

Growth Energy's Comments on July 31, 2015, 15-Day Notice for the Proposed Revisions to the LCFS Regulation

Growth Energy submits the following comments on the California Air Resources Board's ("CARB") July 31, 2015, Notice of Public Availability of Modified Text and Availability of Additional Documents (the "Third 15-Day Notice") for CARB's proposed revisions to the Low Carbon Fuel Standard (the "LCFS regulation").

The Third 15-Day Notice represents the third time CARB staff has performed substantive modifications to the proposed LCFS regulation since it initially circulated an Initial Statement of Reasons (the "ISOR") and an Environmental Analysis ("EA") for public review on December 30, 2014. CARB circulated the first 15-day notice for public review on June 4, 2015 (the "First 15-Day Notice"). CARB circulated the second 15-day notice for public review on June 23, 2015 (the "Second 15-Day Notice").

In light of all the remaining and important open issues, uncertainties, inconsistencies, and procedural errors that have marked this regulatory process, Growth Energy believes that the Board cannot take final action on the now thrice-amended regulatory proposal without publication of a new rulemaking notice that allows 45 days for public comment, leading to a new public hearing. In addition, Growth Energy submits the following comments on the Third 15-Day Notice. Submitted with these comments are the declarations of James M. Lyons and Thomas L. Darlington, which are enclosed as Attachments "A" and "B," respectively.

A. CARB's Assumptions Regarding the Usage of Renewable Natural Gas in Heavy-Duty Vehicles Are Not Supported by Substantial Evidence

1. CARB's Analysis of Renewable Natural Gas is Internally Inconsistent with CARB's Method of Analysis for Electric Vehicles

As part of its recent 15-day notice, CARB added a spreadsheet entitled "Estimate of Electricity Use by ZEVs" to the rulemaking file. The spreadsheet reveals the assumptions made by CARB staff in estimating the amount of electricity that would be used by light-duty battery electric vehicles (EVs) and plug-in hybrid electric vehicles (PHEVs). This analysis was used to develop "illustrative compliance scenarios and evaluat[e] potential compliance curves" included in Appendix B of the ISOR (and updates). The assumptions include the values for the number of EVs and PHEVs in operation, vehicle miles traveled, and fuel efficiency, which are generally consistent with the conclusions published by CARB staff in connection with the Zero Emission Vehicle (ZEV) regulation, which requires automobile manufacturers to produce EVs and PHEVs and offer them for sale in California. (Decl. Lyons ¶ 6.) This information is necessary to understand how CARB staff "arrived at its conclusions regarding the use of

electricity as a transportation fuel in the light-duty vehicle fleet, which . . . is critical to assessing the veracity of the illustrative compliance scenarios, the environmental analysis of the proposed LCFS regulation and the estimated cost of the regulation.” (*Id.* ¶ 8.) CARB has not explained why this information was not included in the original 45-day notice, nor why it waited until now to make the information available for public comment. The 15 days allowed for public review and comment are insufficient, although Growth Energy has attempted to prepare limited, time-constrained comments in Attachment “A.” Among other problems, the record does not include any comparable information for the use of renewable natural gas in heavy-duty vehicles. In fact, CARB staff has advised that it “never performed an analysis similar to that disclosed for ZEVs for natural gas usage by heavy-duty vehicles under the LCFS.” (Decl. Lyons ¶ 9.) This is surprising and raises serious concerns regarding the validity of the LCFS illustrative compliance scenario and, consequently, the environmental and economic analysis that were based upon that scenario. (See *id.*) “Further, it is impossible for any stakeholder or reviewing body such as the Office of Administrative Law to understand how the staff arrived at its conclusions regarding the use of electricity as a transportation fuel in the light-duty vehicle fleet, which again is critical to assessing the veracity of the illustrative compliance scenarios, the environmental analysis of the proposed LCFS regulation, and the estimated cost of the regulation.” (*Id.*)

Because CARB’s methods of analysis for EVs/PHEVs and natural gas are internally inconsistent, CARB’s conclusions regarding natural gas usage are not supported by substantial evidence. (See, e.g., *Friends of Oroville v. City of Oroville* (2013) 219 Cal.App.4th 832, 844 [concluding that “speculative and contradictory conclusions do not close the evidentiary sufficiency gap involving the City’s finding that the Project’s GHG emissions will have a less than significant environmental impact after mitigation.”]; see also *Vineyard Area Citizens for Responsible Growth, Inc. v. City of Rancho Cordova* (2007) 40 Cal.4th 412, 439 [“Factual inconsistencies and lack of clarity in the FEIR leave the reader – and the decision makers – without substantial evidence for concluding that sufficient water is, in fact, likely to be available for the Sunrise Douglas project at full build-out.”].)

Accordingly, before CARB considers the revised LCFS regulation for approval, it should first disclose the assumptions and analysis used to estimate the use of natural gas in heavy-duty vehicles. Under its certified program, the Board must then permit full public comment and conduct a public hearing. (17 Cal. Code Regs., §§ 60000-60007.)

2. CARB Has Failed to Meet its Information Disclosure Requirements With Respect to the Use of Natural Gas in Heavy Duty Trucks

“CARB’s projected increase in natural gas use in heavy-duty vehicles relative to 2014 levels is 2.6 times in 2020 and 4.4 times in 2025.” (Decl. Lyons, Exhibit B-1.) To meet these increases, there would need to be “a massive increase in natural gas as a fuel for heavy-

duty vehicles, which directly implies a similar massive increase in the number of heavy-duty natural gas vehicles in operation in California.” (*Id.*, Exhibit B-3.) Notably, however, CARB’s analysis includes no estimate of “number of vehicles required” to meet the projected increase in natural gas as a fuel for heavy-duty vehicles, nor is there any evidence in the record “to support that it is reasonably foreseeable that the required number of vehicles will be in operation in California” to correspond to this demand. (*Id.*, Exhibit B-3.)

CARB’s failure in this regard has resulted in a flawed and unreliable analysis. First, by (i) failing to estimate the number of vehicles required to meet CARB’s projected increase in natural gas, and (ii) failing to include any evidence that it is “reasonably foreseeable” such increase would occur, CARB has failed to meet its information disclosure obligations under CEQA. Specifically, CEQA requires that an environmental analysis “provide sufficient information to enable the “public [to] discern . . . the ‘analytic route . . . from evidence to action’” (*City of Maywood v. Los Angeles Unif. Sch. Dist.* (2012) 208 Cal.App.4th 362, 393 [quoting *Calif. Oak Found. v. Regents of Univ. of Calif.* (2010) 188 Cal.App.4th 227, 262].) Because CARB staff did not prepare any detailed estimate of natural gas use by heavy-duty vehicles, and CARB’s conclusions regarding natural gas usage are “unsupported by empirical or experimental data, scientific authorities, or explanatory information of any kind,” the public and the decision makers have been left without any “basis for a comparison of the problems involved with the proposed project and the difficulties involved in the alternatives.” (*Citizens to Preserve the Ojai v. County of Ventura* (1985) 176 Cal.App.3d 421, 429.)

CARB’s failure to provide evidence supporting any increase in heavy-duty gas vehicles in California is particularly puzzling here, as any such increase is contrary to the evidence. Analysis by Sierra Research shows “there will be no significant increase in either the heavy-duty natural gas vehicle population or natural gas use by such vehicles unless CARB requires the purchase and use of such vehicles.” (Decl. Lyons, Exhibit B-3.)

Specifically, there “are no existing CARB regulations like the ZEV mandate that require dramatic increases in the sale of heavy-duty natural gas vehicles.” (*Id.*) “[I]ncreases in the California heavy-duty natural vehicle population will” therefore “be driven by market forces,” and “[i]f CARB believes that the market will drive those increases, staff needs to explain why and allow the public to comment on that explanation.” (*Id.*, Exhibit B-4.)

Moreover, any projected increase in the entry of a significant number of heavy-duty natural gas vehicles into the market is contradicted by CARB’s own data, which show “substantial barriers to increases in heavy-duty natural gas populations.” (*Id.*, Exhibit B-4.) These barriers include: (1) Shorter range between refueling; (2) Increased weight; (3) 10 to 15% lower fuel economy; (4) Higher purchase costs which range from \$30,000 to \$80,000 per vehicle; (5) Higher maintenance costs of 1-2 cents per mile; and (6) a limited number of

publically accessible refueling stations. (*Id.*) There is simply no evidence CARB took these factors into account when it estimated future natural gas use by heavy-duty vehicles.

If the entry of heavy-duty natural gas vehicles into the market does not materialize, there will also be potentially significant environmental effects, as regulated parties would have to look to other fuels to comply with the LCFS regulation. If heavy-duty users turn to biodiesel, for example, the LCFS regulation has the potential to increase NOx emissions statewide, including “significant increases in NOx emissions in the South Coast and San Joaquin Valley air basins which are already in extreme non-attainment of the federal ozone NAAQS and moderate non-attainment of the federal fine particulate NAAQS.” (Decl. Lyons ¶ 13.)

In any event, CARB’s analysis relies upon “unsupported speculation that contradicts economic logic and CARB staff assessments of heavy-duty natural gas vehicles outside of the LCFS rulemaking process.” (Decl. Lyons ¶ 13.) Because there is no evidence to suggest a significant increase in heavy-duty gas vehicles is “reasonably foreseeable,” and in fact the evidence points to the exact opposite conclusion, CARB’s analysis does not “provide sufficient information to enable ““public [to] discern . . . the ‘analytic route . . . from evidence to action”” (See *City of Maywood*, *supra*, 208 Cal.App.4th at 393.) As a result, CARB’s environmental analysis should be revised to address whether a significant increase in heavy-duty gas vehicles is truly reasonably foreseeable.

3. CARB Must Revise its Economic Impact Analysis to Account for the Need for California’s Heavy-Duty Gas Vehicle Population to More than Quadruple By 2025

Because there is no analysis in the ISOR (or elsewhere) regarding the number of vehicles required to meet CARB’s projected increase in natural gas, Sierra Research performed this analysis. According to Sierra Research, to meet CARB’s projected increase, the number of California Heavy-Duty Natural Gas Vehicles would need to more than *quadruple* in just ten years. California heavy-duty vehicle users would need to spend approximately \$2.4 billion to meet CARB’s fuel forecast in order to use natural gas instead of diesel vehicles, in addition to increased maintenance costs of between \$22 and \$44 million per year. (Decl. Lyons, Exhibit B-4.)

