our illustrative scenario in comparison to the ISOR EJAC and proposed scenarios, and the April Workshop scenario with a 5% stepdown in Figure 3 and Table 4.[7] As stated above, our illustrative scenario is not intended as a new proposal, but instead to enable a sensitivity analysis based on CARB's existing modeling results. It shows that a scenario consistent with many of the asks from the environmental justice community, can be constructed using CARB's modeling tools and consistent with many of CARB's stated objectives both from the Scoping Plan Update and as stated in the current LCFS amendment process.

As stated above, the illustrative scenario contains both a volumetric limit on RD at 2023 levels and a transition of pathways for dairy methane crediting that assume a baseline of flaring rather than venting, similar to sewage treatment methane. It is based on the April Workshop input files and so also contains the 5% stepdown in CI. The illustrative scenario allows for reasonably similar credit prices to those proposed by CARB staff, it achieves similar emission reduction objectives in the liquid fuels sector, and it does not rely on burning more fossil fuels in order to limit RD or livestock dairy book-and-claim crediting. The illustrative scenario achieves this by relying on modest changes to assumptions about the mix of ZEV and emitting vehicles on the road that we believe more realistically depict what has and is actually happening in California since the Scoping Plan modeling was conducted (see above).

We emphasize that this scenario is illustrative and does not attempt to fully represent any proposal from the EJAC or other stakeholders. Other choices about RD limits, dairy methane pathways, or other changes to the LCFS are also possible. We believe that what is most important here is to illustrate the fundamental sensitivity of conclusions in the rulemaking to

[6] https://ww2.arb.ca.gov/sites/default/files/barcu/board/books/2023/091423/ejacpres.pdf
[7] https://ww2.arb.ca.gov/resources/documents/supplemental-2023-lcfs-isor-documentation

assumptions that we believe are out of date and unduly pessimistic. Updating assumptions to take better account of actual data that shows California's early success in deployment of ZEVS unlocks options that would not have been apparent in modeling that relied on older assumptions related to the Scoping Plan Update. We are happy to share additional details regarding our scenario with staff or other stakeholders upon request.

Figure 3: Comparison of credit prices across scenarios

Table 4: Comparison of cumulative fossil diesel (ULSD), renewable diesel (RD), and biodiesel across scenarios. The Illustrative scenario uses less ULSD, RD and BD than the CARB scenarios.

Fuel type	ISOR Proposed	ISOR EJAC	April Workshop (5% stepdown)	Illustrative_May24
ULSD [mm gal]	50708	50708	27104	21567
Renewable Diesel [mm gal]	16026	16026	42187	38245
Biodiesel [mm gal]	7088	7088	7029	6930

V. Conclusion

CARB's history demonstrates the agency's successful track record of incentivizing transformative innovation that drives positive environmental outcomes through regulation. Indeed, technology-forcing rules are necessary to achieve the LCFS's climate goals, especially to facilitate the transition to an electric- and hydrogen-fueled future. CARB staff's most recent modeling, because it fails to incorporate new information about progress that CARB has itself achieved in pushing ZEVs into the medium and heavy duty fleets and neglects the extraordinary pace of growth in RD supply, paints a picture for the Board that appears to limit its freedom to modify the LCFS to limit RD supply, constrain book and claim methane crediting, or make other changes.

We remain optimistic about the potential of the LCFS to drive progress toward a just and equitable zero-emissions future. We are hopeful that the analysis we present above, both of assumptions and in our illustrative scenario, may prove useful to CARB staff, the Board, and other stakeholders in considering a broader set of options for updating the LCFS to reflect both the incredible achievements in ZEV deployments as well as the EJAC's priorities.