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California Air Resources Board
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Submitted electronically via: https://ww2.arb.ca.gov/public-comments/public-comments-regarding-auto-acceleration-mechanisms-low-carbon-fuel-standard

RE: POET COMMENTS ON MAY 23, 2023 LCFS AUTO-ACCELERATION MECHANISM WORKSHOP

Dear Dr. Laskowski:

POET appreciates the opportunity to provide comments on the May 23, 2023 Public Workshop on an Auto-Acceleration Mechanism and Step Down Benchmark Considerations for the Low Carbon Fuel Standard.

I. ABOUT POET

POET is deeply committed to reducing greenhouse gas (GHG) emissions and developing cleaner, affordable alternative fuels in California and the United States. POET is the world's largest biofuels producer and currently operates 34 biorefineries capable of producing three billion gallons of starch and cellulosic ethanol. Renewable, clean-burning biofuels like those produced by POET cut carbon emissions by an average of 46 percent compared to gasoline,[1] which can have an enormous impact on reducing the amount of GHG in the atmosphere. POET continues to innovate and further reduce its products' GHG emissions.

POET strongly supports CARB's dedication to the decarbonization of the transportation sector and is committed to continuing to deliver increasingly lower-carbon, sustainable biofuels that will play an integral role in supporting the achievement of California's climate goals. POET has previously provided extensive and detailed data and information to CARB regarding the significant climate, as well as air quality and economic benefits that low-carbon, sustainable biofuels provide for California. (For reference, some of this information is again included below).

[1] Scully, Melissa *et al*, *Carbon intensity of corn ethanol in the United States: state of the science*, 2021 Environ. Res. Lett 16 043001, 4 (2021), https://iopscience.iop.org/article/10.1088/1748-9326/abde08.

II. SPECIFIC COMMENTS ON THE MAY 23 WORKSHOP

As presented at the May 23 workshop, the objectives for the LCFS rulemaking include 1) updating the program to support increased low-carbon fuel supply as identified in the 2022 Scoping Plan Update; and 2) to provide long-term price signals and increase regulatory clarity for the market to support deeper transportation sector decarbonization. A near-term compliance target step-down and a well designed auto-acceleration mechanism can help achieve these objectives most effectively if CARB ensures that the LCFS program continues to appropriately recognize and accurately account for the significant benefits that sustainable biofuels can deliver for California's transportation sector decarbonization goals.

POET supports the consideration of an auto-acceleration mechanism as part of the upcoming LCFS rulemaking. However, such a mechanism will only be successful in helping to promote achievement of more stringent 2030 (and future year) carbon intensity reduction targets if the LCFS program is optimally designed to drive ongoing and maximal investment in all low-carbon fuels and technologies, including plant-based biofuels. To meet its ambitous climate goals, California cannot afford to constrain the role that proven and constantly innovating low-carbon fuels can deliver – especially as GHG reductions in the transportation sector will need to increase significantly in coming years. As such, it is crucial that CARB – in addition to considering incorporation of an auto-acceleration mechanism – take the necessary steps as part of the upcoming rulemaking to ensure that plant-based biofuels continue to play a central role moving forward.

III. LOW-CARBON PLANT-BASED BIOFUELS MUST CONTINUE TO PLAY A CENTRAL ROLE MOVING FORWARD

Sustainable biofuels have delivered major support to California's efforts to drive down emissions in the transportation sector, and it is critical to ensure that plant-based biofuels continue to play a central role moving forward.

a. Environmental Benefits of Biofuels

i. Air Quality and GHG Emissions

Biofuels are readily available to support CARB's efforts to decarbonize the transportation sector while also providing immediate air quality and public health benefits to California and its residents.

The Scoping Plan acknowledges that liquid petroleum fuel will remain in California's transportation fuel mix for decades to come, as sales of gasoline-fueled cars will not end overnight and internal combustion vehicles will remain on the road for many years.[2] CARB should incentivize the reduction of gasoline's carbon intensity (CI) in this legacy fleet, and we urge CARB to look to biofuels to achieve these reductions. Recent research demonstrates that corn bioethanol has a 46 percent average lower CI than gasoline,[3] which means that as long as there are gasoline-fueled cars on the road in California, incentives to increase blending of bioethanol into that fuel

[2] *2022 Scoping Plan for Achieving Carbon Neutrality* (Nov. 16, 2022), p. 190.
[3] Scully, *supra* note 1.

will immediately advance California's decarbonization efforts. The LCFS must continue to incentivize lower-carbon biofuels, just as it has for over a decade.

The LCFS also plays an important role in driving innovation that will further reduce the CI of biofuels and, accordingly, of the transportation sector. There have been many advances with respect to the GHG impact of biofuels over the past decade, including emissions reductions associated with improved production methods, CO_2 utilization and sequestration, climate-smart farming practices, and co-products that reduce waste and provide additional benefits. The LCFS provides a major incentive to continue these innovations.

Biofuels not only drive down the CI of the transportation sector but also provide air quality benefits as they displace liquid petroleum fuels. Recent analyses from leading national experts from Harvard find air quality and public health benefits from higher biofuel blends in gasoline, including reductions in particulate matter (PM), carbon monoxide (CO), and total hydrocarbons (THC).[4] This study is the first large-scale analysis of data from light-duty vehicle emissions that examines real-world impacts of bioethanol-blended fuels on regulated air pollutant emissions. The study found that CO and THC emissions were significantly lower for higher bioethanol fuels for port fuel injected engines under cold-start conditions. THCs include VOCs, meaning that both primary ozone precursors decreased with higher bioethanol blends. The study found no statistically significant relationship between higher bioethanol blends and NOx emissions. These improvements to air quality can benefit all Californians, but the research shows that the associated health benefits may be most significant in disadvantaged communities in areas of high traffic density and congestion.[5] Additionally, CARB recently published a Multimedia Evaluation of E11-E15 Tier 1 Report with conclusions consistent with the these analyses.[6]

These benefits are directly attributable to biofuels, proving that biofuel should play a key role in helping CARB meet the state's climate goals, improving public health, and achieving federal and state air quality standards. CARB recognized the role of bioethanol in the LCFS program's success during the December 7, 2021 Public Workshop on Potential Future Changes to the LCFS program. As CARB noted, bioethanol has effectively displaced fossil fuels to reduce net GHG emissions. In 2020, bioethanol was the largest source of LCFS compliance by volume and the second-largest source by number of credits. Bioethanol has accomplished all of this, and even levels of production that allow the U.S. to export bioethanol, without any noticeable impact on corn acres in the U.S. or on food prices.

Further, bioethanol is poised to make even greater contributions to the LCFS program moving forward. As the chart below shows, bioethanol has the ability to become a zero-carbon fuel with technologies already being implemented or on the cusp of commercialization.

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[4] *See* Kazemiparkouhi, Fatemeh et al., *Comprehensive US database and model for ethanol blend effects on regulated tailpipe emissions,* SCIENCE OF THE TOTAL ENVIRONMENT (March 2022), https://www.sciencedirect.com/science/article/pii/S0048969721065049?via%3Dihub.

[5] *See* Attachment A, Tufts University Department of Civil and Environmental Engineering, *Air Quality and Public Health Comments to RFS* (Feb. 3, 2022).

[6] *Multimedia Evaluation of E11-E15 Tier 1 Report* (June 4, 2020), https://ww2.arb.ca.gov/sites/default/files/2022-07/E15_Tier_I_Report_June_2020.pdf.

While POET is aware that there is disagreement over aspects of bioethanol's CI, several things are clear: bioethanol has played a key role in the LCFS program's success, bioethanol producers have worked and continue to work hard to lower their product's CI in ways that meaningfully reduce national and global GHG emissions, and bioethanol is poised to remain a key element of the low-carbon fuels market for decades to come.

