Comments to the California Air Resources Board by the Clean Air Task Force

On the Proposed Re-Adoption of the Low Carbon Fuel Standard

February 17, 2015

SUMMARY

The Clean Air Task Force (CATF) appreciates this opportunity to comment to the California Air Resources Board on the Low Carbon Fuel Standard (LCFS). CATF is a nonprofit organization that works to help safeguard against the worst impacts of climate change by catalyzing the rapid global development and deployment of low carbon energy and other climate-protecting technologies through research and analysis, public advocacy leadership, and partnership with the private sector.

Our comments focus on the following points:

- ARB should readopt the LCFS through 2020. Achieving compliance with the 2020 target will be difficult, but the LCFS remains the most promising policy tool available for reducing the climate impacts of the transportation sector.
- The LCFS's promise is undermined by the proposed adjustment to the lifecycle emissions for corn ethanol, and by the likelihood that regulated entities will increase their reliance on corn ethanol to meet LCFS targets.
- The proposed adjustment to corn ethanol's lifecycle emissions score rewards corn for its negative impact on global food security. ARB must acknowledge and address this issue before it erodes the legitimacy of the LCFS program.
- The prospects for deep reductions in transportation sector GHG emissions are likely to improve significantly after 2020, particularly if liquid ammonia's potential as an affordable low-carbon fuel is proven out.

READOPTION OF THE LCFS

Consistent with an order issued by the California Court of Appeals in *POET, LLC v. California Air Resources Board*, 218 Cal.App.4th 681 (2013), ARB staff has reviewed and revised the LCFS, and is now

> proposing that the Board re-adopt the LCFS, replacing the current LCFS regulation in its entirety. The proposed LCFS regulation will maintain the basic framework of the current LCFS regulation, including: declining carbon intensity targets; use of life cycle analyses; inclusion of indirect land use change effects;

quarterly and annual reporting requirements; and credit generation and trading.[1]

CATF urges the Board to readopt the LCFS. California's LCFS is the country's most promising public policy for bringing low-C fuels into the transportation market. It has several key attributes, all of which positively differentiate it from the federal Renewable Fuel Standard (RFS):

- Dynamic requirements: Increasingly stringent annual reduction requirements dissuade regulated entities from investing in marginally effective compliance strategies.
- Dynamic analyses: There are important ongoing debates about the performance of lifecycle GHG analyses—both with respect to specific technologies and their overall effectiveness. Regular reanalysis of compliance strategies prevents "lock-in" of outdated analyses and ineffectual technologies.
- No grandfathering: Under the LCFS, compliance options are measured according to their performance. Under the RFS, corn ethanol—which is largely exempt from the program's GHG reduction requirements—accounted for 83% of the overall volume mandate finalized by the Environmental Protection Agency (EPA) in 2013, the most recent year in which final renewable volume obligations were issued by EPA.
- Not limited to biofuels: Climate change mitigation depends on strategies that are scalable. That poses a problem for biofuels: the climate benefits of conventional biofuels typically diminish as production scales up, and advanced biofuels tend to be difficult (or impossible) to produce at a large scale.
- Clear focus on GHG reductions: The LCFS cannot blind itself to critically important non-climate impacts, especially the effect that increased consumption of biofuels can have on food prices and global food security. With appropriate safeguards in place, however, ARB can pursue the program's singular goal of GHG reductions without having to accommodate related-but-different objectives like price support for the agricultural sector or energy security.

A strong, stringent, flexible, intellectually honest LCFS creates a forum in which to consider new, truly low-carbon fuels, and a key market in which to commercialize them. It needs to succeed. However, that success must be achieved in terms of real GHG reductions, not merely on paper. CATF is concerned that a short-term reliance on conventional biofuels—especially corn ethanol—could pull the LCFS in the wrong direction, and imperil its prospects for long term success.

NET GHG EMISSIONS FROM CORN ETHANOL

When assessing a biofuel's net GHG emissions in the context of a given policy, an important—and complicated—component is the carbon release associated with land use changes. Of particular concern is indirect land use change (ILUC), or the amount of land use change that occurs as agricultural markets accommodate new policy-driven demand for biofuel feedstocks, and the amount of soil and plant-carbon that is released into the atmosphere as a consequence of those changes.

[1] California ARB, *Staff Report-Initial Statement of Reasons* (December 30, 2014) at ES-3.