These costs were not included by CARB in its economic analysis for the LCFS regulation, as required under the Government Code, including Sections 11346.3 and 11346.5. (Decl. Lyons, Exhibit B-4.) Because CARB’s economic analysis does not take into consideration over \$2.4 billion in additional costs associated with the need for California businesses to purchase heavy-duty natural gas vehicles to meet CARB’s projections of natural gas usage, CARB’s economic impact assessments are not adequately supported by “facts, evidence, documents, testimony or other evidence.” (Govt. Code, § 11346.5(a)(8).) If CARB does not agree with our cost estimate, it should explain why, and provide a different estimate

along with the basis for its different estimate. If CARB does not believe that these costs must be considered in the current rulemaking, it must explain why.

4. CARB Failed to Address the Potential Environmental Impacts Associated with the Potential Inability to Meet CARB's 2025 Natural Gas Targets

As explained above, CARB's estimates for natural gas usage by heavy-duty vehicles is exceptionally optimistic, and unlikely to be realized. Nevertheless, there is no indication in CARB's environmental document that CARB analyzed the potential impacts associated with the inability to meet those optimistic targets.

Specifically, if there is no demand in California for the \$2.4 billion in heavy-duty natural gas vehicles contemplated under the revised LCFS regulation, this will have a substantial impact on CARB's estimation of credits and deficits generated by the proposed LCFS regulation. For example, if demand for natural gas remains at 2014 levels – *i.e.*, 110 million diesel gallon equivalents – during the years 2015 through 2025, natural gas credits will be reduced significantly, while diesel deficits will increase. (Decl. Lyons, Exhibit C-1.) This would result in deficits of -3.85 MMTs in 2025 for the May 22 natural gas compliance scenario alone, along with net total deficits for the LCFS program generally. (*Id.*, Exhibit C-1, C-2.)

Accordingly, CARB must significantly reevaluate the number of credits and deficits that will likely result from the implementation of the LCFS regulation, (Decl. Lyons, Exhibit C-1), and evaluate the potential environmental effects associated with the potential credit imbalance caused by the proposed LCFS regulation. Thereafter, CARB should recirculate both the environmental analysis and the revised LCFS regulation for public review.

B. CARB's Indirect Land Use Change Factor for Corn Ethanol Is Based on Incomplete Data and Faulty Analysis, and Lacks Evidentiary Support

CARB's proposed revisions to the LCFS regulation contemplate a land use change ("LUC") value for corn ethanol of 19.8 gCO₂e/MJ. This value is based, in large part, on the Global Trade Analysis Project Model (the "GTAP Model"). The price-yield elasticity¹ of a particular biofuel "is an important parameter used in the GTAP [M]odel to estimate the

¹ "[P]rice-yield elasticity is a measure of the change in yield with a change in price of a commodity." (Decl. Darlington ¶ 4.) For example, "[a] price-yield elasticity of 0.25 . . . means that if corn prices increase by 1%, corn yield would be expected to increase by 0.25%." (*Id.*) "The increase in yield is brought about by producers using seed types that are resistant to drought and disease, more intensive planting, possibly more fertilizer, irrigation, and other methods." (*Id.*)

magnitude of land use changes” that CARB contends is associated with that biofuel. (Decl. Darlington ¶ 4.)

To calculate the corn ethanol LUC value, CARB staff used the average of five price-yield values [0.05, 0.10, 0.175, 0.25, and 0.35], which is 0.185. (*Id.* ¶ 6.) To select these five values, CARB used (1) input from the expert working group (EWG) on elasticities, (2) its own review of various price-yield studies, and (3) a report by David Rocke reviewing some price-yield studies. The data Rocke relied upon to critique one of the studies, the Perez study, was not provided by ARB for review until August 1, 2015. (Decl. Darlington ¶ 7.) As with the late addition of the ZEV spreadsheet to rulemaking file, CARB’s failure to comply with the Government Code’s requirements is unexplained, prejudicial, and impossible to correct merely by allowing a brief period for review with no opportunity for the public to address at a hearing by the Board.

As is now plainly apparent, in light of the late addition of the Rocke data to the rulemaking file, the 0.185 price-yield value is not supported by the evidence. CARB’s own Elasticity Values Expert Working Group (EWG) recommended a mid-point value of 0.25.² The only report relied upon by CARB to support a lower price-yield value was prepared by David Rocke of UC Davis. The Rocke analysis is based on only one set of data – a 2012 dissertation by Juan Francisco Rosas Perez, who concluded that price-yield response was approximately 0.29. Despite claiming to use that data set, the Rocke study ignored the Perez data, and somehow concluded the price yield should be lower. (*Id.* ¶¶ 16-18.) Until approximately August 1, 2015, the rulemaking file did not contain an explanation as to how the Rocke study reached this conclusion or performed his statistical analysis. (*Id.* ¶ 7.) Once the information was finally made available to the public, it became readily apparent the lower price-yield values were deeply flawed and unsupported by the evidence. Specifically, although the Perez study found a price-yield value of 0.29, Rocke used the same data as Perez to reach an entirely different result, *i.e.*, that “price elasticities of yield” are “small to zero.” (Decl. Darlington ¶ 18.) This conclusion is contrary to the evidence, misinterpret the Perez study, and is based on modeling practices that are inconsistent with the methods CARB has used for other rulemakings.

First, in performing his “simple” analysis, Rocke only used “a small part of the Perez data.” (Decl. Darlington ¶ 23.) Because Rocke’s analysis only uses a small portion of the Perez data, and CARB relied upon the Rocke analysis to depart from the 0.25 price yield value recommended by its own EWG, CARB’s use of a price-yield value of 0.185 is unsupported by the evidence. Without public access to the data on which he relied, the public was completely misled about the nature of Dr. Rocke’s analysis and its unreliability.

² *Final Recommendations from the Elasticity Values Subgroup*, ARB LCFs Expert Workgroup, available at <http://www.arb.ca.gov/fuels/lcfs/workgroups/ewg/010511-final-rpt-elasticity.pdf>

Rocke's conclusions also misinterpret the Perez study, and are thus wholly unreliable. The entire point of the Perez study was to show how "a wide range of related parameters" affect the price yield values. (Decl. Darlington ¶ 20.) Rocke, however, simply took a small subset of the parameters, and determined based on the incomplete data there was no price yield elasticity. (*Id.* ¶ 16-19.) Nothing in the open record from Dr. Rocke or any other source explains why he took that approach.

Rocke's method of modeling is also inconsistent with the methods CARB has used for other rulemakings. (Decl. Darlington ¶ 19.) Rocke's simple modeling focuses only on one parameter, which has a higher likelihood of resulting in conclusions suggesting a certain parameter is statistically insignificant. (*Id.*) Reliable and scientifically defensive modeling practices include a full range of inputs that could influence vehicle emissions; for example, CARB's Predictive Model for gasoline estimates emissions from cars and trucks in response to a number of gasoline inputs, including sulfur, benzene, T50, T90, aromatics, olefins, volatility, and total oxygen. (*Id.* ¶ 19 n.14.) Rather than relying upon Rocke's conclusions based on incomplete data, CARB should instead rely upon the conclusions of its own EWG, and studies that are internally consistent with the methodologies it uses in other contexts. Among other steps that CARB must take now, Dr. Rocke's analysis, including the data on which he relied, must receive the external scientific review mandated by Section 57004 of the Health and Safety Code. One, though by no means the only, indication of the need for external review is the fact CARB's own EWG examined the same issue, yet reached a vastly different result. If CARB does not agree, it should explain its reasons for disagreement in full, and address the following issues:

- Whether CARB believes Rocke's very limited analysis of price and supply data alone constitutes an adequate analysis of the Perez data, when CARB's own typical methods of analyzing data are much more robust than those employed by Rocke.
- Why CARB deviated from the EWG recommendation of 0.25 for a central value or average value for YPE.
- What exactly was wrong with how Perez handled autocorrelation in his analysis.

(See *id.* ¶ 25.)

CARB's improper reliance on the Rocke data has significant real-world consequences. Using a factually-supported price-yield value, such as the 0.25 recommended by CARB's EWG, the LUC for corn ethanol would be 17.3 gCO₂/MJ, compared to the 19.8 gCO₂/MJ using the proposed inputs. (Decl. Darlington ¶ 32.) Although Growth Energy considers the use of indirect LUC factors in the LCFS regulation to be generally unsound, CARB has included LUC factors as a component of the Carbon Intensity ("CI") Value placed on a fuel

by CARB. If CARB inaccurately calculates the LUC (and thus the CI Value) of a fuel – such as corn ethanol – as being too high, it will prevent achievement of reductions in greenhouse gas emissions in the most cost-effective manner possible, which is the purpose of the LCFS regulation and a mandatory duty under the 2006 Global Warming Solutions Act. By reducing the CI value assigned to corn ethanol above a level that is scientifically supportable relative to other renewable fuels, CARB is incentivizing the use of fuels that do not provide the maximum GHG reductions in a cost-effective manner. The LCFS regulation will create incorrect “market signals” contrary to the intended effect of the overall LCFS program.³ (*Cf. id.* ¶ 33.)

To avoid these potential adverse consequences, and to develop LUC Values (and thereby CI Values) that are based on scientific data and the facts, the GTAP should use a price-yield value that is no less than 0.25, the amount recommended by CARB’s EWG. If CARB does not take this action, it should explain why in a new rulemaking notice and permit testimony at a public hearing.

C. Because the 15-Day Review Period Provides Insufficient Time for Commenting Parties to Evaluate the New Evidence and Modifications to the Revised LCFS Regulation, CARB Should Recirculate the EA

Finally, it bears further emphasis that fifteen calendar days provides insufficient time for the public to review CARB’s modifications to the proposed LCFS regulation.

The 15-Day Notice not only includes substantial modifications to the proposed LCFS regulation, but extensive new information regarding CARB’s analyses. This information includes, for example, detailed information underlying CARB’s analysis of EVs/PHEVs and information regarding the Rocke analysis. This information appears to have been available since the original 45-day comment period, and Growth Energy’s representatives have requested that information on many occasions since that time. The statement in the 15-day notice that CARB is seeking public comment on the additional materials in “the interests of fairness and transparency” is ironic, and misleading. It has taken the pressure of litigation against CARB under the Public Records Act – in which CARB has raised its duties under the rulemaking-file provisions of the Government Code as a type of defense – to force CARB to put the new materials in the rulemaking file. CARB initially resisted that Public Records Act request with dilatory motions practice, until the Court with jurisdiction in that case became fully engaged in the issues. No private party should have to bear the expense of attempting to require a public agency to comply with its information disclosure obligations under the Government Code during the rulemaking process, yet this is exactly what CARB forced Growth Energy to do here.

