

May 24, 2013

The Honorable Fred Upton
Chairman
Committee on Energy and Commerce
U.S. House of Representatives

The Honorable Henry Waxman
Ranking Member
Committee on Energy and Commerce
U.S. House of Representatives

Dear Chairman Upton and Ranking Member Waxman:

The Renewable Fuels Association (RFA) is the national trade association representing the U.S. ethanol industry. The RFA appreciates the opportunity to respond to the questions posed in the third white paper, “Greenhouse Gas Emissions and Other Environmental Impacts,” as part of the Committee’s review of the Renewable Fuel Standard (RFS).

An important policy objective of the RFS2, as adopted by Congress as part of the Energy Independence & Security Act of 2007, was to reduce greenhouse gas emissions (GHG) and displace petroleum imports with cleaner, renewable fuels. As demonstrated in these comments, the RFS has succeeded in reducing GHG emissions, decreasing other harmful tailpipe pollutants, and displacing crude oil imports with more sustainable renewable transportation fuels.

When assessing the environmental impacts of renewable fuels, it is absolutely imperative to make appropriate comparisons to the impacts associated with the use of petroleum fuels. In other words, it is inappropriate to examine the environmental effects of the RFS without simultaneously examining the effects of *not having the RFS*. It is also important to compare new renewable fuels entering the market to the actual sources of marginal petroleum they are delaying and displacing. In that regard, the questions posed by the Committee appear woefully incomplete. By focusing exclusively on the environmental impacts of ethanol and other biofuels used for the RFS, the Committee is missing the significant environmental and public health consequences of increased petroleum production and use in the absence of ethanol and the RFS. The RFA would respectfully suggest that for a complete understanding of this important program, the following questions should also be asked and answered:

1. **What are the environmental effects of oil exploration, including seismic surveys, drilling and well logging, deployment of marine platforms, and infrastructure development?** Please discuss among other issues the potential environmental effects resulting from disturbing ecologically sensitive areas including wetlands and tundra, loss of natural vegetation, functional habitat loss, reduced populations and densities of birds and animals, perforations in cap rock

formations, air and groundwater contamination from disposal of drill cuttings, structural impacts on marine life, seabird mortality from collision, oiling, incineration by flame, hydrologic alteration through long term surface water mining for ice roads, and decline in aquatic macro invertebrate density and taxonomic diversity due to siltation.

2. **What are the environmental effects of oil extraction, including fracturing, pumping, and additional infrastructure establishment?** Please include a discussion about the potential health and environmental effects associated with chemicals used in fracturing, alteration of groundwater flow and quality, surface and subsurface contamination from improperly abandoned wells, seismic events, bird fatalities in produced water ponds, fires from terrestrial oil spills, loss of saltmarsh vegetation from oil spills, air pollution from flaring, permanent depletion of subsurface deposits of petroleum, loss of wetlands or habitat, species decline, and animal avoidance.
3. **What are the environmental effects of crude oil distribution, including transportation (ocean tanker, rail and/or truck) and pipeline?** Please discuss specifically the potential effects of marine oil spills, aquatic and shoreline biological effects of spills, land clearing for pipeline construction, disturbance of remote areas such as the North Slope tundra and Ecuadorian Amazon, and the biological effects of spills.
4. **What are the environmental effects of gasoline production at the refinery?** Please discuss specifically among other things the potential impacts of air pollution from refining, water pollution, soil pollution, petroleum coke and radioactive solid waste streams due to buildup of naturally occurring radioactive materials.
5. **What are the environmental effects resulting from gasoline distribution, including transportation, pipeline shipment and storage?** Please discuss specifically the air pollution from trucks and rail, gasoline spills, freshwater spills from pipeline ruptures leading to fish kills and species fragmentation, the toxicity of spills to terrestrial plants and soils, evaporative emissions from storage facilities, and leaking of underground storage tanks and associated groundwater contamination.
6. **What are the environmental and public health effects of gasoline use, including fuel blending, fuel dispensing and driving?** Please discuss specifically the potential environmental and health effects of tailpipe pollutants from gasoline combustion, spills and evaporation at retail locations, leaking underground storage tanks and associated groundwater contamination. Also, please discuss specifically the impact on gasoline toxicity, aromatics content generally and the level of benzene, toluene and xylene specifically resulting from reduced ethanol use under a scenario where the RFS didn't exist.
7. **What are the GHG emissions impacts of increased unconventional oil production from Canadian oil sands, tight oil from fracking, thermally enhanced oil recovery, and gasoline production, distribution and use?** Please discuss specifically the direct and indirect emissions, such as land use change and methane releases, resulting from unconventional oil production.
8. **How has the composition of gasoline and resulting emissions changed since 2005?** Please discuss specifically the toxicity, ozone-forming potential and carbon profile of today's marginal

gallon of gasoline (unconventional tight oil and oil sands) relative to the 2005 baseline fuel used by EPA for RFS comparison and compliance.