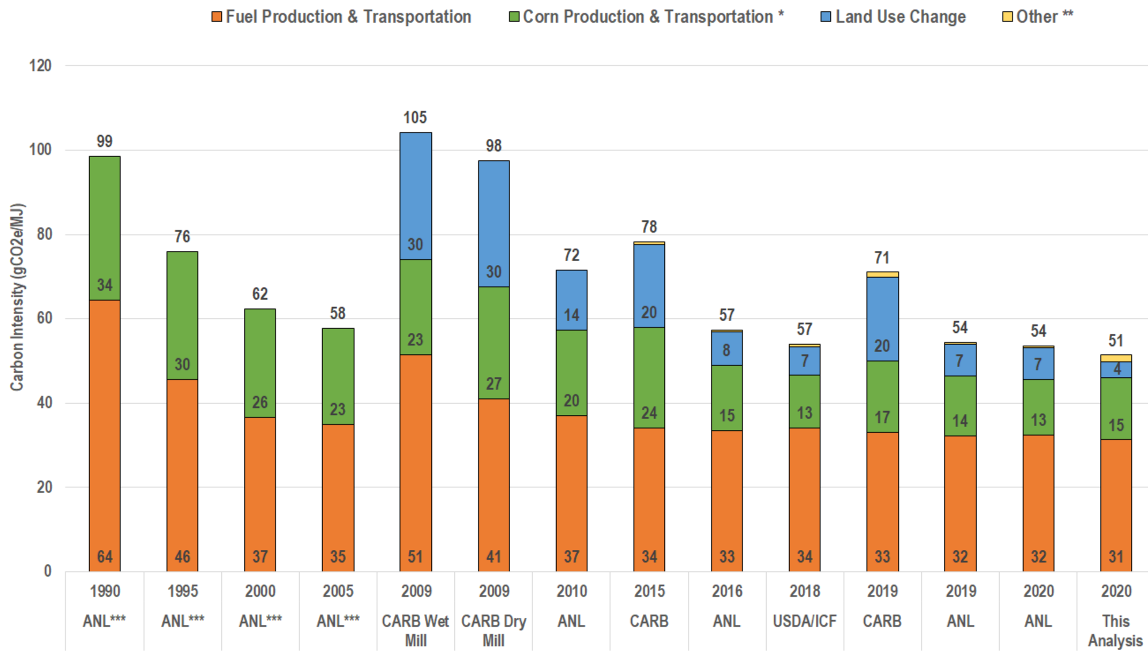
ii. Land Use Change

POET acknowledges that there has been much debate about the effect that biofuels have on land use change (LUC), but we respectfully contend that those concerns are misplaced. Fears about the impact of biofuels on LUC are invariably based on outdated research, a misinterpretation of valid data, or the use of invalid data. The best available scientific literature concludes that the CI value for corn bioethanol's LUC is approximately 4 gCO_2e/MJ, including direct and indirect LUC (ILUC).[7] That CI value is significantly lower than California's LCFS 2019 iteration of GREET (CA GREET3.0). Some studies even indicate that biofuel production does not induce any ILUC.[8]

Since 2008, scientific assessments of LUC associated with bioethanol production have changed substantially. Most of these studies have shown downward trends in LUC carbon impacts, as illustrated in the figure below:

[7] Scully, *supra* note 1 at pg. 4.

[8] Kim S, Dale BE. 2011. *Indirect land use change for biofuels: Testing predictions and improving analytical methodologies.* BIOMASS AND BIOENERGY, 35(7):3235-3240. 10.1016/j.biombioe.2011.04.039; Kline KL, Oladosu GA, Dale VH, McBride AC. *Scientific analysis is essential to assess biofuel policy effects: In response to the paper by Kim and Dale on "Indirect land-use change for biofuels: Testing predictions and improving analytical methodologies"*. (10):4488-4491. 10.1016/j.biombioe.2011.08.011.



* Corn Production & Transportation includes farming, feedstock transport, and co-product credit.
** Other less significant emission categories account for fewer than 2 gCO_2e/MJ.
*** Models did not incorporate land use change.

Most LUC estimates are now converging on substantially lower estimates than those established through CARB's prior analysis in the March 2015 Staff Report on ILUC values.[9] Reliable analyses of LUC impacts generally draw from the GTAP agro-economic model and have consistent approaches to the economic baseline year (2004), incorporation of yield price elasticity (of approximately .25), and, significantly, address the concept of land intensification.[10] Scientific literature supports the conclusion that land intensification—defined as the production of greater volumes of a crop or multiple crops on existing land—is a key factor in appropriately assessing LUC.[11] From 2005 to 2012, a period in which the United States experienced a significant increase in bioethanol production, the surge in harvested crop was due primarily to land intensification rather than conversion of land to agricultural uses.[12]

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[9] A recent study by Lark, et al., estimates a higher LUC value for corn starch bioethanol. Rebuttals were recently published by Environmental Health & Engineering, https://www.pnas.org/doi/10.1073/pnas.2213961119, and the Department of Energy, https://greet.es.anl.gov/publication-comment_environ_outcomes_us_rfs. *See* Lark, Tyler et al., *Environmental Outcomes of the US Renewable Fuel Standard,* PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES (PNAS) (2022), https://doi.org/10.1073/pnas.2101084119.

[10] *See*, *e.g.*, Rosenfeld J, Lewandrowski J, Hendrickson T, Jaglo K, et al., *A Life-Cycle Analysis of the Greenhouse Gas Emissions from Corn-Based Ethanol.*, ICF (2018); Taheripour F, Zhao X, Tyner WE, *The impact of considering land intensification and updated data on biofuels land use change and emissions estimates.* BIOTECHNOL. BIOFUELS, (2017) DOI: 10:191. 10.1186/s13068-017-0877-y.

[11] Scully, *supra* note 1 at pg. 7.

[12] Babcock BA, Iqbal Z, *Using Recent Land Use Changes to Validate Land Use Change Models,* CARD Staff Reports (2014); Taheripour F, Cui H, Tyner WE, *An Exploration of agricultural land use change at the intensive and extensive margins: implications for biofuels induced land use change*, BIOENERGY AND LAND USE CHANGE:19-37 (2017a).

b. Consumer Benefits of Biofuels

Real-world evidence and economic analyses both show that increased bioethanol blends lower the cost of gasoline for consumers. In states where gasoline blended with 15% bioethanol (E15) is available for sale (31 states today), E15 has sold this year for as much as $1 less per gallon compared to regular gasoline blended with only 10% bioethanol (E10).[13] A recent economic analysis found that similar benefits could be realized by California if E15 is authorized for sale in the state.[14] Similarly, gasoline blended with 51-83% bioethanol (E85) has sold for $2-$3 less per gallon compared to regular gasoline. In each case, the LCFS provides incentives for those increased bioethanol blends and the associated consumer cost-saving benefits, which are of particular importance at this time in light of the historically high transportation fuel costs that Californians have recently experienced.

c. Biofuels and Food Supplies

Biofuel production in the United States does not meaningfully reduce supplies of food for a number of reasons. It is a common misconception that bioethanol production diverts corn from dinner plates to gas tanks. Corn-based bioethanol is made from field corn, a different type of crop than the sweet corn that is produced for human consumption.[15] Furthermore, the bioethanol process results in a wide variety of co-products, perhaps the most significant of which is high-quality animal feed that contributes directly to the production of chicken, beef, pork, and other nutritious food. Specifically, one bushel of corn produces 2.8 gallons of bioethanol as well as 17-18 pounds of distillers dried grains (DDGS), a highly nutritious animal feed. That feed is supplied to food producers here in the U.S. and around the world. The renewable CO_2 from bioethanol production is also critical for meat processing, beer and soda carbonation, and water treatment.

Finally, as discussed above, farming practices like crop intensification and cover cropping have significantly improved the yield of all crops, further negating the impact of biofuel production on food crops. As USDA and numerous others have noted, yields have and continue to climb while acreage has remained unchanged for the last century.

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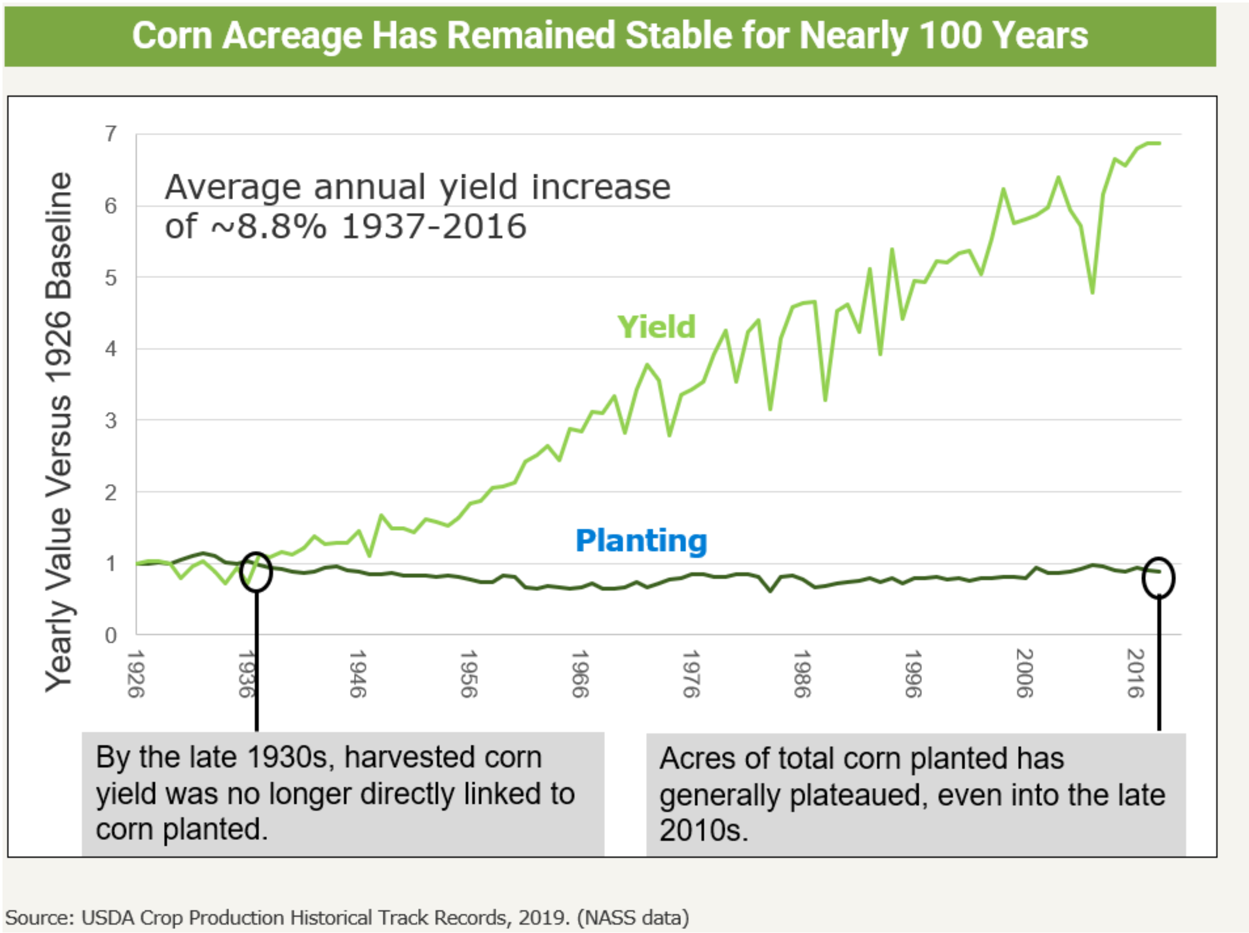
[13] *Nationwide E15 Would Save Drivers Over $20 Billion in Annual Fuel Cost*, GROWTH ENERGY (Oct. 17, 2022), https://growthenergy.org/2022/10/17/study-access-to-e15-fuel-would-save-drivers-over-20-billion-in-annual-fuel-costs/.