³ See CARB, “Staff Report: Initial Statement of Reasons, Proposed Regulation to Implement the Low Carbon Fuel Standard,” Vol. I at VI-20 (March 5, 2006), available at http://www.arb.ca.gov/fuels/lcfs/030409lcfs_isor_vol1.pdf.

Rather than providing all interested parties, including Growth Energy, with an adequate opportunity to review these highly relevant documents – which, as explained above, show fundamental flaws in CARB’s analysis – CARB instead placed the documents into the rulemaking file concurrently with its third 15-day notice. Fifteen days is simply insufficient for technical experts with relevant knowledge of the subject matter of the proposed LCFS regulation; certainly, a member of the public with no technical or legal background could not meaningfully be asked to provide comments on CARB’s modifications and new evidence within this short timeframe.

In light of the foregoing, and the significant new information provided by CARB with respect to its analysis of the revised LCFS regulation, CARB should recirculate both the proposed LCFS regulation and a revised EA for 45-day review.

STATE OF CALIFORNIA
BEFORE THE AIR RESOURCES BOARD

Declaration of James M. Lyons

I, James Michael Lyons, declare as follows:

1. I make this Declaration based upon my own personal knowledge and my familiarity with the matters recited herein. It is based on my experience of nearly 30 years as a regulator, consultant, and professional in the field of emissions and air pollution control. A copy of my résumé can be found in Exhibit A.

2. I am a Senior Partner of Sierra Research, Inc., an environmental consulting firm located at 1801 J Street, Sacramento, California owned by Trinity Consultants, Inc. Sierra specializes in research and regulatory matters pertaining to air pollution control, and does work for both governmental and private industry clients. I have been employed at Sierra Research since 1991. I received a B.S. degree in Chemistry from the University of California, Irvine, and a M.S. Degree in Chemical Engineering from the University of California, Los Angeles. Before joining Sierra in 1991, I was employed by the State of California at the Mobile Source Division of the California Air Resources Board (CARB).

3. During my career, I have worked on many projects related to the following areas: 1) the assessment of emissions from on- and non-road mobile sources, 2) assessment of the impacts of changes in fuel composition and alternative fuels on engine emissions, including emissions of green-house gases, 3) analyses of the unintended consequences of regulatory actions, and 4) the feasibility of compliance with air quality regulations.

4. I have testified as an expert under state and federal court rules in cases involving CARB regulations for gasoline, Stage II vapor recovery systems and their design, factors affecting emissions from diesel vehicles, evaporative emission control system design and function, as well as combustion chamber system design. While at Sierra I have acted as a consultant on automobile air pollution control matters for CARB and for the United States Environmental Protection Agency. I am a member of the American Chemical Society and the Society of Automotive Engineers and have co-authored nine peer-reviewed monographs concerned with automotive emissions, including greenhouse gases and their control. In addition, over the course of my career, I have conducted peer-reviews of numerous papers related to a wide variety of issues associated with pollutant emissions and air quality.

5. This Declaration summarizes the results of my review of the CARB Notice of Public Availability of Modified Text and Availability of Additional Documents for the Proposed Re-Adoption of the Low Carbon Fuel Standard Regulation (the LCFS Regulation) dated July 31, 2015. I have performed this review as an independent expert

for Growth Energy. If called upon to do so, I would testify in accord with the facts and opinions presented here.

6. According to CARB staff, the illustrative compliance scenario published in the ISOR and last updated as part of the May 15-day notice has been used for a number of purposes. These include preparation of the environmental analysis¹ and assessment of economic impacts.² In response to a lawsuit under the Public Records Act and discussions between counsel for CARB and Growth Energy, CARB has recently added a spreadsheet entitled “Estimate of Electricity Use by ZEVs” to the rulemaking file. This spreadsheet reveals the assumptions made by CARB staff in estimating the amount of electricity that would be used by light-duty battery electric vehicles (EVs) and plug-in hybrid electric vehicles (PHEVs) for the purposes of developing illustrative compliance scenarios and evaluating potential compliance curves as documented in Appendix B of the Initial Statement of Reasons (ISOR) and subsequent updates. These assumptions include the number of EVs and PHEVs in operation, as well as the annual number of miles traveled and the fuel efficiency of the vehicles. In general, the assumptions reflect the regulatory requirements of the Zero Emission Vehicle (ZEV) regulation,³ which requires automobile manufacturers to produce EVs and PHEVs and offer them for sale in California.

7. Once it became clear that CARB was using ZEV vehicle population estimates to estimate the amount of electricity expected to be used as a fuel for light-duty vehicles in developing the LCFS illustrative compliance scenario, Growth Energy renewed earlier requests for similar data used by CARB to estimate of the amount of natural gas that will be used in heavy-duty vehicles under the LCFS. I understand that, since the publication of the July 31 public notice, counsel for CARB has advised counsel for Growth Energy that no heavy-duty natural gas vehicle population estimates were used to prepare the LCFS illustrative compliance scenario. I further understand that CARB staff never performed an analysis similar to that disclosed for ZEVs to estimate natural gas use in heavy-duty vehicles under the LCFS. This is surprising, and raises serious concerns regarding the validity of the LCFS illustrative compliance scenario, and therefore the environmental and economic analyses that were performed based on it.

8. If, unlike the situation with ZEVs, CARB has failed to perform any technical analysis to estimate the amount of natural gas that would be used in heavy-duty vehicles which have been assumed in the illustrative compliance scenario and evaluation of potential compliance curves, the compliance scenario and all conclusions drawn from it cannot be relied upon. Further, it is impossible for any stakeholder or reviewing body

¹ See page V-1 of the LCFS ISOR.

² See page VII-15 of the LCFS ISOR.

³ See for example the ZEV population forecasts in Table 3.6 of www.arb.ca.gov/regact/2012/zev2012/zevisor.pdf.

such as the Office of Administrative Law to understand how the staff arrived at its conclusions regarding the use of electricity as a transportation fuel in the light-duty vehicle fleet, which again is critical to assessing the veracity of the illustrative compliance scenarios, the environmental analysis of the proposed LCFS regulation, and the estimated cost of the regulation.

9. Although it is not possible to understand how CARB staff arrived at its estimates of natural gas use in heavy-duty vehicles based on the available information, it is possible to estimate what CARB's assumptions would have been if staff performed the analysis required to provide a technical basis that would justify the forecast use of natural gas in heavy-duty vehicles. Once these estimates are established, it is then possible to assess their implications with respect to the veracity of the illustrative compliance scenarios, the environmental analysis of the proposed LCFS regulation, and the estimated cost of the regulation.

10. I have estimated the increase in the number of heavy-duty natural gas vehicles that would be required to come into operation in California in order to consume the volume of natural gas forecast by CARB staff. I have also performed an analysis to determine if that required increase in vehicle population is reasonably foreseeable. Both analyses are documented in Exhibit B to this declaration. As demonstrated by these analyses, the required increase in the number of heavy-duty natural gas vehicles is large, and the available data and information contradict CARB's unsupported assumptions regarding large increases in the use of natural gas in heavy-duty vehicles.

11. Exhibit B also identifies substantial costs that would be incurred as a result of CARB's natural gas usage assumptions that were not considered in the assessment of the economic impacts of the LCFS regulation. To the extent that CARB staff continues to rely on its current illustrative compliance scenario, which incorporates flawed assumptions regarding natural gas use in heavy-duty vehicles, these costs must be included in the economic impact assessment.

12. The correction of CARB's use of flawed assumptions regarding increased natural gas use in heavy-duty vehicles would significantly impact the results of the illustrative compliance scenario. As shown in Exhibit C, using corrected assumptions that limit natural gas use in heavy-duty vehicles to 2014 volumes and increase the use of diesel fuel, total LCFS credit balances under the compliance scenario become negative for the years 2021 to 2025, indicating that compliance with the LCFS regulation will not be feasible based on the remaining assumptions.


13. CARB staff might try to develop illustrative compliance scenarios based on other assumptions. These other assumptions would likely include greater use of biodiesel in heavy-duty vehicles. As I have shown previously,⁴ increased use of biodiesel in

⁴ See Appendix I of Growth Energy's February 17, 2015 comments on the Alternative Diesel Fuel and LCFS regulations.

heavy-duty diesel vehicles under the proposed LCFS and Alternative Diesel Fuel regulations will lead to increased NOx emissions, including significant increases in NOx emissions in the South Coast and San Joaquin Valley air basins which are already in extreme non-attainment of the federal ozone NAAQS, and moderate non-attainment of the federal fine particulate NAAQS. However, given CARB's reliance on the original illustrative compliance scenario in performing the environmental analysis and assessment of economic impacts, revisions to those analyses would also have to be performed if CARB revises the illustrative compliance scenario. In any case, at present CARB is relying on unsupported speculation that contradicts economic logic and CARB staff assessments of heavy-duty natural gas vehicles outside of the LCFS rulemaking process.

I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct.

Executed this 17th day of August, 2015 at Sacramento, California.



JAMES M. LYONS

Exhibit A to Declaration of James M. Lyons



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Résumé

James Michael Lyons

Education

1985, M.S., Chemical Engineering, University of California, Los Angeles

1983, B.S., Cum Laude, Chemistry, University of California, Irvine

Professional Experience

4/91 to present Senior Engineer/Partner/Senior Partner
Sierra Research

Primary responsibilities include oversight and execution of complex analyses of the emission benefits, costs, and cost-effectiveness of mobile source air pollution control measures. Mr. Lyons has developed particular expertise with respect to the assessment of control measures involving fuel reformulation, fuel additives, and alternative fuels, as well as accelerated vehicle/engine retirement programs, the deployment of advanced emission control systems for on- and non-road gasoline- and Diesel-powered engines, on-vehicle evaporative and refueling emission control systems, and Stage I and Stage II service station vapor recovery systems. Additional duties include assessments of the activities of federal, state, and local regulatory agencies with respect to motor vehicle emissions and reports to clients regarding those activities. Mr. Lyons has extensive litigation experience related to air quality regulations, product liability, and intellectual property issues.

7/89 to 4/91 Senior Air Pollution Specialist
California Air Resources Board

Supervised a staff of four professionals responsible for identifying and controlling emissions of toxic air contaminants from mobile sources and determining the effects of compositional changes to gasoline and diesel fuel on emissions of regulated and unregulated pollutants. Other responsibilities included development of new test procedures and emission standards for evaporative and running loss emissions of hydrocarbons from vehicles; overseeing the development of the state plan to control toxic emissions from motor vehicles; and reducing emissions of CFCs from motor vehicles.