As supply margins for corn and other crops tighten in the face of competition from policy-driven demand for biofuels, the price of foodstuffs increases. The increase in food prices encourages farmers around the world to cultivate previously unfarmed land—a process that results in substantial losses of soil- and plant-carbon to the atmosphere. Accordingly, a biofuel must "pay back" this "carbon debt" (via CO_2 sequestration by subsequent energy crop growth) before it can be credited with any net climate benefits as compared to petroleum-based fuels (which have comparatively insignificant land use-related carbon impacts).

ARB staff have proposed that the ILUC score for corn ethanol should be reduced from the current score of 30 gCO_2/MJ. Adopting the proposed reduction would be wrong, both as a matter of emissions accounting and as a matter of climate mitigation policy. The proposed reduction would make corn ethanol a more viable LCFS compliance strategy. Heavier reliance on corn ethanol would limit the near- and long-term GHG reductions that can be achieved by the LCFS and would undermine the program's innovation-forcing objective—despite corn ethanol's status as an outmoded technology, the significant uncertainty about whether corn delivers any climate benefits, and the concerns about the non-climate environmental damage associated with its production.

Reducing the ILUC score for corn would be wrong from an emissions accounting perspective because it ignores a host of relevant factors that ARB has not yet been able to effectively quantify in CA GTAP-BIO, but which it knows will raise the ILUC score if/when the factors are correctly incorporated into the model. These factors have been identified by ARB staff[2] and in comments submitted by CATF and other stakeholders.[3] They include:

- The effect of water scarcity constraints on projected crop expansion. Researchers from Purdue University who used GTAP to examine the likely role of water scarcity on crop expansion found that earlier ILUC analyses "likely underestimated induced land use emissions due to ethanol production by more than one quarter."[4] As discussed below, ARB has not yet succeeded in sensitizing CA GTAP-BIO to water constraints, so the effect that such constraints have on LUC patterns and resulting emissions are not fully accounted for.
- GTAP's inability to differentiate commercial forest from non-commercial forests, which means that the model wrongly assumes that markets respond to the conversion of both land types in the same way.
- The yield improvement assumptions in GTAP overlook important differences among crops and growing regions, they fail to incorporate new research on future corn yields in the Midwest United States, and they do not adequately address the climate impact associated with the increased use of nitrogen-based fertilizers to sustain yield growth.

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[2] John Courtis, Anil Prabhu, Farshid Mojaver, and Kamran Adili. iLUC Analysis for the Low Carbon Fuel Standard (Update), California Air Resources Board, (March 11, 2014).
[3] CATF, Comments on ARB Proposed ILUC Analysis (May 2014) (http://www.catf.us/resources/filings/biofuels/20140519-CATF%20Comments%20on%20ARB%20Proposed%20ILUC%20Analysis.pdf)
[4] Farzad Taheripour, Thomas W. Hertel and Jing Liu. 2013. The Role of Irrigation in Determining the Global Land Use Impacts of Biofuels. ENERGY, SUSTAINABILITY AND SOCIETY.

These issues are described more fully in the appended comments that CATF submitted to ARB in May 2014.

Even if the fundamental concerns described above are put aside for a moment, the proposed ILUC reduction for corn ethanol is problematic because the materials prepared by ARB staff appear to consider two different reduced scores. The first—19.8 gCO_2/MJ—is the unweighted average of the thirty different production scenarios run on CA GTAP-BIO.[5] ARB's potential reliance on this value implies that it believes all thirty scenarios are equally plausible—a position that ARB has not, and cannot, justify. The second score—21.8 gCO_2/MJ—was derived by performing a Monte Carlo simulation (MCS). ARB's Expert Working Group has urged the use of MCS because of its "ability to represent arbitrary input and output distributions, … perform global sensitivity analysis (e.g., contribution to variance) to identify which input parameters contribute most to the variance in the output, and … represent parameter correlations."[6] As between the two scores, the value that was derived from the Monte Carlo simulation—*i.e.*, 21.8 gCO_2/MJ—is superior.