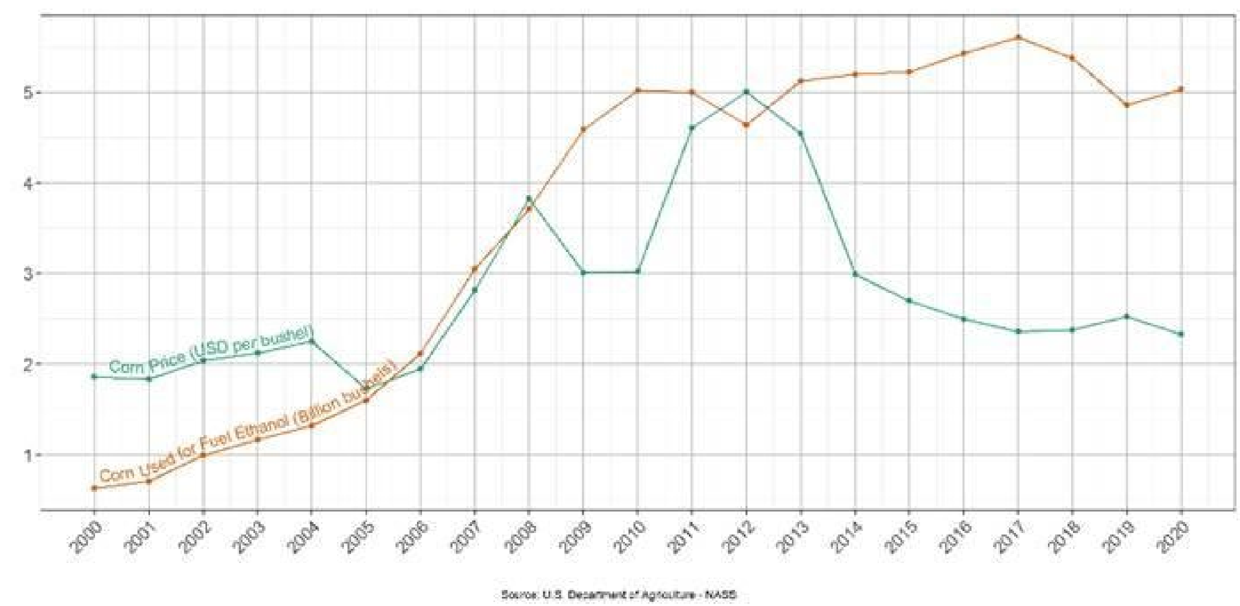
[14] *See* Attachment B*, Evaluation of Potential E15 Salfes in California*, EDGEWORTH ECONOMICS (April 5, 2022).

[15] *See* https://growthenergy.org/choice-at-the-pump/setting-the-record-straight/.



Empirical data show that the price of food is closely correlated with the cost of crude oil rather than field corn. The graph below using FAO EIA data shows this significant correlation between food and oil prices:

The below graph compares overall corn prices with prices of corn used for bioethanol, showing that there is no statistically significant correlation between bioethanol prices and food prices:



California's LCFS has incentivized biofuel production, which has driven down the CI of liquid fuels, reduced air pollution, improved Californians' health, and saved Californians money. At the same time, concerns about the impacts of biofuel production are not supported by facts or science and therefore should not distract CARB from further incentivizing biofuel production. We appreciate CARB staff's ongoing commitment to carefully review and analyze the data and information that POET and others have previously and are here again providing. As CARB works to address climate change, we urge you to ensure that the LCFS and other programs recognize how important biofuels are to decarbonizing the transportation sector and reaching the state's ambitious goals.

IV. APPROVE E15 AS A FUEL IN CALIFORNIA

A key stated rationale for this LCFS rulemaking is to "support increased low carbon fuel supply." In addition to evaluating how more stringent CI reduction targets and the addition of features like an auto-acceleration mechanism can further this goal, CARB should take action as expeditiously as possible to complete the process it has begun to approve E15 as a fuel in the state. California is now one of only two locations in the nation, along with Montana, that currently do not allow the sale of E15. By expanding the market for one of the largest sources of compliance by almost 50% in California, E15 would ease compliance burdens and support CARB's goal to achieve greater GHG emission reductions in coming years under the LCFS, while also delivering air quality benefits for Californians, especially in disadvantaged communities that often experience disparate effects from mobile source emissions.

For the last several years, CARB has been undertaking a multimedia analysis of E15 to ensure that its introduction will not have unanticipated environmental consequences. On Friday, July 29, 2022, CARB posted the multimedia evaluation of E15 blends Tier 1 report. As discussed above, the results of the analysis show positive net environmental impacts due to E15, such as reductions in PM emissions. So these additional environmental benefits can be realized, CARB should immediately undertake an update to its fuel specifications to allow for the sale of E15 in California.

V. CONCLUSION

At POET, our mission is to cultivate a world in harmony with nature, where everyone has equal access to affordable, environmentally conscious fuel choices. We are constantly innovating to make biofuel production more efficient while developing more renewable bioproducts that will pave the way to a smarter, more sustainable future.

POET appreciates the opportunity to comment and looks forward to working with CARB to make the LCFS a continued success for California. If you have any questions, please contact me at Janie.Kilgore@POET.COM or (202)756-5603.

Sincerely,

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Associate Regulatory Counsel

ATTACHMENT A

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Potential Air Quality and Public Health Benefits of Real-World Ethanol Fuels

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Introduction

For over twenty years, ethanol has been used as a fuel additive in gasoline to boost octane without the harmful impacts on the environment posed by previous fuel additives such as MTBE and lead. While ethanol's benefits to groundwater and lead contamination are well established, uncertainty remains regarding the impacts of ethanol on air quality and public health based on existing literature. This uncertainty largely results from the previous lack of studies that have been conducted using fuels that reflect the actual or real-world composition of gasoline with differing ethanol content.

This document addresses this uncertainty by providing new scientific evidence of the air quality and public health benefits provided by higher ethanol blends. We specifically present findings from our two recent studies, which characterized ethanol blending effects on light duty vehicle regulated emissions of criteria air pollutants[1] and air toxics. Findings from these studies demonstrate ethanol-associated reductions in emissions of key air pollutants and by extension, provide further evidence of the potential for ethanol-blended fuels to improve air quality and public health, particularly for environmental justice communities.

Impact of Ethanol-Containing Fuels on Air Pollutant Emissions

Kazemiparkouhi et al. (2022a) and Kazemiparkouhi et al. (2022b) are the first large-scale analyses of data from light-duty vehicle emissions studies to examine real-world impacts of ethanol-blended fuels on air pollutant emissions, including PM, NOx, CO, and THC (Kazemiparkouhi et al., 2022a), as well as BTEX (benzene, toluene, ethylbenzene, xylene) and 1,3-butadiene (Kazemiparkouhi et al., 2022b). In each study, we used similar approaches. We extracted data from a comprehensive set of emissions and market fuel studies conducted in the US. Using these data, we (1) estimated composition of market fuels for different ethanol volumes and (2) developed regression models to estimate the impact of changes in ethanol volumes in market fuels on air pollutant emissions for different engine types and operating conditions. Importantly, our models estimated these changes accounting for not only ethanol

[1] https://doi.org/10.1016/j.scitotenv.2021.151426

volume fraction, but also aromatic volume fraction, 90% volume distillation temperature (T90) and Reid Vapor Pressure (RVP). Further, our models examined the impacts of ethanol fuels on emissions under both cold start and hot stabilized running conditions and for gasoline-direct injection engines (GDI) and port-fuel injection (PFI) engine types. In doing so, our two papers provided important new information about real-world market fuels and their corresponding air pollutant emissions, as highlighted below.