4/89 to 7/89

Air Pollution Research Specialist
California Air Resources Board

Responsibilities included identification of motor vehicle research needs; writing requests for proposals; preparation of technical papers and reports; as well as monitoring and overseeing research programs.

9/85 to 4/89

Associate Engineer/Engineer
California Air Resources Board

Duties included analysis of vehicle emissions data for trends and determining the effectiveness of various types of emissions control systems for both regulated and toxic emissions; determining the impact of gasoline and diesel powered vehicles on ambient levels of toxic air contaminants; participation in the development of regulations for “gray market” vehicles; and preparation of technical papers and reports.

Professional Affiliations

American Chemical Society
Society of Automotive Engineers

Selected Publications (Author or Co-Author)

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Exhibit B to Declaration of James M. Lyons

Exhibit B

Estimation of the Heavy-Duty Natural Gas Vehicle Requirements Implied by CARB's LCFS Illustrative Compliance Scenario

As described in detail in the ISOR and Appendix B to the ISOR, in developing proposed revisions to the Low Carbon Fuel Standard (LCFS) regulation, CARB staff has prepared an “illustrative compliance scenario” which, for purposes of its Environmental Assessment, must be “reasonably foreseeable.”¹ However, CARB staff has failed to publish many of the assumptions and data that underlie that scenario, making it impossible to understand the technical basis, if any, which supports CARB’s claim that the scenario is in fact reasonably foreseeable. In particular, CARB staff has failed to provide any technical basis that supports the large increase in natural gas use by heavy-duty vehicles assumed in the compliance scenario. As documented below, an analysis that estimates the implications of CARB’s assumptions regarding natural gas use in heavy-duty vehicles indicates that the CARB assumptions are not in fact reasonably foreseeable. Given this, CARB’s environmental analysis and its assessment of the economic impacts of the proposed LCFS regulation are flawed and cannot be used to comply with the California Environmental Quality Act (CEQA) or the rulemaking requirements of the Administrative Procedures Act (APA).

CARB Staff Assumptions Regarding Natural Gas Use in Heavy-Duty Vehicles

CARB staff has published several versions of the compliance scenario during the course of the LCFS rulemaking process. The most recent version is dated May 22, 2015 and is titled “Analysis of Compliance Curve Reflecting the Impact of May 2015 Proposed 15-Day Changes.” The CARB assumptions regarding conventional and renewable natural gas to be used in heavy-duty vehicles as a function of time are presented in Table 1 in diesel equivalent gallons. As shown, CARB assumes a dramatic increase in total natural gas use over time, with that gas being derived from “renewable” sources that include landfills and waste digesters. More specifically, CARB’s projected increase in natural gas use in heavy-duty vehicles, relative to 2014 levels, is 2.6 times greater in 2020 and 4.4 times greater in 2025.

Required Heavy-Duty Natural Gas Vehicle Populations

Using CARB staff’s assumptions regarding natural gas use in heavy-duty vehicles, it is possible to estimate the required number of heavy-duty vehicles as a function of time. This process begins with determining the current population of heavy-duty natural gas vehicles in California. Data regarding that population (exclusive of conversions) in 2013 have been published by the

¹ See pages ES-18 and 19 of the LCFS ISOR.

National Renewable Energy Laboratory.² These data can then be used with EMFAC2014 annual mileage accumulation rates and an average natural gas fuel economy value of 5.6 miles per diesel equivalent value for the 2013 fleet³ to estimate natural gas use. These data and the resulting estimate of natural gas consumption by heavy-duty vehicles in 2013 are presented in Table 2. As shown, the estimated volume of 102 million diesel equivalent gallons for the 2013 fleet is in reasonable agreement with the 2014 CARB assumed value of 110 million.

Assuming that both the relative distribution of heavy-duty natural gas vehicles in the fleet and their fuel economy remain constant, the growth in vehicle population required to satisfy CARB's forecast demand is directly proportional to the growth in that demand. The resulting populations for 2015 to 2025 are shown in Table 3. It should be noted that while the assumption of constant fuel economy is likely to be incorrect, the expected increase in fleet fuel economy would only serve to increase the number of natural gas vehicles required to consume the fuel volumes assumed by CARB for future years.

Table 1 CARB Assumptions Regarding Natural Gas Use In Heavy-Duty Vehicles (million diesel equivalent gallons)			
Year	Conventional	Renewable	Total
2014	86	23	110
2015	70	55	125
2016	75	70	145
2017	75	90	165
2018	75	130	205
2019	75	170	245
2020	55	230	285
2021	35	290	325
2022	35	330	365
2023	35	370	405
2024	35	410	445
2025	35	450	485

² See www1.eere.energy.gov/cleancities/pdfs/ngvtf14oct_schroeder.pdf

³ See www.energy.ca.gov/2013_energy_policy/documents/2013-06-26_workshop/presentations/07_Medium_Heavy_Vehicles_Bob_RAS_22Jun2013.pdf

Table 2 2013 Heavy-Duty Natural Gas Fleet Data and Estimated Fuel Consumption			
Type	Population	Annual Miles	NG Use (million diesel equivalent gallons)
Class 4-6	1,009	18,228	3
Class 7	2,148	20,215	8
Class 8	9,791	52,023	91
Total	12,947	-	102

Table 3 Estimated California Heavy-Duty Natural Gas Vehicle Population Required to Consume Natural Gas Volumes Forecast by CARB (vehicles)				
Year	Class 8	Class 7	Class 4-6	Total
2013	9,791	2,148	1,009	12,947
2015	11,156	2,447	1,149	14,753
2016	12,941	2,839	1,333	17,113
2017	14,726	3,230	1,517	19,474
2018	18,296	4,013	1,885	24,194
2019	21,866	4,796	2,253	28,915
2020	25,436	5,579	2,620	33,636
2021	29,006	6,362	2,988	38,357
2022	32,576	7,146	3,356	43,078
2023	36,147	7,929	3,724	47,799
2024	39,717	8,712	4,091	52,520
2025	43,287	9,495	4,459	57,241
Increase from 2013 to 2025	33,496	7,347	3,451	44,294

Assessment of Required Heavy-Duty Natural Gas Vehicle Populations

As documented above, the CARB illustrative scenario assumes a massive increase in natural gas as a fuel for heavy-duty vehicles, which directly implies a similar massive increase in the number of heavy-duty natural gas vehicles in operation in California. Although, CARB staff might be able to show that it is possible to divert the forecast volume of natural gas intended for other purposes to use as a transportation fuel, staff has apparently not estimated the number of vehicles required nor published any data or analysis to support that it is reasonably foreseeable that the required number of vehicles will be in operation in California. Rather, as is demonstrated below, what is reasonably foreseeable is that there will be no significant increase in either the heavy-duty natural gas vehicle population or natural gas use by such vehicles unless CARB requires the purchase and use of such vehicles.

It should be noted that while there are several existing CARB regulations that have resulted in the deployment of natural gas vehicles, such as Solid Waste Collection Vehicle rule and the Fleet Rule for Transit Agencies, those regulatory programs are mature and will not lead to further increases in heavy-duty natural gas vehicle use. There are simply no existing CARB regulations like the ZEV mandate that require dramatic increases in the sale of heavy-duty natural gas vehicles. Given this, increases in the California heavy-duty natural vehicle population would have to be driven by market. If CARB believes that the market will drive those increases, staff needs to explain why and allow the public to comment on that explanation. Indeed, CARB's own recent assessment of heavy-duty natural gas vehicle technology⁴ compares heavy-duty natural gas vehicles with diesel vehicles and notes that natural gas vehicles suffer from a number of disadvantages including the following:

1. Shorter range between refueling;
2. Increased weight;
3. 10 to 15% lower fuel economy;
4. Higher purchase costs which range from \$30,000 to \$80,000 per vehicle;
5. Higher maintenance costs of 1-2 cents per mile; and
6. A limited number of publically accessible refueling stations.

All of these factors serve as substantial barriers to increases in heavy-duty natural gas populations. For example, multiplying the \$55,000 mid-point of the range in increased vehicle costs by the estimated 44,924 additional natural gas vehicles that would be required in 2025 to meet CARB's fuel forecast, indicates that an additional \$2.4 billion dollars would have to be spent by California heavy-duty vehicle users in order to use natural gas instead of diesel vehicles. Similarly, the increased maintenance costs associated with the additional natural gas vehicles would amount to between \$22 and \$44 million in 2025 alone. There are also substantial costs associated with installation of natural gas refueling facilities.⁵ It should be noted that these costs were not included by CARB staff in its economic analysis of the LCFS regulation.

The two primary advantages associated with natural gas vehicles that have been identified by CARB staff are (1) lower tailpipe emissions of particulate matter and oxides of nitrogen, and (2) lower fuel price. Given that less expensive diesel vehicles will be available, the lower emission levels associated with natural gas vehicles are unlikely to influence the purchasing decisions of vehicle operators. In addition, given the recent changes in the oil prices, the price difference between natural gas and diesel fuel has dropped dramatically as shown in Figure 1, which was obtained from a U.S. Department of Energy website.⁶ It should be noted that the price differential shown in Figure 1 does not reflect the 10 to 15% lower fuel economy cited by CARB as a disadvantage of natural gas vehicles, which would further reduce the price differential. Further, current EIA forecasts for diesel fuel prices indicate that lower prices will persist for a considerable period of time.⁷ Given this, the advantage associated with lower prices for natural gas does not appear to be a substantial factor.