A recent paper by Bruce Babcock and Zabid Iqbal of Iowa State University asserts that ILUC models utilized by ARB and EPA have overestimated land use changes by "attribut[ing] all supply response[s] not captured by increased crop yields to land use conversion on the extensive margin."[7] The paper argues for the use of lower ILUC scores by attempting to prove that "the primary land use change response of the world's farmers from 2004 to 2012 has been to use available land resources more efficiently rather than to expand the amount of land brought into production."[8] The paper has several shortcomings, however:

- Babcock and Iqbal only consider intensification techniques such as double cropping rather than analyzing yield increases over this time period.
- The paper dismisses data on extensive land use changes in Africa on the grounds that the linkage between global food prices and those in rural Africa is weak (implying that biofuel policies in the US and EU have little effect on African food prices and land use change)—even though the authors note a correlation between global food prices and food prices in urban Africa.
- The paper makes overly generous assumptions about the extensiveness of double cropping. As Jeremy Martin of the Union of Concerned Scientists wrote in recent comments to ARB, double cropping is not widely used in Southeast Asia where palm oil plantations have moved into formerly uncultivated areas. Nor is double cropping widely adopted in parts of the Midwest where most U.S. biofuels feedstocks—primarily corn and soybeans—are grown. The Babcock and Iqbal paper also fails to account for increased GHG emissions from increased fertilizer usage where it does assume the use of additional double cropping in response to higher crop prices.

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[5] California ARB, *Staff Report-Appendix I: Detailed Analysis for Indirect Land Use Change* (December 30, 2014) at I-25.
[6] *Id*. at I-38, I-17.
[7] *See* Bruce A. Babcock and Zabid Iqbal, *Using Recent Land Use Changes to Validate Land Use Change Models* (Staff Report 14-SR 109) (http://www.card.iastate.edu/publications/dbs/pdffiles/14sr109.pdf)
[8] *Id*.

- Finally, the authors assume the "only net contributor to US cropland from 2007 to 2010 was a reduction in [Conservation Reserve Program (CRP)] land," but this too is an inappropriate assumption, because several studies (from South Dakota State University and even U.S. Department of Agriculture Economic Research Service, Farm Service Agency, and Natural Resources Conservation Service data) show that cropland conversions exceeded acres exiting CRP, with huge impacts on GHG emissions.[9]

Reducing the ILUC score for corn ethanol would also be a mistake in terms of climate mitigation policy. The use of highly complex models like CA GTAP-BIO to determine the net emissions associated with biofuels produces values that have the veneer of objective validity. But the modeling outputs are enormously dependent on the data that are fed into the system and on the system's assumptions about how those data affect physical and economic processes.

A recently published paper examines the extent to which subjective decisions about incorporating different assumptions and data into a lifecycle model can affect the outcome.[10] Plevin *et al.* used a Monte Carlo simulation to characterize the parametric uncertainty associated with the two components of the lifecycle analysis that California used to evaluate biofuels: "an economic modeling component that propagates market-mediated changes in commodity production and land use induced by increased demand for biofuel globally, and a carbon accounting component that calculates the GHG emissions associated with (some) of these induced changes."[11]

The authors found that three parameters have particularly strong influences on the uncertainty importance for ILUC emissions intensity:

- Elasticity of crop yield with respect to price (YDEL) (in the economic model);
- Relative productivity of newly converted cropland (in the economic model); and
- Ratio of emissions from cropland-pasture to cropland, as compared to the ratio from converting standard pasture (in the emissions factor model).[12]

Among these factors, "[b]y far, the greatest contributor to variance in the estimate of ILUC

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[9] *See* Christopher K. Wright and Michael C. Wimberly. 2013. *Recent land use change in the Western Corn Belt threatens grasslands and wetlands*. PNAS 4134–4139 (doi: 10.1073/pnas.1215404110) (http://www.pnas.org/content/110/10/4134.abstract); Steven Wallander *et al. The Ethanol Decade: An Expansion of U.S. Corn Production, 2000-09*. Economic Information Bulletin No. EIB-79 (August 2011) (http://www.ers.usda.gov/publications/eib-economic-information-bulletin/eib79.aspx); U.S. Department of Agriculture Farm Service Agency. *Cropland Conversion* (July 31, 2013) (http://www.fsa.usda.gov/FSA/webapp?area=newsroom&subject=landing&topic=foi-er-fri-dtc); U.S. Department of Agriculture Natural Resources Conservation Service and Center for Survey Statistics and Methodology, Iowa State University. *Summary Report: 2010 National Resources Inventory* (September 2013) (http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1167354.pdf); *see also* Lark, TJ, Salmon, JM, Gibbs, HK. *Cropland expansion outpaces agricultural and biofuel policies in the United States*. ENVIRONMENTAL RESEARCH LETTERS. Expected Spring 2015.