- ***Aromatic levels in market fuels decreased by ~7% by volume for each 10% by volume increase in ethanol content*** (Table 1)**.** Our findings of lower aromatic content with increasing ethanol content are consistent with market fuel studies by EPA and others, and with octane blending studies (Anderson et al., 2010, Anderson et al., 2012, Stratiev et al., 2017, US EPA, 2017). As discussed in EPA's Fuel Trends Report, for example, ethanol volume in market fuels increased by approximately 6.66% between 2006 and 2016, while aromatics over the same time period were found to drop by 5.4% (US EPA, 2017).

  We note that our estimated market fuel properties differ from those used in the recent US EPA Anti-Backsliding Study (ABS), which examined the impacts of changes in vehicle and engine emissions from ethanol-blended fuels on air quality (US EPA, 2020). Contrary to our study, ABS was based on fuels with targeted properties that were intended to satisfy experimental considerations rather than mimic real-world fuels. It did not consider published fuel trends; rather, the ABS used inaccurate fuel property adjustment factors in its modeling, reducing aromatics by only 2% (Table 5.3 of ABS 2020), substantially lower than the reductions found in our paper and in fuel survey data (Kazemiparkouhi et al., 2022a, US EPA, 2017). As a result, ABS's findings and their extension to public health impacts are not generalizable to real world conditions.

Table 1. Estimated market fuel properties

Fuel ID	EtOH Vol (%)	T50 (^{o}F)	T90 (^{o}F)	Aromatics Vol (%)	AKI	RVP (psi)
E0	0	219	325	30	87	8.6
E10	10	192	320	22	87	8.6
E15	15	162	316	19	87	8.6
E20	20	165	314	15	87	8.6
E30	30	167	310	8	87	8.6

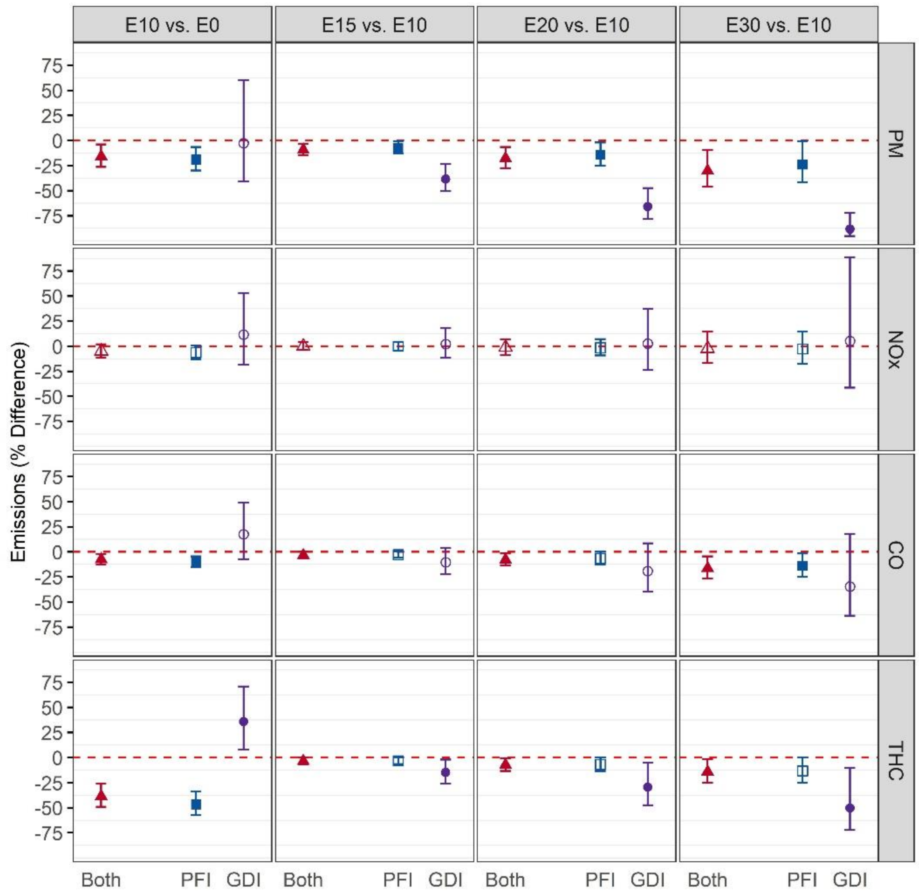
Abbreviations: EtOH = ethanol volume; T50 = 50% volume distillation temperature; T90 = 90% volume distillation temperature; Aromatics=aromatic volume; AKI = Anti-knock Index; RVP = Reid Vapor Pressure.

- ***PM emissions decreased with increasing ethanol content under cold-start conditions.*** Primary PM emissions decreased by 15-18% on average for each 10% increase in ethanol content under cold-start conditions (Figure 1). While statistically significant for both engine types, PM emission reductions were larger for GDI as compared to PFI engines, with 88% and 24% lower PM emissions, respectively, when engines burned E30 as compared to E10. In contrast, ethanol content in market fuels had no association with PM emissions during hot-running conditions.

Importantly, our findings are consistent with recent studies that examined the effect of ethanol blending on light duty vehicle PM emissions. Karavalakis et al. (2014), (2015), Yang et al. (2019a), (2019b), Schuchmann and Crawford (2019), for example, assessed the influence of different mid-level ethanol blends – with proper adjustment for aromatics – on the PM emissions from GDI engines and Jimenez and Buckingham (2014) from PFI engines. As in our study, which also adjusted for aromatics, each of these recent studies found higher ethanol blends to emit lower PM as compared to lower or zero ethanol fuels. Our findings of PM reductions are also consistent with recently published studies, for example from a California Air Resources Board (CARB) study (Karavalakis et al., 2022, Tang et al., 2022) that assessed the impact of splash-blending E10 to E15 on PM and other air pollutant emissions for late model year vehicles (2016-2021). The CARB study found a 16.6% reduction in cold start PM in comparison to a 23% PM reduction for E15S versus E10 in our study.

Together, our findings support the ability of ethanol-blended fuels to offer important PM emission reduction opportunities. Cold start PM emissions have consistently been shown to account for a substantial portion of all direct tailpipe PM emissions from motor vehicles, with data from the EPAct study estimating this portion to equal 42% (Darlington et al., 2016, US EPA, 2013). The cold start contribution to total PM vehicle emissions, together with our findings of emission reductions during cold starts, suggest that a ***10% increase in ethanol fuel content from E10 to E20 would reduce total tailpipe PM emissions from motor vehicles by 6-8%.***

Figure 1. Change (%) in cold-start emissions for comparisons of different ethanol-content market fuels[a]