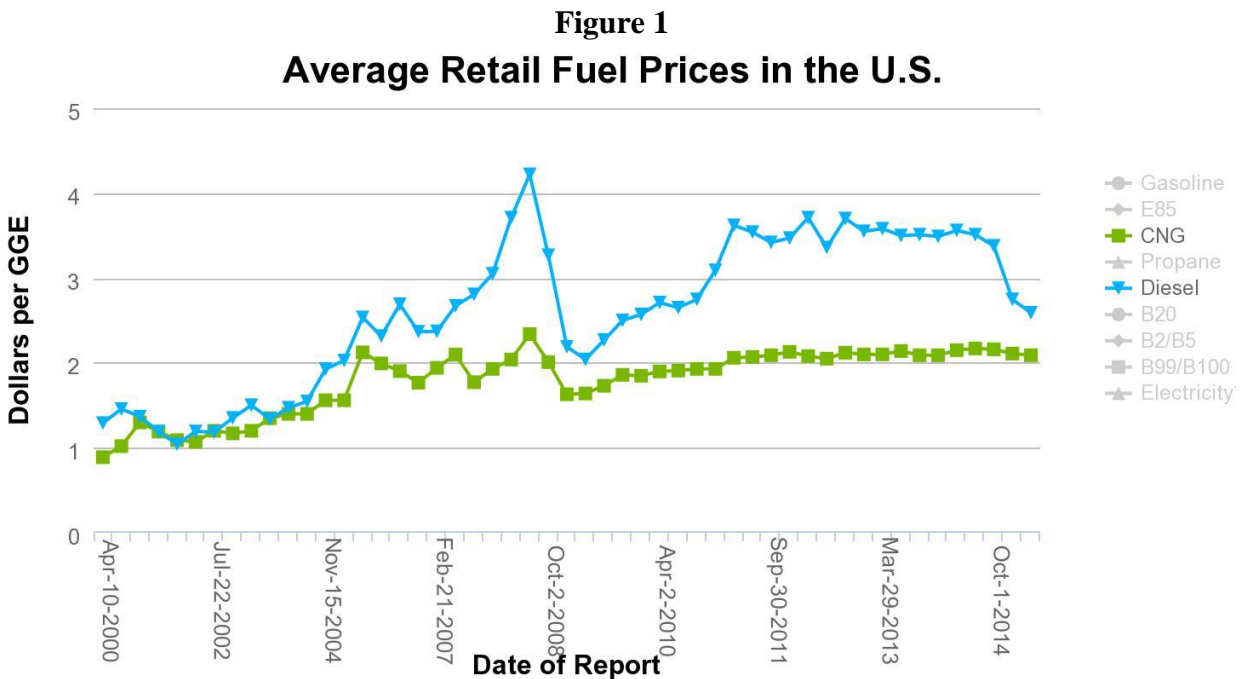
⁴ See www.arb.ca.gov/msprog/tech/presentation/lowernoxfuel.pdf.

⁵ See www.afdc.energy.gov/uploads/publication/cng_infrastructure_costs.pdf.

⁶ See www.afdc.energy.gov/fuels/prices.html.

⁷ See Table 12 at www.eia.gov/forecasts/aeo/tables_ref.cfm.

Overall, as documented above, there are substantial disadvantages associated with heavy-duty natural gas vehicles relative to diesel vehicles, and there is no technical basis that supports CARB's implied assumption that there will be a dramatic increase in the population of such vehicles. This conclusion is supported for the nation as a whole by EIA which forecasts little growth in the number of heavy-duty natural gas vehicles, and a decrease in the total amount of natural gas used by those vehicles over time.⁸ CARB's LCFS illustrative compliance scenarios are therefore based on arbitrary and unsupported speculation which is inconsistent with CARB's own analysis outside the LCFS rulemaking process and with EIA's analysis.



⁸ See Table 50 at www.eia.gov/forecasts/aeo/tables_ref.cfm.

Exhibit C to Declaration of James M. Lyons

Exhibit C

Impact of CARB's Flawed Assumption Regarding Natural Gas Use in Heavy-Duty Vehicles on CARB Illustrative Compliance Scenario

As described in Attachment B, it has only now become apparent that CARB's LCFS Illustrative Compliance Scenario envisioning dramatic growth in natural gas use by heavy-duty vehicles has no empirical or specific analytic basis. The available information shows now and has long shown that the only reasonable assumption is that there will be little or no growth in natural gas use in heavy-duty vehicles. Given this, it is important to understand the impact associated with correcting CARB's flawed assumptions for the Illustrative Compliance Scenario.

In order to perform this assessment, the May 22 Illustrative Compliance Scenario was used as the starting point, and CARB staff's assumptions regarding the use of conventional natural gas and renewable natural gas were corrected such that the total demand for natural gas remained at 110 million diesel gallon equivalents during the years 2015 through 2025. It was assumed that renewable gas would be used to the maximum degree feasible based on CARB's original forecast up to a maximum of 110 million diesel gallon equivalents. Diesel fuel was assumed to replace the reduced volume of natural gas relative to CARB's original assumptions.

In Table 1, the original May 22 diesel deficit and conventional and renewable natural gas credit volumes are compared to those resulting from the corrected assumptions described above. As shown, the corrected assumptions lead to reduced natural gas credits and increased diesel deficits, relative to the May 22 version.

Table 1
Calendar Year 2014-2025 Diesel Deficit and Natural Gas Credit Volumes
(Flawed vs. Corrected NG Use Assumptions)

	MMTs of Credits or Deficits											
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
	May 22 Scenario											
Diesel Deficits	-0.46	-0.45	-0.91	-1.57	-2.23	-3.33	-4.41	-4.30	-4.27	-4.23	-4.26	-4.29
Conv. Natural Gas Credits	0.19	0.15	0.10	0.09	0.07	0.05	0.01	0.01	0.01	0.01	0.01	0.01
Renewable NG Credits	0.18	0.50	0.66	0.85	1.22	1.54	2.01	2.53	2.88	3.23	3.58	3.93
Sum	-0.09	0.20	-0.15	-0.63	-0.94	-1.74	-2.39	-1.76	-1.38	-0.99	-0.67	-0.36
	May 22 Scenario - With Corrected Heavy Duty Natural Gas Assumptions											
Diesel Deficits	-0.46	-0.45	-0.92	-1.60	-2.30	-3.47	-4.65	-4.60	-4.62	-4.64	-4.72	-4.81
Conv. Natural Gas Credits	0.19	0.12	0.05	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Renewable NG Credits	0.18	0.50	0.66	0.85	1.03	0.99	0.96	0.96	0.96	0.96	0.96	0.96
Sum	-0.09	0.17	-0.20	-0.72	-1.27	-2.47	-3.69	-3.64	-3.66	-3.68	-3.76	-3.85

A similar comparison of total LCFS program credits and deficits as well as the total credit balance is provided in Table 2. As highlighted in Table 2, with the corrected assumptions, the credit surpluses forecast by CARB for the years 2021 to 2025 become deficits indicating that compliance with the LCFS regulation would not occur. Therefore, CARB's conclusion that compliance with the LCFS regulation is demonstrated by the May 22 version of the Illustrative Compliance Scenario is incorrect and has no empirical or analytical support in the rulemaking file.

CARB staff could try to formulate other Illustrative Compliance Scenarios that demonstrate compliance based on other assumptions, which would likely include greater use of biodiesel in heavy-duty vehicles. However, use of these different assumptions would require revisions to CARB staff's environmental and economic analyses, which should be made available for public review and comment.

Table 2
Calendar Year 2014-2025 LCFS Program Credits and Deficits
(Flawed vs. Corrected NG Use Assumptions)

	MMTs of Credits or Deficits											
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
	May 22 Scenario											
Total Credits	4.12	5.71	9.00	10.65	12.10	13.09	14.29	17.08	19.08	21.08	22.78	24.44
Total Deficits	-2.35	-2.31	-6.75	-8.68	-11.43	-15.99	-20.38	-19.87	-19.43	-19.02	-18.65	-18.31
Total Credit Balance	4.76	8.16	10.40	12.37	13.04	10.14	4.05	1.26	0.90	2.97	7.10	13.23
	May 22 Scenario - With Corrected Heavy Duty Natural Gas Assumptions											
Total Credits	4.12	5.67	8.95	10.58	11.83	12.49	13.23	15.50	17.15	18.80	20.15	21.46
Total Deficits	-2.35	-2.31	-6.76	-8.71	-11.49	-16.12	-20.62	-20.16	-19.78	-19.42	-19.11	-18.82
Total Credit Balance	4.76	8.12	10.31	12.18	12.52	8.89	1.50	-3.16	-5.80	-6.42	-5.37	-2.74

Exhibit A to Declaration of Thomas L. Darlington

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

CALIFORNIA AIR RESOURCES BOARD

DECLARATION OF THOMAS L. DARLINGTON

I, Thomas L. Darlington, declare as follows:

1. I am an engineer with training and expertise in lifecycle emissions analysis, the use of models to estimate lifecycle emissions and to attribute emissions to the production, distribution and use of various fuels, and use of regulations to control mobile-source emissions. My areas of expertise also include land-use change (“LUC”) modeling and the application of econometric models to attributional and consequential lifecycle emissions analysis. Following my graduation from the University of Michigan in 1979, I served for eight years as an Engineer and Project Manager at the United States Environmental Protection Agency’s Motor Vehicle Emissions and Fuels Laboratory in Ann Arbor, Michigan. Thereafter I worked at Detroit Diesel Corporation and General Motors Corporation, and as the Director of Mobile Source Programs at Systems Application International. I am the President of Air Improvement Resource (“AIR”), a company formed in 1994 to provide mobile source emission modeling to government and industry. A copy of my CV is attached to this Declaration as Exhibit “A.”

2. I have participated on behalf of renewable fuels producers in the public consultation and rulemaking processes at the California Air Resources Board (“ARB” or “the Board”) to consider, adopt and revise the low-carbon fuel standard (“LCFS”) regulation since 2008. I testified at the Board’s February 2015 hearing concerning proposed amendments to the LCFS regulation. I am fully familiar with the models released by CARB to establish and implement the LCFS regulation, including the versions of the Global Trade Analysis Project (“GTAP”) modeling systems used by CARB or proposed for use by the CARB staff as part of the current and proposed LCFS regulation.

3. I make this Declaration based upon my personal knowledge, my training and expertise, and my familiarity with the subjects that I address here.

A. Overview of LCFS Regulation’s Treatment of Price-Yield Elasticity

4. The price-yield elasticity is an important parameter used in the GTAP model¹ to estimate the magnitude of land use changes in response to biofuel expansion. The price-yield elasticity is a measure of the change in yield with a change in price of a commodity. A price-yield elasticity of 0.25, therefore means that if corn prices increase by 1%, corn yield would be expected to increase by 0.25%. The increase in yield is brought

¹ GTAP stands for Global Trade Analysis Project, which is the model ARB uses to develop the land use impacts of biofuels.

about by producers using seed types that are resistant to drought and disease, more intensive planting, possibly more fertilizer, irrigation, and other methods.

5. The increase in investment by producers to achieve a higher yield is justified by the increase in the prices the producer will obtain for the crop. In GTAP, the predicted increase in prices is a result of “shocking” the model with increased demand for feedstocks for biofuels. When the model is shocked with this increase in demand, the model responds by simulating an increase in price of various commodities. This in turn leads to some crop switching (to biofuel feedstocks), higher yields on existing land (due to the YPE elasticity) and conversion of pasture and, to a much lesser extent, forest to cropland.²

6. In GTAP, the price-yield parameter (or elasticity) is referred to as YDEL; ARB refers to it as YPE. ARB used five different price-yield elasticities in its analysis of land-use emissions (0.05, 0.1, 0.175, 0.25, and 0.35) for all biofuels.³ The average of these five values is 0.185.