[10] Richard Plevin, *et al.* 2015. Carbon accounting and economic model uncertainty of emissions from biofuels-induced land use change. ENVIRON. SCI. TECHNOL. (doi**:** 10.1021/es505481d)

[11] *Id.*

[12] *Id.*

emissions was YDEL, the elasticity of crop yield to price;" in fact, in ILUC analyses for corn ethanol, YDEL accounts for "nearly 50%"of the variance among possible modeling results.[13] ARB currently uses a YDEL value of 0.25 in GTAP-BIO—a subjective decision that is increasingly difficult to justify in light of separate analyses conducted for ARB by Steven Berry and David Locke. Berry reviewed a collection of studies on yield price elasticity (YPE) and, according to an ARB staff report, "concluded that YPE was mostly zero and the largest value that could be used was 0.1."[14] Locke ran a statistical analysis of a similar set of studies and found "that based on methodologically sound analyses, yield price elasticities are generally small to zero."[15] ARB has nonetheless chosen to include YPE values up 0.35 in its ILUC analyses.[16] [[Id. at Attachment 1-6]]

Developing the relevant data and determining which datasets to use (and which to exclude) are highly subjective exercises, as are the processes of choosing and programming the relational assumptions that drive the model. Viewed in this context, the proposal to reduce the corn ethanol ILUC score can be more appropriately understood as the product of a subjective process—one that reflects the current availability of certain data and analyses that would contribute to a lower ILUC score, but fails to account for a host of countervailing factors that ARB does not yet understand how to model.

The Board should recognize these limitations, as well as the necessary role that it and ARB staff play in interpreting and acting upon modeling results. The Board should exercise its best judgment in light of the overarching policy objective of the LCFS, which CATF understands to be a meaningful reduction in GHG emissions from the transportation sector. Because corn ethanol's lifecycle GHG emissions are—at best—only slightly lower than those from gasoline, and because increased reliance on corn ethanol would frustrate the development of more innovative and effective compliance options, the proposal to reduce the ILUC score for corn ethanol undermines the objectives of the LCFS. Accordingly, CATF urges the Board to table the proposal.

CORN ETHANOL'S IMPACT ON FOOD SECURITY

Another critically important way in which ILUC estimates are the product of subjective decisions (and not just objective calculations) relates to the treatment of food price increases associated with policy-induced demand for biofuels. As Plevin *et al.* (2015) write, "ILUC emission estimates depend on various modeling choices, such as whether a reduction of food consumption resulting from biofuel expansion is treated as a climate benefit."[17] ARB currently chooses to count GHG reductions that result from reduced food consumption when analyzing the lifecycle emissions of biofuels, but that—again—is a subjective decision. (Moreover, doing

[13] *Id.*
[14] California ARB, *Staff Report-Appendix I: Detailed Analysis for Indirect Land Use Change* (December 30, 2014) at Attachment 1-2.
[15] *Id.* at Attachment 1-5.
[16] *Id.* at Attachment 1-6.
[17] Plevin *et al.* (2015), *supra*.

so implies that ARB assumes that national governments would not subsidize food consumption in the face of rising food prices.)

If instead ARB chose to assume that society would limit the extent to which food consumption would decline (especially taking into consideration a growing world population demanding significantly more calories and protein), its ILUC analysis would produce different results. For example, Thomas Hertel *et al.* (2010) found that if food consumption were held constant in GTAP, the estimated emissions from biofuel expansion would increase by 41%.[18]

As with the other factors discussed above, the problematic and highly subjective treatment of reduced food consumption reinforces the point that ARB is not obligated to reduce the ILUC score for corn ethanol on the basis of the most recent—but highly incomplete—modeling results.

More generally, CATF urges ARB to reconsider how it accounts for reduced food consumption within the LCFS context, before the issues erodes the legitimacy of the LCFS program.

EMISSION REDUCTION OPPORTUNITIES POST-2020

ARB is appropriately interested in using the LCFS to achieve deep, long-term reductions.

> Although post-2020 goals for the LCFS are not part of this proposed rulemaking, continuing these policies beyond 2020 will ensure that fuel carbon intensity continues to decline and that low-carbon alternatives to petroleum are available in sufficient quantities in the long term. Achieving California's mid and long-term greenhouse gas and air quality goals will require a renewable portfolio of transportation fuels—including electricity and hydrogen—well beyond the current policy trajectories. Accordingly, ARB, in a future rulemaking, will consider extending the LCFS with more aggressive targets for 2030.[19]

An unwarranted reduction to the corn ethanol ILUC score would do more than undermine the actual climate benefits that the LCFS can achieve through 2020; it would lower the ceiling on the long-term effectiveness of the program by extending the period in which marginally beneficial technologies can compete with the far better options that will be available to California after 2020. Chief among these better options may be ammonia, a hydrogen-based energy carrier that CATF has previously discussed with ARB management and staff.