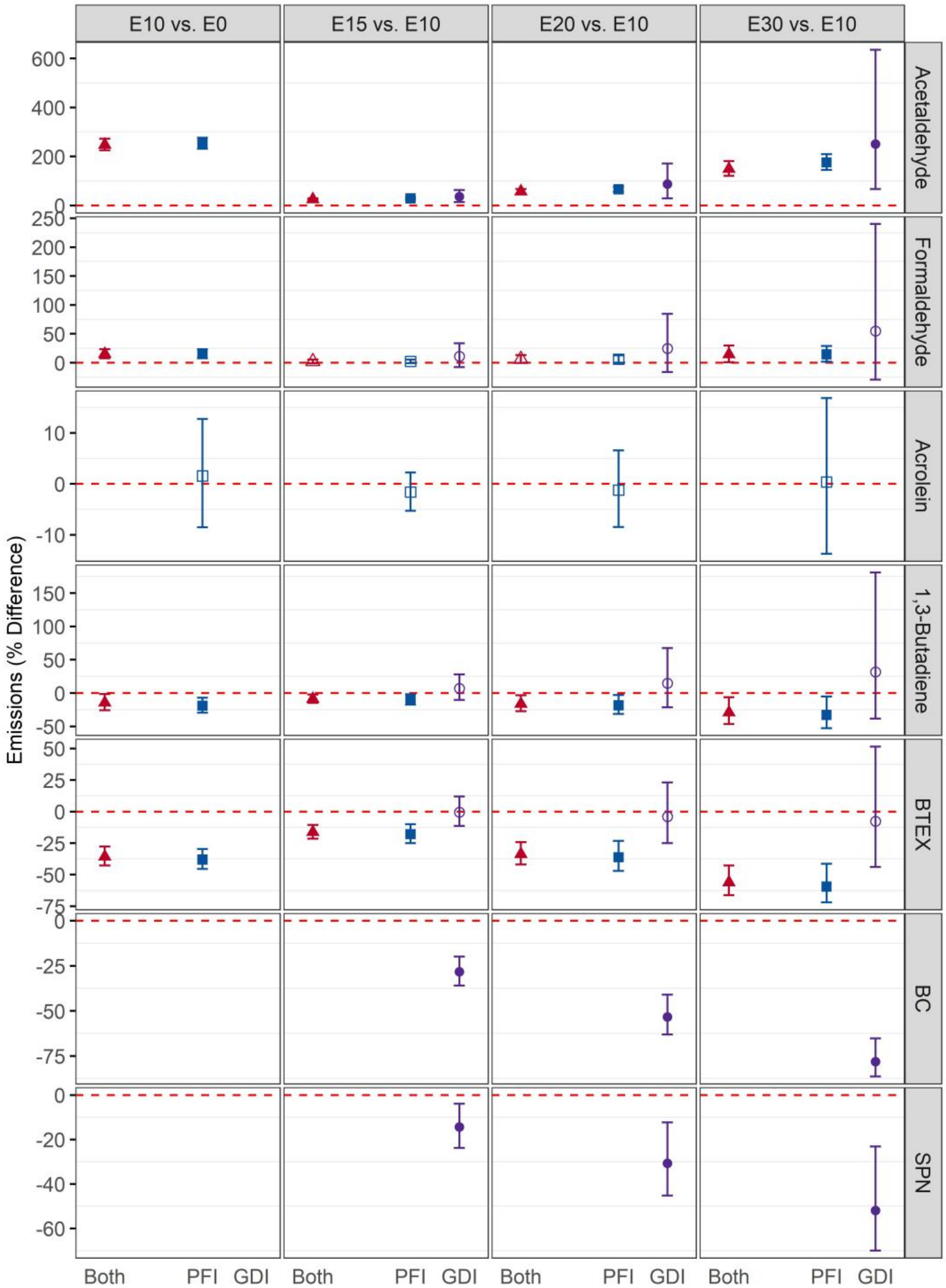


[a] Emissions were predicted from regression models that included ethanol and aromatics volume fraction, T90, and RVP as independent variables (Kazemiparkouhi et al., 2022a)

- ***Emissions of CO and THC generally decreased with increasing ethanol fuel content under cold running conditions, while NOx emissions did not change*** **(**Figure 1). The magnitude of the decrease in CO and THC emissions were comparable to those from the CARB-sponsored Karavalakis et al. (2022) study, which also found significant reductions in cold start THC and CO emissions for splash blended E15, with reductions of 6.1% and 12.1%, respectively. Under hot running conditions, CO, THC and NOx emissions were comparable for each of the examined ethanol fuels. Together, these findings add to the scientific evidence demonstrating emission reduction benefits of ethanol fuels for PM that are achieved with no concomitant increase in emissions for CO, THC, and NOx.

- ***Air toxic emissions showed lower BTEX, 1-3 butadiene, black carbon, and particle number emissions with increasing ethanol content*** in summer market fuels (Figure 2). Acrolein emissions did not vary with ethanol fuel content, while formaldehyde emissions showed little to no significant change with increasing ethanol fuel content. As expected, emissions of acetaldehyde, produced directly from ethanol combustion, increases with ethanol content. Notably, our findings are similar to those from the CARB study of splash-blended fuels (Karavalakis et al., 2022), for which ethylbenzene and xylene were significantly reduced by ~10% for splash-blended E15 (No significant change for Benzene and Toluene).

Figure 2. Change (%) in cumulative run toxics emissions for comparisons of different ethanol-content market fuels[a]



[a] Emissions were predicted from regression models that included ethanol and aromatics volume fraction, T90, and RVP as independent variables (Kazemiparkouhi et al., 2022a)
SPN = Solid Particle Number

Implications for Public Health and Environmental Justice Communities

The estimated reductions in air pollutant emissions, particularly of PM, indicate that increasing ethanol content offers opportunities to improve air quality and public health. As has been shown in numerous studies, lower PM emissions result in lower ambient PM concentrations and exposures (Kheirbek et al., 2016, Pan et al., 2019), which, in turn, are causally associated with lower risks of total mortality and cardiovascular effects (Laden et al., 2006, Pun et al., 2017, US EPA, 2019, Wang et al., 2020).

The above benefits to air quality and public health associated with higher ethanol fuels may be particularly great for environmental justice (EJ) communities. EJ communities are predominantly located in urban neighborhoods with high traffic density and congestion and are thus exposed to disproportionately higher concentrations of PM emitted from motor vehicle tailpipes (Bell and Ebisu, 2012, Clark et al., 2014, Tian et al., 2013). Further, vehicle trips within urban EJ communities tend to be short in duration and distance, with approximately 50% of all trips in dense urban communities under three miles long (de Nazelle et al., 2010, Reiter and Kockelman, 2016, US DOT, 2010). As a result, a large proportion of urban vehicle operation occurs under cold start conditions (de Nazelle et al., 2010), when PM emissions are highest. Given the evidence that ethanol-blended fuels during cold-start conditions substantially reduce PM, CO, and THC emissions while keeping NOx emissions constant, it follows that ethanol-blended fuels may represent an effective method to reduce PM health risks for EJ communities.

Summary

Findings from Kazemiparkouhi et al. (2022a, 2022b) provide important, new evidence of ethanol-related reductions in vehicular emissions of PM, CO, and THC based on real-world fuels and cold-start conditions. Recent experimental data from CARB studies reinforce this evidence. Given the substantial magnitude of the emission reductions and their potential to improve air quality and through this public health, our findings demonstrate the potential for policies that encourage higher concentrations of ethanol in gasoline to improve public health. These improvements are especially needed to protect the health of EJ communities, who experience higher exposures to motor vehicle pollution and are at greatest risk from their effects.

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ATTACHMENT B

EVALUATION OF POTENTIAL E15 SALES IN CALIFORNIA

Edgeworth Economics

April 5, 2022

I. Introduction

Blending ethanol into gasoline provides a variety of benefits for consumers, the environment, and the U.S. economy more generally. Domestically produced ethanol has largely replaced other fuel additives (which may be harmful to health, more expensive, and/or less effective), and further reduces the need for imported crude oil, reduces carbon emissions, and reduces the total costs to produce gasoline. Most gasoline sold at retail today is a blend known as "E10" which contains approximately 10 percent ethanol combined with petroleum-based gasoline blendstock.

These benefits, however, are not limited to a 10-percent ethanol blend. Increasing the share of ethanol in gasoline is a trend that has accelerated around the U.S. in recent years. Increasing the ethanol blend up to 15 percent ("E15") results in gasoline with comparable quality to E10, while providing proportionately more of the benefits noted above. In 2012, the U.S. Department of Energy (DOE) conducted a rigorous test of E15 across a range of engine types and found no adverse impact on any measure of performance, including fuel economy as well as maintenance, stating:[1]

> The Energy Department testing program was run on standard gasoline, E10, E15, and E20. The Energy Department test program was comprised of 86 vehicles operated up to 120,000 miles each using an industry-standard EPA-defined test cycle (called the Standard Road Cycle). *The resulting Energy Department data showed no statistically significant loss of vehicle performance (emissions, fuel economy, and maintenance issues) attributable to the use of E15 fuel compared to straight gasoline.*

Currently, E15 is offered for sale in 30 states. However, the largest market for gasoline in the U.S., California, has yet to approve E15 for retail sale. This paper analyzes trends in E15 sales across the U.S. and assesses the potential benefits for California consumers and retailers from the introduction of that fuel blend.

II. Cost-Related Benefits of E15 to Consumers and Gasoline Retailers

As noted above, in addition to benefits related to energy security and sustainability, the use of E15 provides potential savings for consumers and retailers based on the difference in the wholesale cost of the components of E15 relative to E10. In particular, ethanol generally sells for less, per gallon, than gasoline blendstock, and the generation of credits under the national Renewable Fuel Standard program (known as Renewable Identification Numbers or "RINS") when blending ethanol into gasoline provides additional value from increasing the proportion of ethanol in retail gasoline. In California, ethanol provides further benefits due to the Carbon Intensity ("CI") value under the Low Carbon Fuel Standard ("LCFS") program. The