7. To select these five levels, ARB relied on (1) input from the expert working group (EWG) on elasticities, (2) its own review of various price-yield studies, and (3) a report by David Rocke reviewing some price-yield studies.⁴ While the Rocke report was provided by ARB with the ISOR, the data Rocke relied upon to critique one of the studies, the Perez study, was not provided by ARB for review until August 1, 2015.

8. ARB’s comments on the Rocke study appear at the end of Attachment 1 to Appendix I of the ISOR. Appendix I discusses the land use emissions estimated by ARB, and Attachment 1 discusses ARB’s method for determining YPE values to use in estimating land-use emissions. ARB’s summary of the Rocke report is below:

Staff contacted with David Rocke from the University of California, Davis to perform a statistical analysis of the data used by some of the researchers in Table 1-2. David reviewed analysis (and data where available) for Goodwin et al, Perez, and Berry and Schlenker and additional studies and concluded based on methodologically sound analyses, yield price elasticities are small to zero.

9. Since ARB relied on Rocke’s review of recent studies in selecting YPE values, we reviewed Rocke’s analysis of the Perez data, and his review of the other studies. In this report, we will show that:

- (i) ARB’s Elasticity Values Expert Working Group (EWG) recommended a mid-point value of 0.25, not 0.185.

² In the real world, fallow or idled lands are also converted to crops resulting in little real land use change. However, GTAP currently does not currently model the conversion of idle or fallow land.

³ Table I-4, Appendix I, Detailed Analysis for Indirect Land Use Change, Initial Statement of Reasons, ARB.

⁴ *Statistical Issues Related to the Low-Carbon Fuel Standard*, David M. Rocke, PhD, October 31, 2014, under contract 13-405 (2014).

- (ii) ARB arbitrarily relied on the Rocke study to select a range of YPE values and a mid-point that were significantly lower than what the EWG recommended.
- (iii) The Rocke study critically evaluated another study, the Perez study that derived a price yield value of 0.29, which supports the EWG recommendation to ARB.
- (iv) The Rocke study used only part of the Perez data to attempt to duplicate Perez's results. Since the Perez results were not duplicated by Rocke's analysis of the Perez data, Rocke assumed that Perez's results were inappropriately determined. Rocke's analysis constitutes bad modeling practice, is inconsistent with ARB's modeling methodologies used in connection with other regulations, and is unsupported by the evidence in the Perez study.
- (v) Emissions associated with indirect land use change for biofuels are significantly greater (i.e., 15% higher for corn ethanol) with a central YPE value that ARB chose of 0.185 than with the 0.25 that EWG recommended.

Each of these aspects is discussed further below. As an initial matter, however, it is important to be clear that the time allowed for comment on the new material placed in the docket is not sufficient to prepare all the analysis that could and should be possible in a regular 30- or 45-day comment period. For example, now that the limitations of the Rocke study are known, including the fact that Rocke relied on only a very limited set of the Perez data, stakeholders should be permitted time to conduct studies that use the best available scientific data to assess the relationship between price and yield, and to submit a full price-yield analysis to CARB for consideration in the current rulemaking. AIR has done what is possible in the limited time allowed, but does not understand why it has taken until August 2015 to provide materials that were requested in the fall of 2014. AIR's ability to comment has been limited and prejudiced by this delay.

**B. ARB's Elasticity Values Expert Working Group (EWG)
Recommended a Mid-Point Value of 0.25, not 0.185**

10. The EWG's summary recommendation on price-yield is as follows:

It is not clear if GTAP can assign different elasticities to different crops in different countries. If not then if the long-run price-yield elasticity not accounting for double-cropping is set at 0.175, and if South America and the United States are the countries that contribute the most incremental commodity production in response to higher prices, *then a mid-point value of 0.25 for the price-yield*

elasticity seems reasonable (emphasis added). If differentiation can occur by country, then setting the price-yield elasticity to 0.175 for countries with no double cropping, 0.25 for the U.S. and 0.30 for Brazil and Argentina will provide a more reasonable approximation to reality.”⁵

When ARB varied price-yield, they did this variation for all countries simultaneously, (i.e., they did not utilize separate values for the US and Brazil/Argentina). Thus, the EWG recommendation is clear – the central, or average value used in land use modeling, if regional-specific values are not used, should be 0.25.⁶

C. ARB Arbitrarily Relied on the Rocke Study to Select a Range of YPE Values and a Mid-Point that Were Significantly Lower Than What the EWG Recommended

11. ARB’s Attachment 1 to Appendix I contains a discussion of the EWG recommendations, the Rocke report, and other recent YPE research. ARB summarizes the recent research in the table below, which is taken directly from Attachment 1 of Appendix I of the ISOR.

⁵ *Final Recommendations from the Elasticity Values Subgroup*, ARB LCFs Expert Workgroup, <http://www.arb.ca.gov/fuels/lcfs/workgroups/ewg/010511-final-rpt-elasticity.pdf>

⁶ In Attachment 1 to Appendix I of the ISOR, ARB quotes the EWG report statement “perhaps a reasonable increment to the short-run elasticity to account for long-run response is 0.05, which brings the average value between 0.10 to 0.25.” This seems to support the ARB-selected central value of 0.185. However, the quote is followed by a paragraph where the EWG discusses the impacts of double-cropping on its YPE recommendation. Thus, the range of “between 0.10 to 0.25” was not the EWG’s final recommendation on YPE, as the final recommendation is given two paragraphs later. Additionally, the GTAP model ARB used to model land use emissions is capable of having separate price-yield elasticities by region, so ARB could have adopted the EWG recommendation to utilize 0.25 for the US, 0.30 for Brazil/Argentina, and 0.175 for all other countries.

Table 1-2. Updated Literature Estimates of YPEs				
Authors	Period	Elasticity	Crop	Data, Method
Huang and Khanna	1977-2007	0.15	U.S. corn, soybean, wheat	County level data, instrumental variable (IV)
Smith and Sumner	1961-2005	Negative and Significant	U.S. corn	County level data, ordinary least squares (OLS)
Berry and Schlenker	1961-2009	0.1, Net	U.S. corn	Country level data, instrumental variable
Goodwin, et al	1996-2010	0.01 short run, 0.19-0.27 long run	Iowa, Illinois, Indiana Corn	Ordinary least squares
Perez	1960-2004	0.29	Iowa corn and soybeans	Duality-Bayesian

12. The first three studies appear to support low YPEs. The last two studies support the EWG recommendation of a central value of 0.25. With regard to the Smith and Sumner study, ARB notes that it is “a work in progress.”⁷ It is also worth noting that none of these studies evaluate double-cropping. Double- or multiple-cropping, is the common practice of planting more than one crop on the same land in the same year. Researchers use higher values of YPE to simulate double- or multiple-cropping.

13. ARB contracted with Rocke to evaluate the last three studies (Berry and Schlenker, Goodwin, and Perez). ARB summarized Rocke’s conclusions:

David (Rocke) reviewed analysis (and data where available) for Goodwin et al, Perez, and Berry and Schlenker and additional studies, and concluded that based on methodologically sound analyses, yield price elasticities are generally small to zero.⁸

14. ARB’s conclusion in Attachment 1 to Appendix I is as follows:

Taking all these (issues) into consideration, and with a wide range of likely values for YPE from published literature, staff used a range of values between 0.05 and 0.35 to conduct scenario runs for all biofuels studied for the LCFS. These input values are used for all

⁷ See footnote 55 of Attachment 1 to Appendix I of the ISOR.

⁸ Appendix I to ISOR, Attachment 1-5.

crops and regions for the 30 scenario runs conducted for each of the 6 biofuels.⁹

15. ARB failed to inform the public that its central or average value was 0.185, or 26% less than the EWG recommendation. ARB clearly relied on the Rocke analysis to select a central value that was less than the EWG recommendation.

D. The Rocke Study Critically Evaluated Another Study, the Perez Study, that Derived a Price Yield Value of 0.29, that Supports the EWG Recommendation to ARB

16. While Rocke reviewed all three studies, he only obtained and analyzed data from one study – the Perez study.¹⁰

The data were used in a 2012 dissertation of Juan Francisco Rosas Perez. In these works, the price elasticity of yield was estimated from data on corn (maize) in Iowa for 1960-2004, and was said to be in the range of 0.29. The data set was publicly available so it was used for a re-analysis. The analysis used by Perez was complex, and can be criticized for insufficiently handling autocorrelation in the series. Therefore, a simpler analysis was conducted that should have similar results to the more complex analysis if the latter is not flawed.¹¹

17. Rocke performed time-series regressions of corn supply in a given year by corn price in that year, by corn supply in the previous year, and by corn price in the previous year. Rocke used the log of these variables in his regressions, apparently on the premise that the coefficient for price (either the current year or the previous year) would provide a measure of YPE. Rocke failed to find a relationship between yield and price in either the current or previous year. As noted above, Rocke attributes Perez' finding of a YPE of 0.29 to Perez insufficiently handling autocorrelation. Autocorrelation is the concept of supply in the current year being somewhat dependent on supply in the previous year rather than on other factors such as price.

18. In his final statement in the report for ARB, Rocke states:

As documented in Berry (2011), Berry and Schlenker (2011) and Roberts and Schlenker (2013), much of the literature providing purported estimates of the price elasticity of yield is deeply methodologically flawed. In addition to the problems of endogeneity and autocorrelation that are badly handled, there are other important issues. In Goodwin et al, for example, 15 years of data are multiplied into 405 datapoints by considering 27 different districts. But there

⁹ Attachment 1 to Appendix I, 1-6.

¹⁰ *Essays on the environmental effects of agricultural production*, Juan Francisco Rosas Perez, Iowa State University (2012). Graduate These and Dissertations. Paper 12737. [http://lib/dr.iastate.edu.etc](http://lib.dr.iastate.edu.etc).

¹¹ Rocke, page 5.

are still only 15 price values and it is hard to believe that the strong relationships of weather, price, and technology within a given year can be handled by econometric tricks. The analyses, such as those by Roberts and Schlenker (2013) that are methodologically sound all show small to zero price elasticities of yield.¹²

In other words, Roche dismisses both Goodwin and Perez as methodologically unsound.