The potential benefits associated with ammonia fuel ammonia are enormous, both for the environment and for the prospects of the LCFS:

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[18] TW Hertel, *et al.* 2010. *Effects of US Maize Ethanol on Global Land Use and Greenhouse Gas Emissions: Estimating Market-Mediated Responses*. BIOSCIENCE. 60:223-231(doi: 10.1525/bio.2010.60.3.8).
[19] California ARB, *Staff Report-Initial Statement of Reasons* (December 30, 2014) at ES-1.

- Zero-carbon ammonia can be produced using air, water, and electricity generated by renewable or nuclear power plants, or by fossil fuel-based generating stations equipped with carbon capture and storage systems.
- A wide range of engines and fuel cells can use ammonia to generate electricity or to power vehicles, and can do so without emitting CO_2.
- Substantial global ammonia production and transport infrastructure is already in place. At 150 million metric tons per year, it is the third largest chemical produced globally.
- At $3.27 per gallon (on an energy equivalent basis to gasoline, at current prices) and $1.78 per gallon (when compared against gasoline's 10-year average price), ammonia is affordable. And as a liquid, it can be more easily transported and stored than hydrogen and natural gas.

The steps that need to be taken before a widespread transition to ammonia fuel can occur are significant—but not insurmountable. These include:

- Building awareness among industry, regulators, and other stakeholders about the economic and environmental advantages of using ammonia fuel for power generation and transportation (especially, at the outset, rail and long-haul truck fleets).
- Helping innovators and investors identify small volume/high profit projects to jumpstart the ammonia energy industry.
- Highlighting opportunities to shift ammonia production to zero-carbon processes (*e.g.*, using stranded or otherwise underutilized wind power assets for ammonia synthesis).
- Detailing ammonia's toxicity risk (which is similar to that of LPG), describing how that risk is managed by farmers globally, and outlining protocols for how it can be managed in the power and transportation sectors.
- Developing a long-term roadmap for building up ammonia production and distribution capacity to the scale of a global energy commodity.

Since CATF briefed ARB on ammonia in July 2014, research in Texas (on ammonia-gasoline blending in internal combustion engines), Toronto (on the use of ammonia to fuel locomotives), and California have continued to validate the concept and develop demonstration projects.

The California project—which involves the University of California at Los Angeles (UCLA), California Energy Commission, and South Coast Air Quality Management District (SCAQMD)—is among the most interesting efforts to date. UCLA is spearheading a comprehensive program to utilize advanced engines from Sturman Industries for a multifuel (gas and ammonia), low NO_x combined-heat-and-power system. The system will be designed, installed, and optimized at a metals foundry in Los Angeles called California Metal-X (CMX). The project goal is to provide power at $0.097/kwh compared to a current base load cost of $0.18/kwh and peak power costs ranging from $0.20-$0.50/kwh from the grid. These cost savings come along with the potential to prove out an ammonia-based, scalable power source that meets the stringent air quality requirements implemented by SCAQMD.

The system will be designed to run in a wide range of modes including pure ammonia as a peak fuel and a variety of combined heat/power modes depending on power pricing, air quality standards, process efficiency, and power export profitability. UCLA, Sturman Industries, and

other project partners will instrument the system to test and optimize ammonia engines, emissions, costs, maintenance, safety and other aspects of these types of operations in the real world. This project is being designed to provide a robust prototype for low cost, clean electricity across the California economy. If successful, the project will provide a technology and engineering basis for installing ammonia power in various markets around the world.

CONCLUSION

CATF urges ARB to readopt the LCFS through 2020. Although significant challenges remain, the LCFS is the most promising policy tool available for reducing the climate impacts of the transportation sector.

However, that promise is undermined by the proposed adjustment to the lifecycle emissions for corn ethanol, and by the likelihood that regulated entities will increase their reliance on corn ethanol to meet LCFS targets. The proposed adjustment to corn ethanol's lifecycle emissions score rewards corn for its negative impact on global food security. ARB must acknowledge and address this issue before it erodes the legitimacy of the LCFS program.

An unwarranted reduction to the corn ethanol ILUC score would also lower the ceiling on the long-term effectiveness of the program by extending the period in which marginally beneficial technologies can compete with the far better options that will be available to California after 2020. The prospects for deep reductions in transportation sector GHG emissions are likely to improve significantly after 2020, particularly if liquid ammonia's potential as an affordable low-carbon fuel is proven out.

Respectfully submitted,

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