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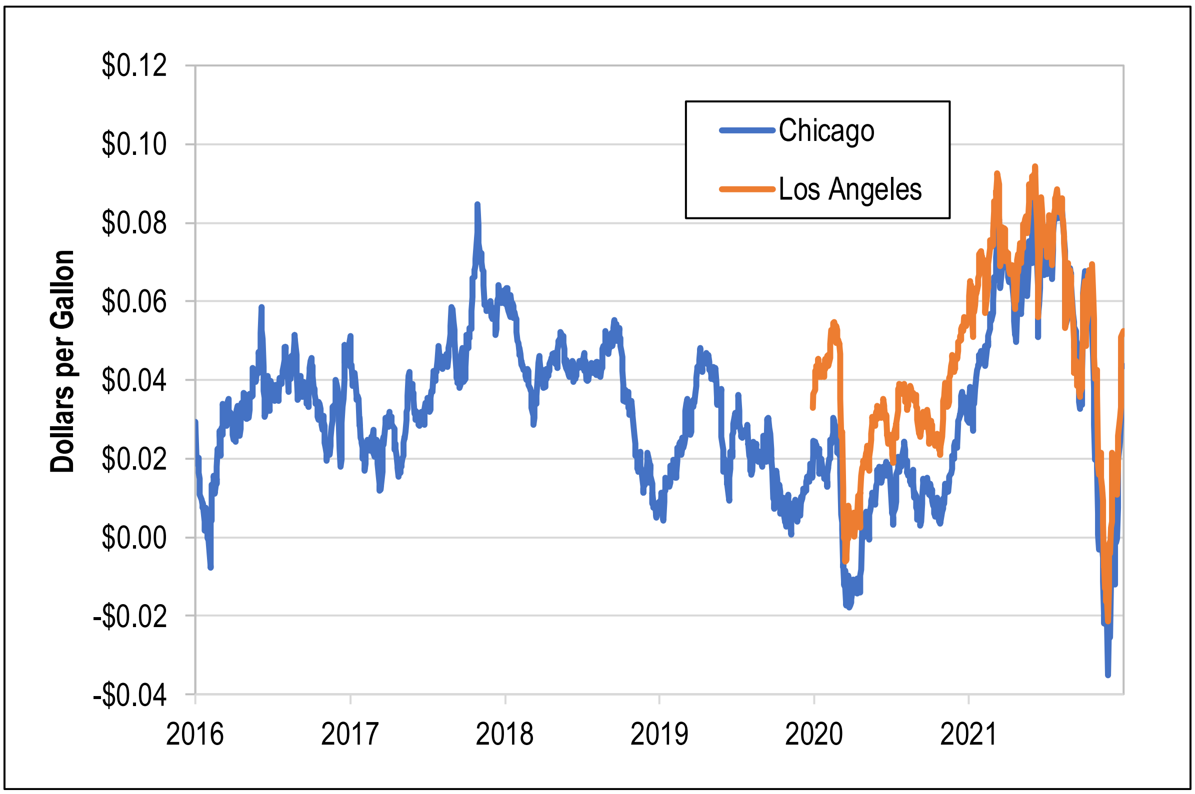
[1] DOE, "Getting It Right: Accurate Testing and Assessments Critical to Deploying the Next Generation of Auto Fuels," May 16, 2012 (emphasis added), available at www.energy.gov/articles/getting-it-right-accurate-testing-and-assessments-critical-deploying-next-generation-auto.

savings generated by E15 relative to E10 can be calculated from the wholesale prices of gasoline blendstock, ethanol, D6 (conventional) RINs, and (for California) CI value as follows:[2]

E15 Savings Relative to E10 per Gallon of Gasoline = (Blendstock Price - Ethanol Price + RIN Price + CI Value) × 5%

Using this formula, the savings as measured at Los Angeles and Chicago generally have fluctuated between zero and 8 cents per gallon over the last several years, as shown in Figure 1.[3] In 2021, the E15 discount averaged $0.051 per gallon using Chicago pricing and $0.060 per gallon using Los Angeles pricing combined with the CI value in California.

Figure 1
E15 Savings Relative to E10 (Wholesale), 2016 – 2021



Source: OPIS and Edgeworth Economics calculations (see text).

Moreover, these savings apparently are being passed on to consumers, as retail price differentials have generally equaled, if not exceeded, the wholesale differentials in recent months. As shown in Figure 2,

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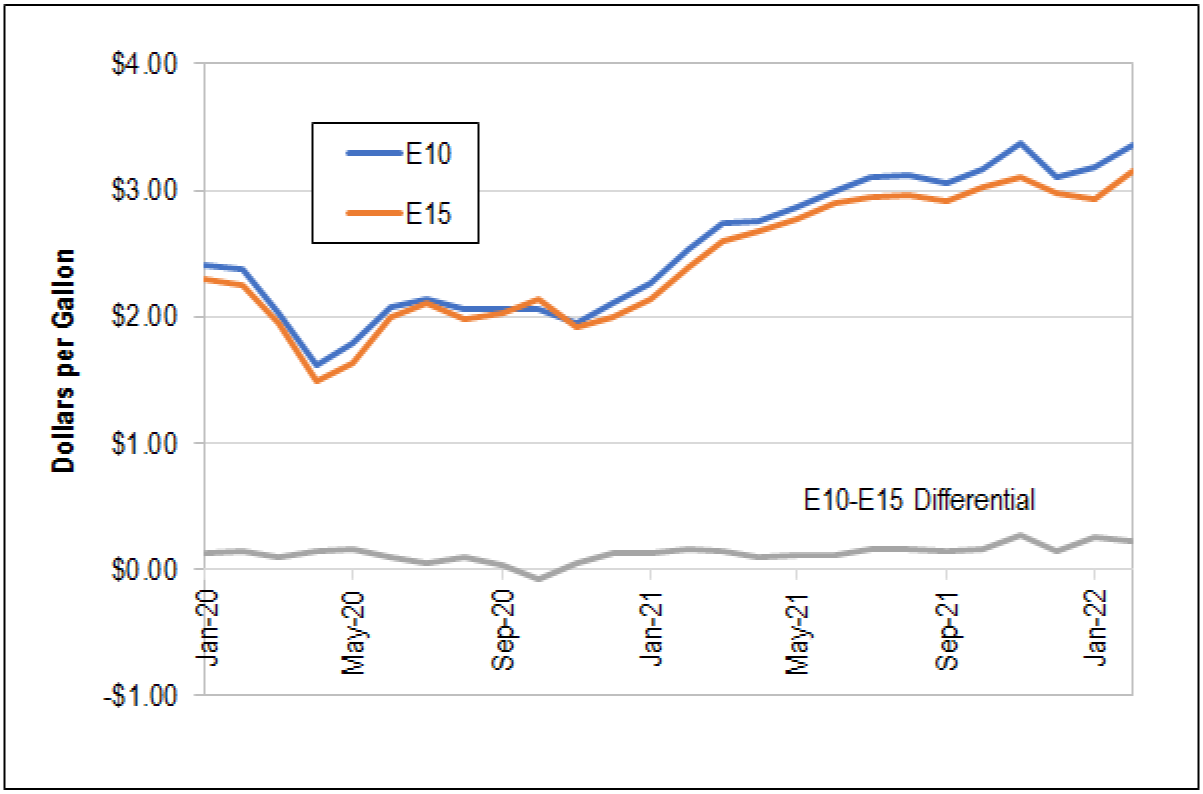
[2] For this calculation, the OPIS ethanol quote for Los Angeles is assumed to incorporate a CI score of 79.9. The average CI score for actual ethanol volumes in California is assumed to be 58.6, based on 2020 values. [RFA, "The California LCFS and Ethanol: A Decade of Reducing Greenhouse Gas Emissions," May 2021]

[3] As shown in Figure 1, for brief periods the discount for E15 relative to E10 has fallen below zero due to temporary increases in the prices of ethanol relative to gasoline blendstock, two fuels which otherwise generally move in similar directions. A variety of circumstances can lead to these conditions; but they usually last for short periods and usually are related to the higher volatility of gasoline prices relative to ethanol prices. For example, CBOB prices fell substantially in March-April 2020 due to conditions associated with the COVID pandemic, while ethanol prices were affected less significantly. The opposite circumstances occurred in late-2021, when CBOB prices rose significantly for about two months, while ethanol prices remained relatively flat.

according to data self-reported by certain stations to the Renewable Fuels Association ("RFA"), the discount for E15 relative to E10 has averaged approximately $0.12 per gallon since January 2020.[4]

Figure 2
Average E10/E15 Differential at Retail, January 2020 – February 2022



Source: RFA website, e85prices.com.
Note: These averages are based on self-reporting to RFA by dozens of stations across approximately 20 states.

III. E15 Sales/Station Growth

The experiences from a number of states across the U.S. demonstrate the potential for E15 growth in California. E15 was introduced in a few states in 2012, and growth in terms of the number of stations offering the product as well as sales per station began to accelerate around 2016/2017. While corn-producing states in the Midwest have led the industry, with some states now offering E15 at more than 5 percent and even more than 10 percent of all gas stations, significant gains have been seen in many other states, including large states distant from the corn-growing region such as Florida and Pennsylvania. Nationwide, there are now approximately 2,600 stations that offer E15 across 30 different states (see Table 1). This figure has more than doubled in just the last four years, as shown in Figure 3.

[4] There are a variety of reasons why retail discounts for E15 may exceed the wholesale values, as calculated above. For example, some stations may choose to price E15 below the notional spread from E10 as a loss leader. Other stations may expect different assessments by consumers regarding the octane value of ethanol-based fuels. Finally, the stations reporting E15 prices to RFA may not be representative of the entire industry due to regional factors or particular marketing strategies.