19. We repeated Roche's simplified analysis of the Perez data. We were able to replicate Roche's results, using two different statistical packages, in order to establish our ability to work with Roche's methods. We did not have adequate time to replicate Perez's analysis. Fundamentally, price-yield elasticity cannot be properly estimated with ordinary least squares (OLS) regressions of current price, last year's price, the current supply, and last year's supply only (i.e., the Roche simplified analysis). Such a narrowly focused analysis is unreliable and is an indefensible modeling practice, and it is not a practice that ARB relies on in other analyses it performs.¹³ There are too many other factors influencing yield (supply) that should be accounted for in a reliable prediction model.

E. The Roche Study Only Used Part of the Perez Data to Attempt to Duplicate Perez's Results

20. In his 2012 dissertation entitled "Essays on the Environmental Effects of Agricultural Production," Juan Francisco Rosas Perez describes his complex, multi-faceted agricultural prediction system. The mechanics, mathematical, and statistical components of this system cannot be fully addressed in this report, given the limited time since its relevance to the Roche work and the relevant content of the dissertation have become available and known. Nevertheless, in brief: Perez's model is designed to estimate the impact on supply (and under his assumptions the underlying yield) in relation to a wide range of related parameters. The estimated yields can be determined for corn, soybeans, other crops, and livestock products.

21. The related parameters used by the Perez model are divided into two categories, "inputs," which are usually more time dependent and variable, and so-called "netputs," which are usually more stable. The inputs category includes the quantities and prices for fertilizer, hired labor, and intermediates. The broad intermediate parameters cover seeds, pesticides, energy (petroleum fuels, natural gas, and electricity), and other

¹² Roche, page 6.

¹³ ARB's Predictive Model for gasoline is a good example of the modeling practices that ARB relies on (see www.arb.ca.gov/fuels/gasoline/premodel/premodel.htm.) The Predictive Model estimates emissions from cars and trucks in response to a number of gasoline inputs, including sulfur, benzene, T50, T90, aromatics, olefins, volatility, and total oxygen. All of these inputs are recognized to influence vehicle emissions to varying degrees. If ARB were to analyze the emissions data focusing on only one of these fuel parameters at a time, it would likely find certain fuel parameters to be statistically insignificant. ARB did not do that; it analyzed all of the input parameters that affect emissions simultaneously in creating the Predictive Model. Similarly, ARB should, in determining the impact of price on yield, not rely on analyses that examine only price impacts on yield, but rely on studies that attempt to model as many factors as possible on crop yields.

purchased intermediate inputs (contract labor services, custom machine services, machine and building maintenance and repairs, and irrigation). The “netputs” category includes agricultural capital, Conservation Reserve Program (CRP) land, family labor, farmland, and farm related output. In his analysis, Perez obtained data from 1960-2004 and transformed it to fulfill the requirements of his model.

22. The results of Perez’s model are summarized in the table below, which was taken directly from his report. As can be seen, the elasticity of corn yield to corn price ranges from 0.14 to 0.53, with a median of 0.29.

Table 9. Corn yield elasticities with respect to selected prices and quantities.

	Lower bound	Median	Upper bound
Elasticity of corn yields with respect to:			
Corn price	0.14	0.29	0.53
Hired Labor price	-0.29	-0.12	0.01
Intermediate Inputs price	-0.43	-0.15	-0.01
Fertilizer price	-1.09	-0.17	0.04
Hired Labor quantity	0.000	0.190	0.461
Intermediate Inputs quantity	0.412	0.420	0.429
Fertilizer quantity	0.413	0.422	0.431

Note: Lower and upper bounds represent extremes of the 95% highest probability interval of the marginal posterior density function of each elasticity.

23. Clearly the Perez analysis takes into account many more factors affecting yield than Roche’s simple analysis of only a small part of the Perez data. The fact that Roche’s simple analysis using incomplete data failed to confirm the Perez results does not negate the Perez results. The Perez results also fall in line with the Goodwin et al results. Goodwin et al performed a detailed analysis similar to Perez, where many factors affecting yield were included in the prediction model.

24. Regarding Roche’s criticism of Perez insufficiently handling autocorrelation, Perez does address this issue in the dissertation:

We assume there is no autocorrelation within equations, but that there is a contemporary correlation among the equation errors. The assumption of autocorrelation absence arises from the fact that, prior to the estimation, we take pseudo-differences of the time-series to remove serial autocorrelation found in the time series.¹⁴

¹⁴ Perez, page 100.

Either Roche failed to read this part of the dissertation, or he did read it and disagreed with how Perez handled autocorrelation. In either case, Roche does not explain in his report for ARB what is wrong with how Perez handled autocorrelation.

25. Roche's simple analysis, using only some of the Perez data, is not supported by the evidence, and does not negate the Perez results. ARB's reliance on Roche's evaluation of the Perez data in selecting price yield values is misplaced. If CARB does not agree with our position on Roche's analysis, it should explain why, in full detail, and provide us and other stakeholders an adequate opportunity to respond before taking final action on the LCFS regulatory proposal. In particular, CARB should address the following issues:

- Whether ARB believes Roche's very limited analysis of price and supply data alone constitutes an adequate analysis of the Perez data, when ARB's own methods of analyzing data are much more robust than Roche's;
- Why ARB deviated from the EWG recommendation of 0.25 for a central value or average value for YPE; and
- What exactly was wrong with how Perez handled autocorrelation in his analysis.

F. LUC Emissions For Biofuels Are Significantly Greater With a Central YPE Value of 0.185, as Opposed to the 0.25 Recommended By the EWG

26. Emissions attributed to LUC for biofuels are significantly higher, and will be overestimated, with a YPE value of 0.185 than with 0.25.

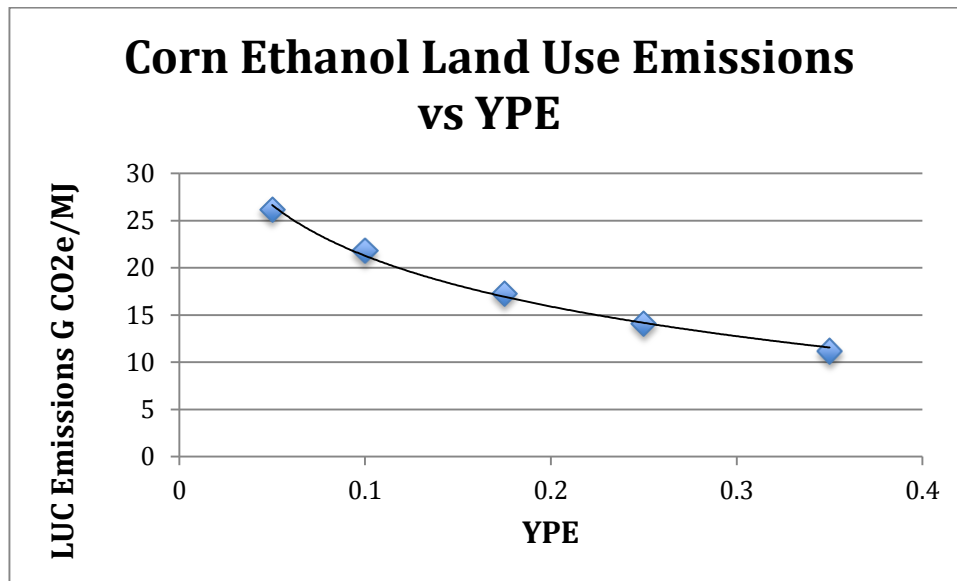
27. AIR has run the GTAP model that ARB uses to estimate land use change emissions for various biofuels. We were able to replicate many of ARB's land use emission outputs, in order to establish our ability to work with ARB's model.

28. ARB ran 30 different GTAP scenarios for each biofuel to estimate LUC emissions. The LUC emissions were estimated as the average of the 30 unique scenarios. For corn ethanol, ARB's average of the 30 scenarios is 19.8 gCO₂/MJ of ethanol. In each of these scenarios, ARB varied several input elasticities, including the price-yield elasticity and two other elasticities. As indicated earlier, there are five input price-yield elasticities, and the average of these is 0.185, which is lower than the central value of 0.25 recommended by the EWG. To do this correctly, one would have to select five price-yield elasticities whose average is 0.25. One possibility—and one that CARB should either use, or justify not using—would be to select the following elasticities: 0.15, 0.20, 0.25, 0.30, and 0.35.¹⁵ These would be used in place of the current price-yield elasticities, and the input elasticities of the other two inputs would remain the same. The 30 scenarios should

¹⁵ There are many other price-yield elasticities that would average 0.25; this is only one example.

then be re-run and new average emissions would be estimated from the new GTAP runs. This average value would then be compared to the 19.8 gCO₂/MJ.

29. To illustrate the impact of the price-yield parameter on corn ethanol land use emissions, we provide a chart below which uses ARB's estimate of corn ethanol land use emissions at the five different YPE values. This chart uses scenarios 2, 4, 6, 8, and 10 in ARB's Table I-4. The other elasticities were held constant in these scenarios; only YPE was altered.



30. The chart shows the high degree of sensitivity of land use emissions for corn ethanol to this input parameter. Small changes in the range and average of YPE values chosen for this analysis are important in estimating land use emissions from biofuels.

31. The time allowed for comments on the Rocke report did not allow running 30 new scenarios. Instead, we ran just two scenarios; one using the ARB average inputs, and a second one using 0.25 for price-yield and the average inputs for the other two elasticities. These two scenarios are shown in Table 1. Given the time constraints, we assume that the difference in these two scenarios will approximate the difference between the two averages of 30 scenarios. The actual differences could be either greater or lesser than estimated here.

Table 1. Scenarios Used to Estimate Impact of Difference Between EWG Recommendation and ARB Price-Yield				
Scenario	Price-Yield	PAEL	ETA	Irrigation Constraint
1 – EWG price yield, ARB average for all other	0.25	0.3/0.15	Baseline	On
2 – ARB average	0.185	0.3/0.15	Baseline	On

PAEL = yield elasticity target for cropland/pasture

ETA = elasticity of effective area with respect to harvested area

32. The land use emissions we obtained for these two scenarios are shown in Table 2. We have used ARB's latest AEZ-EF model with GTAP to estimate emissions for these two scenarios. The corn ethanol LUC emissions difference is 2.5 g CO₂/MJ. Therefore, we would expect that if the 30 scenarios were actually run for both cases, the difference in the averages of the 30 scenarios would be close to 2.5 g/MJ; however, it could be higher because Scenario 2, which represents average ARB inputs, is 17.14 gCO₂e/MJ, and the average of the 30 scenarios for corn ethanol is higher at 19.8 gCO₂e/MJ.