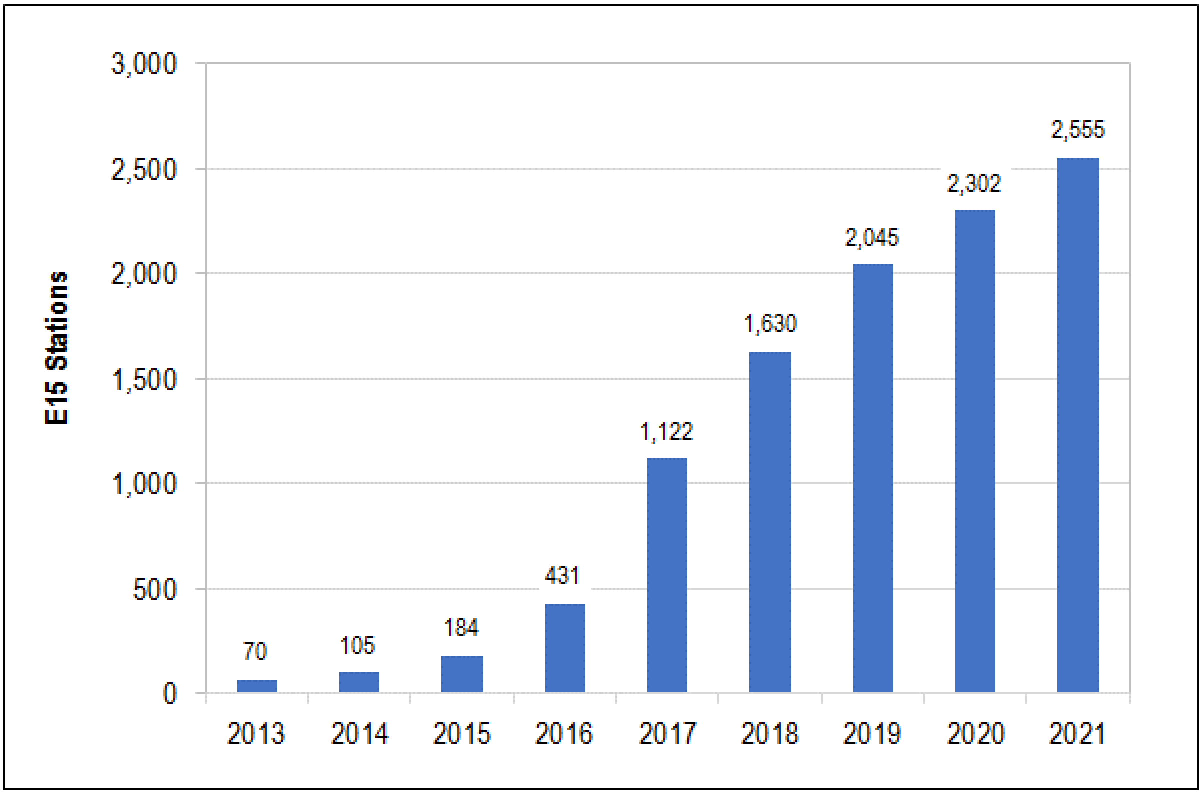
Table 1
Gas Stations Offering E15, by State, as of January 2022

State	Stations Offering E15	% of All Stations in the State
MN	372	14.4%
WI	302	9.1%
IA	274	12.6%
TX	196	1.6%
FL	186	2.3%
PA	155	3.7%
IL	135	3.8%
NE	110	7.8%
GA	95	1.2%
NC	85	1.5%
AL,AR,CO,IN,KS,KY,LA,MD,MI,MO,MS,ND,NM, OH,OK, SD,TN,VA,WV,WY	653	1.3%
AK,AZ,CA,CT,DC,DE,HI,ID,MA,ME,MT,NH,NJ, NV,NY, OR,RI,SC,UT,VT,WA	0	0.0%
U.S. Total	**2,563**	**1.8%**

Sources: RFA station list, as of January 2022; DOE website, afdc.energy.gov/files/u/data/data_source/10333/10333_gasoline_stations_year.xlsx.

Note: Total number of gas stations is based on 2012 data from the NACS, extrapolated to 2022 based on the 2007-2012 trend.

Figure 3
Total Number of Gas Stations in the U.S. Offering E15, 2013 – 2021



Source: RFA.

Two states, Iowa and Minnesota, have tracked E15 sales at the station level and publish data that allows a more granular assessment of these trends. As shown in Table 2, over the last few years, these two states have seen rapid increases in both the number of stations offering E15 as well as the volume of E15 sales per station, resulting in compound annual growth rates ("CAGR") for total E15 sales in the range of 80 to 90 percent annually over the 5-year period through 2020. Prior to the COVID pandemic in 2020, which caused substantial declines in nationwide gasoline consumption, E15 growth was even more rapid, with 4-year average growth rates in the two states exceeding 100 percent—*i.e.*, more than doubling each year. As of 2020, sales of E15 in each of these two states had reached approximately 4 to 5 percent of all gasoline sales.

Table 2
Gas Stations Offering E15 and Total E15 Sales in Iowa and Minnesota, 2016 – 2020

	Iowa				Minnesota			
	Number of Stations Selling E15	E15 Gallons per Station	Total E15 Gallons (Million)	E15 Share of All Gasoline Sales	Number of Stations Selling E15	E15 Gallons per Station	Total E15 Gallons (Million)	E15 Share of All Gasoline Sales
2016	160	34,588	5.5	0.3%	112	50,750	5.7	0.2%
2017	226	122,604	27.7	1.8%	257	74,149	19.1	0.8%
2018	220	161,203	35.5	2.3%	337	177,149	59.7	2.6%
2019	244	200,653	49.0	3.1%	363	217,420	78.9	3.4%
2020	251	241,387	60.6	4.5%	394	190,554	75.1	3.7%
2016-2019 CAGR	15.1%	79.7%	106.8%		48.0%	62.4%	140.3%	
2016-2020 CAGR	11.9%	62.5%	81.9%		37.0%	39.2%	90.6%	

Sources: Minnesota Commerce Department website, mn.gov/commerce/consumers/your-vehicle/clean-energy.jsp; Iowa Department of Revenue website, tax.iowa.gov/report-category/retailers-annual-gallons; and DOE website, www.eia.gov/dnav/pet/pet_cons_prim_a_EPM0_P00_Mgalpd_m.htm.

Note: Total gasoline sales in Minnesota are from DOE estimates of Prime Supplier Sales Volumes of Motor Gasoline.

Due to resistance from the integrated refiners[5], to date most of the growth in E15 sales nationwide has been generated by independent chains (*i.e.*, retailers without refinery/discovery operations) and owners of single stations or a small number of stations. Table 3 lists the major brands currently offering E15 across the U.S.

Table 3
Retail Gas Station Brands Offering E15, as of January 2022

Brand	E15 Stations	% of Total
Kwik Trip	451	17.6%
Casey's General Stores	398	15.5%
Sheetz	325	12.7%
Kum & Go	178	6.9%
RaceTrac	171	6.7%
Murphy USA	75	2.9%
Thorntons	75	2.9%
Kwik Star	73	2.8%
QuikTrip	70	2.7%
Holiday	56	2.2%
Integrated Refiners (e.g., Exxon, Chevron, Shell)	102	4.0%
Other	589	23.0%
Total	**2,563**	100.0%

Source: RFA.

[5] See, for example, American Petroleum Institute website, www.api.org/news-policy-and-issues/fuels-and-renewable-policy/truth-about-e15-fuel.

IV. Potential E15 Sales in California and Savings for Consumers

The pattern of growth evident in states that have allowed, and in some cases actively encouraged, the promotion of E15 provides evidence of the potential for E15 sales in California, as does California's own experience with other ethanol-based fuels, in particular E85.

California is home to a large number of independent retailers. Thus, continued resistance from the integrated refiners does not necessarily represent a limitation for the near-term expansion of E15 in California. According to the California Energy Commission, currently about 3,700 (43 percent) of California's approximately 8,700 gas stations are "unbranded" (*i.e.*, not affiliated with the integrated refiners) or operated by "hypermarts" (retailers whose primary business is unrelated to oil/gasoline such as Costco, Sam's Club, and Von's).[6]

This flexibility is evident from the expansion of E85 in California, which also has been led primarily by independent retailers. Currently, about 250 stations in California already offer E85, with total sales volumes exceeding 40,000,000 gallons in 2019. As shown in Figure 4, E85 volumes in California have grown steadily, with an average increase of 30 percent annually during the 5-year period through 2019.

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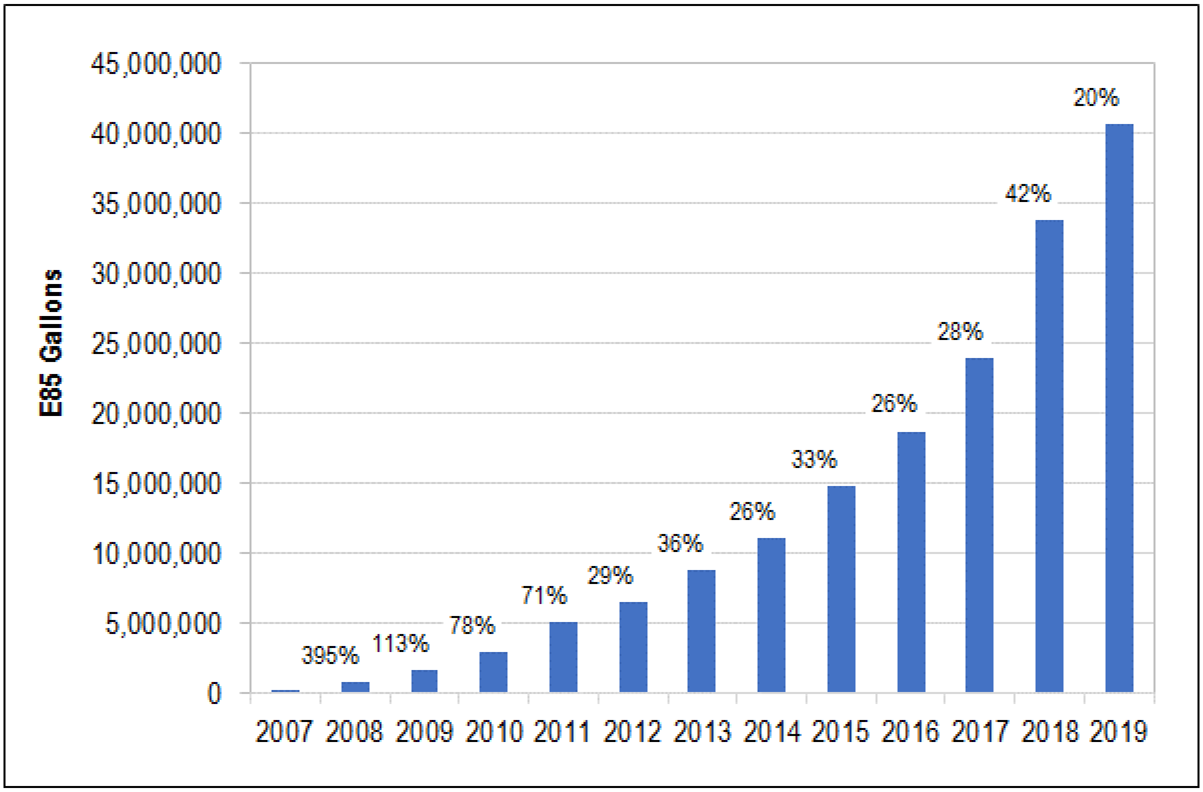
[6] California Energy Commission, *Petroleum Watch*, July 2021, available at www.energy.ca.gov/sites/default/files/ 2021-07/2021-07_Petroleum_Watch.pdf. In addition to these two categories, the CEC notes that ARCO-branded stations, which represent an additional 10 percent of all California stations, purchase unbranded fuel from the rack. (See also, California Energy Commission, *Petroleum Watch*, January 2020, available at www.energy.ca.gov/sites/default/files/2020-02/2020-01_Petroleum_Watch.pdf.)

Figure 4
E85 Sales in California, 2007 – 2019 (with annual growth rate)



Source: California Air Resources Board website, ww2.arb.ca.gov/resources/documents/alternative-fuels-annual-e85-volumes.

If E15 is approved for sale in California, a growth pattern in line with California's own experience with E85 as well as the history of E15 sales in other states would represent a significant addition to California's overall fuel mix and could provide significant savings for consumers. For example, consider that over 13 percent of stations in Iowa and more than 22 percent of stations in Minnesota now offer E15, less than ten years after the first introduction of the product. Moreover, the bulk of that growth has occurred in just the last four years, with total E15 sales growing from less than 1 percent to 4-5 percent of total fuel sales during that period in the two states. If California could attain the same level of E15 penetration, that would represent savings of at least $34 million annually (potentially shared between consumers and retailers), based on recent wholesale fuel prices.[7] If California stations implement pricing strategies more representative of the stations assessed by RFA, as shown in Figure 2, above, then the savings to consumers could be much higher, reaching $67 million annually.[8] Such a transition actually would require

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[7] This figure is equal to a price differential of $0.06 per gallon multiplied by 4 percent of California's annual fuel consumption (approximately 14 billion gallons, based on DOE's figure for 2019). [DOE website, www.eia.gov/dnav/pet/pet_cons_prim_a_EPM0_P00_Mgalpd_a.htm]

[8] This figure incorporates a price differential of $0.12 per gallon, based on the retail differential shown in Figure 2, above.

proportionately less participation from gas stations in California than in the Midwest states, since overall sales volumes tend to be significantly higher at California stations.[9]

Moreover, if any of the integrated refiners were to introduce E15 in California, the trend could accelerate even more rapidly. Recent events may indicate that some refiners are positioning themselves for that eventuality. For example, earlier this year Chevron announced that it was spending more than $3 billion to acquire Iowa-based Renewable Energy Group, a company specializing in biofuel production and marketing.[10] Renewable Energy Group currently sells both E15 and E85, and the company's website identifies the benefits of those fuels to include reduced emissions, improved engine performance, and other contributions to the U.S. economy.[11] Chevron operates more than 1,500 gas stations in California, representing about 20 percent of the total.[12] Thus, If Chevron were to introduce E15 in California, the expansion of that fuel's share of the market could increase even more rapidly than the historical trends in the other states, described above. For example, if, in addition to the growth at independent stations, one half of all Chevron stations in California introduced E15 and reached sales levels now experienced in the Midwest states described above (a modest target, given the higher overall gasoline throughput at California stations), savings for California consumers/retailers could reach approximately $43 million to $86 million annually.[13]

V. Transition Costs

The rapid growth in the number of stations offering E15 elsewhere in the U.S. indicates that transition costs are not likely to be a significant impediment to expansion in California. Adding a new fuel blend or replacing a previously sold blend, such as a mid-grade E10, are both feasible solutions for a gas station seeking to include E15 among its choices for retail customers.[14] Pre-blended E15 currently can be obtained from almost 300 terminals located primarily across the Midwest and southern and eastern U.S., an increase from only five terminals as of 2017.[15] If California approves E15 for retail sale, it is likely that wholesalers will begin to offer pre-blended E15 at terminals in California, as well.

Another option is for stations to blend on-site, using E85 and conventional E10. Blender pumps can be installed to replace pre-existing pumps or added in the normal course of expansion or upgrades over time. Blending on-site apparently is a common option for many stations today, as about 80 percent of the stations that currently offer E15 also offer E85.[16] Thus, the 250 gas stations in California that already offer

[9] Average fuel sales per station in California are approximately 1.9 million gallons annually, compared to about 0.7 million in Iowa and 1.1 million in Minnesota (based on DOE figures for 2019) [DOE websites, www.eia.gov/state/?sid=US and www.eia.gov/dnav/pet/pet_cons_prim_a_EPM0_P00_Mgalpd_a.htm]

[10] Renewable Energy Group press release, "Chevron Announces Agreement to Acquire Renewable Energy Group," February 28, 2022, available at www.regi.com/blogs/blog-details/resource-library/2022/02/28/chevron-announces-agreement-to-acquire-renewable-energy-group.

[11] Renewable Energy Group website, www.regi.com/products/transportation-fuels/reg-gasoline-ethanol-blends.

[12] See footnote 6.

[13] This range incorporates the figures calculated above plus additional E15 sales of 200,000 gallons per year at one half of Chevron's 1,559 stations in California (as of 2020).

[14] See, for example, Jerry Soverinsky, "The Case for E15," *NACS Magazine*, February 2018, available at www.nacsmagazine.com/issues/february-2018/case-e15.

[15] Based on data collected by Growth Energy.

[16] RFA station list as of January 2022.

E85 would be likely candidates for early adoption of E15.[17] The cost of a new blender pump, at about $30,000, could be recouped from the savings generated by E15 in no more than one to three years, based on the range of price differentials observed at wholesale and retail, described above.[18]

Moreover, there exist a variety of programs to assist station owners with the introduction of new biofuels. For example, USDA's Higher Blends Infrastructure Incentive Program has made available up to $100 million in grants to expand the availability of biofuels.[19] Some of these funds already have been used to install blender pumps and new tanks at gas stations seeking to offer E85 and/or E15.[20] Private initiatives, such as Growth Energy's "Prime the Pump" program also offer support, including marketing assistance and funding to help cover transition costs.[21]

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[17] One company, Pearson Fuels, currently supplies E85 to more than 200 stations in California. [RFA station list and Pearson Fuels website, pearsonfuels.com/e85-gas-stations]

[18] At 200,000 gallons per year (approximately the average throughput for E15 experienced at the stations tracked in Iowa and Minnesota, as described above), savings from selling E15 could generate $10,000 to $20,000 in additional profits per year, based on current wholesale/retail differentials. Moreover, since California gas stations generally experience greater levels of throughput than stations in those Midwestern states, payback of an initial investment in pumps likely would occur even more quickly in California.

[19] USDA website, www.rd.usda.gov/hbiip.

[20] See, for example, Environmental and Energy Study Institute, "E15 Bill Attempts to Solve Ethanol Conundrum," June 16, 2017, available at www.eesi.org/articles/view/e15-bill-attempts-to-solve-ethanol-conundrum.

[21] Growth Energy website, growthenergy.org/wp-content/uploads/2019/11/MDEV-19022-PTP-Overview-2019-11-12.pdf.