Table 2. Corn Ethanol LUC Emissions (gCO₂e/MJ)	
Scenario	LUC Emissions
1 – EWG	14.64
2-ARB	17.14
Difference (2-1)	2.50 (15%)

ARB's corn ethanol land use value is 19.8 gCO₂e/MJ. If the emissions of the 30 scenarios run with new YPE values with an average of 0.25 are 2.5 gCO₂/MJ lower, then the new corn ethanol land use value would be 17.3 gCO₂e/MJ.

33. There would be corresponding changes in all biofuels if ARB adopted the EWG central value of 0.25 for price-yield. In addition, the baseline carbon intensities for 2016-2020 would also change, as well as the annual targets, because 10% corn ethanol is included in the baseline 2016-2020 values.

I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct.

Executed this 17th day of August, 2015 in Holland, Michigan.



Thomas L. Darlington

Exhibit A to Declaration of Thomas L. Darlington

Thomas L. Darlington
President, Air Improvement Resource Inc.

Profile

Thomas L. Darlington is President of Air Improvement Resource, a company formed in 1994 specializing in mobile source emission modeling. He is an internationally recognized expert in mobile source emissions modeling, lifecycle analysis, and land use modeling.

Professional Experience

1994-Present	President, Air Improvement Resource
1993-1994	Director, Mobile Source Programs, Systems Application International
1989-1994	Senior Engineer, General Motors Corporation, Environmental Activities
1988-1989	Senior Project Engineer, Detroit Diesel Corporation
1979-1988	Project Manager, U.S. EPA, Ann Arbor, Michigan

Recent Major Projects

- Developed Life Cycle reports and complete applications for 8 plants for the California Low Carbon Fuel Standard; six are currently registered, two plants are pending. Five plants were corn ethanol plants, one is sorghum and two are cellulose.
- Participated in and provided written comments on ARB's three 2014 iLUC workshops
- With Purdue and Don O'Connor, conducted study of iLUC emissions of rapeseed and other oilseeds in 2013 utilizing an updated version of GTAP
- Reviewed EPA's palm oil iLUC emissions in 2013
- Submitted comments on ARB's new GREET2.0 model
- Reviewed CARB's land use emissions for soybean biodiesel
- Reviewed the land use impacts of the RFS2 from EPA, including the notice of Proposed Rule, Regulatory Impact Analysis, and approximately one hundred documents in the rulemaking docket.
- Completed a land use study for Renewable Fuels Association and reviewed California Air Resource Board's Initial Statement of Reasons for the Low Carbon Fuel Standard
- Represented three stakeholders in the recent development of the ARB Predictive Model for reformulated gasoline in California (Alliance of Automobile Manufacturers, Renewable Fuels Association and Western States Petroleum Association)
- Represented two stakeholders in EPA's development of the MOVES on-highway emissions model (Alliance of Automobile Manufacturers and Engine Manufacturers Association)

- Developed the effects of ethanol permeation on on-highway and off-highway mobile sources in California and other states for the American Petroleum Institute
- Studied gasoline and diesel fuel options for Southeast Michigan (for SEMCOG, API and Alliance of Automobile Manufacturers)

Recent Publications

“Study of Transportation Fuel Life Cycle Analysis: Review of Economic Models Use to Assess Land Use Effects”, CRC-E-88-3, July 2014.

“Land Use Change Greenhouse Gas Emissions of European Biofuel Policies Utilizing the Global Trade Analysis Project Model”, Darlington, Kahlbaum, O’Connor, and Mueller, August 30, 2013.

“A Comparison of Corn Ethanol Lifecycle Analyses: California Low Carbon Fuels Standard (LCFS) Versus Renewable Fuels Standard (RFS2)”, June 14, 2010. Renewable Fuels Association and Nebraska Corn Board. This study compared and contrasted the corn ethanol lifecycle analyses performed by both CARB (as a part of the LCFS) and the EPA (as a part of RFS2).

“Review of EPA’s RFS2 Lifecycle Emissions Analysis for Corn Ethanol”, September 25, 2009. Conducted for Renewable Fuels Association. This study reviewed EPA’s land use GHG emissions assessment for corn ethanol, including the FASOM and FAPRI models and Winrock land-use types converted and emission factors by ecosystem type. The study made many recommendations for improving the land-use and emissions modeling.

“Review of CARB’s Low Carbon Fuel Standard Proposal”, April 15, 2009. Conducted for Renewable Fuels Association. This study reviewed CARB’s analysis of land use emissions using GTAP6 and CARB’s overall lifecycle emissions for corn ethanol. This study made many recommendations for improving the land use and lifecycle emissions of corn ethanol.

“Emission Benefits of a National Clean Gasoline”, August 2008. Conducted for the Alliance of Automobile Manufacturers. This study evaluated the nationwide criteria pollutant emission reductions of a national clean gasoline standard.

“Land Use Effects of Corn-Based Ethanol”, February 25, 2009. Conducted for Renewable Fuels Association. This study evaluates possible land use changes and GHG emissions associated with these land use changes as a result of the renewable fuel standard mandated 15 billion gallons of corn ethanol required by calendar year 2015. The study utilized projections of land use in the US and rest of world performed by Informa Economics, LLC, as well as newer estimates of the land use credits of co-products produced by ethanol plants to evaluate possible land use changes.

“On-Road NOx Emission Rates From 1994-2003 Heavy-Duty Trucks”, SAE2008-01-1299, conducted for the Engine Manufacturers Association. This study examined

manufacturers consent decree emissions data to determine on-road NO_x emission rates, and deterioration in emissions from heavy-duty vehicles. (Peer reviewed publication)

“Evaluation of California Greenhouse Gas Standards and Federal Energy Independence and Security Act - Part 2: CO₂ and GHG Impacts”, SAE2008-01-1853, conducted for the Alliance of Automobile Manufacturers. This paper evaluated the comparison of greenhouse gases from cars and light trucks in the US under both the Federal and California GHG policies. (Peer reviewed publication)

“Effectiveness of the California Light Duty Vehicle Regulations as Compared to Federal Regulations”, June 15, 2007. Conducted with NERA Economic Consulting and Sierra Research for The Alliance of Automobile Manufacturers. This study compares the emission benefits of the California and Federal light duty vehicle regulations for HC, CO, NO_x, PM, SO_x, and Toxics taking into account the difference in emission standards, new vehicle costs and its effect on fleet turnover, new vehicle fuel economy and its effect on vehicle miles traveled, and other factors. Both the EPA MOBILE6 and ARB EMFAC on-road emissions models were used to estimate changes in emissions inventories.

“The Case for a Dual Tech 4 Model Within the California Predictive Model”, May 20, 2007. Conducted with ICF International and Transportation Fuels Consulting for the Renewable Fuels Association (RFA). This study developed separate emissions vs fuel property models for lower and higher Tech 4 (1986-1995) vehicles, and showed that utilizing this alternative Predictive Model would result in a higher compliance margin for fuels containing higher volumes of ethanol. It was thought that this could lead to higher ethanol concentrations in the state, but even if the dual model is not used, it is a better representation of the 2015 inventory than the ARB single model.

“Updated Final Report, Effects of Gasoline Ethanol Blends on Permeation Emissions Contribution to VOC Inventory From On-Road and Off-Road Sources, Inclusion of E-65 Phase 3 Data and Other Updates”, June 20, 2007. Conducted for the American Petroleum Institute. This report updates the earlier March 3, 2005 report for API utilizing data collected by CRC and others since of the time of the earlier report.

Final Report, Development of Technical Information for a Regional Fuels Strategy, February 28, 2006. Conducted for the Lake Air Directors Consortium (LADCO). This report provided guidance to the LADCO states (Midwestern states) concerning how to model different types of fuel control programs (in particular) using EPA mobile source models, and how to set up the baseline input files so that results are consistent between the different states.

“Emission Reductions from Changes to Gasoline and Diesel Specifications and Diesel Engine Retrofits in the Southeast Michigan Area”, February 23, 2005. Conducted for the Southeast Michigan Council of Governments (SEMCOG), the Alliance of Automobile Manufacturers, and the American Petroleum Institute. This study examined the on-road and off-road emission benefits of many different possible gasoline and diesel fuel

specifications that the state could adopt to help meet the 8-hour ozone standards. This study formed the basis for the state's move to lower RVP summer gasoline.

"Examination of Temperature and RVP Effects on CO Emissions in EPA's Certification Database, Final Report", CRC Project No. E-74a, April 11, 2005. Conducted for the Coordinating Research Council. This study compared CO vs temperature results from the MOBILE6 model to the certification data, and recommended further testing, which is being conducted by the CRC at this time.

"Effects of Gasoline Ethanol Blends on Permeation Emissions Contribution to VOC Inventory From On-Road and Off-Road Sources" March 3, 2005. Conducted for the American Petroleum Institute (API). Using data from the CRC-E-65 program, and data collected by the California EPA and Federal EPA, this study estimated the impacts of ethanol use on increasing permeation VOC emissions from on-road vehicles, off-road equipment and vehicles, and from portable containers. Emission inventory estimates were made for a number of geographical areas including the state of California, and results showed that the permeation effect increases anthropogenic VOC inventories by 2-4%.

Review of EPA Report "A Comprehensive Analysis of Biodiesel Impacts on Exhaust Emissions", February 11, 2003. Conducted for the American Petroleum Institute. This study critically examined the methods that EPA used to develop the impacts of biodiesel fuels on HC, CO, NOx, and PM emissions.

"Well-To Wheels Analysis of Advanced Fuel/Vehicle Systems – A North American Study of Energy Use, Greenhouse Gas Emissions, and Criteria Pollutant Emissions", May 2005. Conducted for General Motors Corporation, with Argonne National Labs. This study examined many different well to wheels pathways for various fuels, and their impacts on GHG and criteria pollutant emissions.

"Potential Delaware Air Emission Impacts of Switching From MTBE to Ethanol in the Reformulated Gasoline Program", May 26, 2005. Conducted for Lyondell Chemical Company. This study examined the HC, CO, and NOx impacts of switching from MTBE to ethanol.

"Potential Massachusetts Air Emission Impacts of Switching From MTBE to Ethanol in the Reformulated Gasoline Program" June 17, 2005. Conducted for Lyondell Chemical Company. This study is similar to the Delaware study above.

"Potential Maryland Air Emission Impacts of a Ban on MTBE in the Reformulated Gasoline Program", October 18, 2005. Conducted for Lyondell Chemical Company. This study is similar to the Delaware study above.

"MOBILE6.2C with Ethanol Permeation and Ethanol NOx Effects", February 8, 2005. Conducted for Health Canada. This study modified the MOBILE6.2C model for ethanol permeation VOC and ethanol NOx effects.

Education

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