9. **What are the GHG and other environmental impacts of our dependence on imported oil and the national security implications of that dependence?** Because 40% of our oil imports come from OPEC nations, please address specifically the emissions of the Fifth Fleet that protects international oil shipping lanes from the Persian Gulf, the emissions attributable to the transportation, re-supply and training of ground and air forces staged in the region to keep stability amongst oil producing states, and the GHG emissions attributable to the burning of oil fields and deliberate spills following the Gulf War.
10. **Do current lifecycle analysis tools and models fully capture the environmental and carbon effects of oil exploration, extraction, processing, transportation and combustion?** Please discuss how existing analytical tools can be improved.

Context is important. As Congress assesses the merits of ethanol and the RFS, a clear understanding of the fossil fuels being displaced by ethanol and other renewable fuels is imperative. Changes to the RFS would undoubtedly lead to increased use of marginal petroleum, fuels that have their own distinct environmental, public health and carbon effects.

Below please find RFA's responses to questions set forth by the Committee on environmental impacts.

1. **Is the RFS reducing greenhouse gas emissions below that of baseline petroleum-derived fuels (a)? Is the RFS incentivizing the development of a new generation of lower greenhouse gas emitting fuels (b)? Will the RFS produce further greenhouse gas emissions reductions when it is fully implemented (c)?**
 - a. *Is the RFS reducing greenhouse gas emissions below that of baseline petroleum-derived fuels?*

Yes, the RFS is unquestionably reducing GHG emissions today compared to baseline petroleum. As an initial matter, it is important to understand there is a fundamental difference between the carbon cycle of renewable fuels and the carbon cycle of fossil fuels. As highlighted in a recent paper in which scientists from Duke University, Oak Ridge National Laboratory, and the University of Minnesota compared the lifecycle environmental impacts of ethanol and gasoline:

A critical temporal distinction exists when comparing ethanol and gasoline life-cycles. Oil deposits were established millions of years in the past. *The use of oil transfers into today's atmosphere GHGs that had been sequestered and secured for millennia and would have remained out of Earth's atmosphere if not for human intervention.* While the production and use of bioenergy also releases GHGs, there is an intrinsic difference between the two fuels, for GHG emissions associated with biofuels occur at temporal scales that would occur naturally, with or without human intervention. ...Hence, a bioenergy cycle can be managed while maintaining atmospheric conditions similar to those that allowed humans to evolve and thrive on Earth. In contrast, *massive release of fossil fuel carbon*

*alters this balance, and the resulting changes to atmospheric concentrations of GHGs will impact Earth's climate for eons.*¹ (emphasis added)

Indeed, one of the major benefits of using biofuels is that they essentially *recycle* atmospheric carbon. In the case of corn ethanol, for instance, the amount of CO₂ released when the fuel is combusted in an engine has been previously removed from the atmosphere via photosynthesis during growth of corn plant. Although there may be temporary shifts between atmospheric and terrestrial stocks of carbon within the active carbon cycle, the carbon released into the atmosphere during this process is not “new” carbon being introduced into the earth’s carbon cycle. Biogenic carbon emissions then are considered “carbon neutral” based on the feedstock’s carbon uptake. For annual crops like corn, this carbon cycle occurs every year with each new harvest.

While CO₂ emissions from fuel ethanol combustion are carbon neutral, there are some GHG emissions associated with the production and distribution of the fuel. These supply chain emissions are the subject of “lifecycle analysis.” A recent lifecycle analysis paper by Wang et al. published in the journal *Environmental Research Letters* (Attachment 1) found that corn ethanol produced in the 2008-2012 timeframe reduced GHG emissions by an average of 34% compared to baseline gasoline.² Importantly, that figure *includes hypothetical emissions from indirect land use change* (ILUC) for corn ethanol and uses a carbon intensity value for baseline gasoline that is nearly identical to the value used by EPA for the RFS2. If ILUC emissions are excluded from the calculation (i.e., if an equitable comparison of only direct emissions is made), today’s average corn ethanol reduces GHG emissions by 44% relative to gasoline, according to Wang et al. (Figure 1).

The results from Wang et al. are consistent with several other independent lifecycle analyses of corn ethanol. For example, Liska et al. (2009) found modern corn ethanol reduces direct GHG emissions by 48-59% compared to gasoline.³ Meanwhile, a report by O’Connor for the International Energy Agency found 2005-era corn ethanol reduced direct GHG emissions by 39% compared to gasoline, with reductions of up to 55% expected in the near future.⁴ Further, the California Air Resources Board (CARB) has certified individual pathways for nearly 30 grain ethanol plants that serve the California market for the state’s Low Carbon Fuels Standard (LCFS). The ethanol produced by these plants reduces direct GHGs by an average of 40-45% relative to baseline gasoline, according to CARB.⁵ Incidentally, CARB recently reported that ethanol has provided 80% of the GHG emissions reductions required under the LCFS to date.⁶

¹ Parish et al. (2012). “Comparing Scales of Environmental Effects from Gasoline and Ethanol Production.” *Environmental Management*, 50 (6): 979-1246.

² Wang et al. (2012). “Well-to-wheels energy use and greenhouse gas emissions of ethanol from corn, sugarcane and cellulosic biomass for US use.” *Environ. Res. Lett.*, 7 (2012) 045905 (13pp).

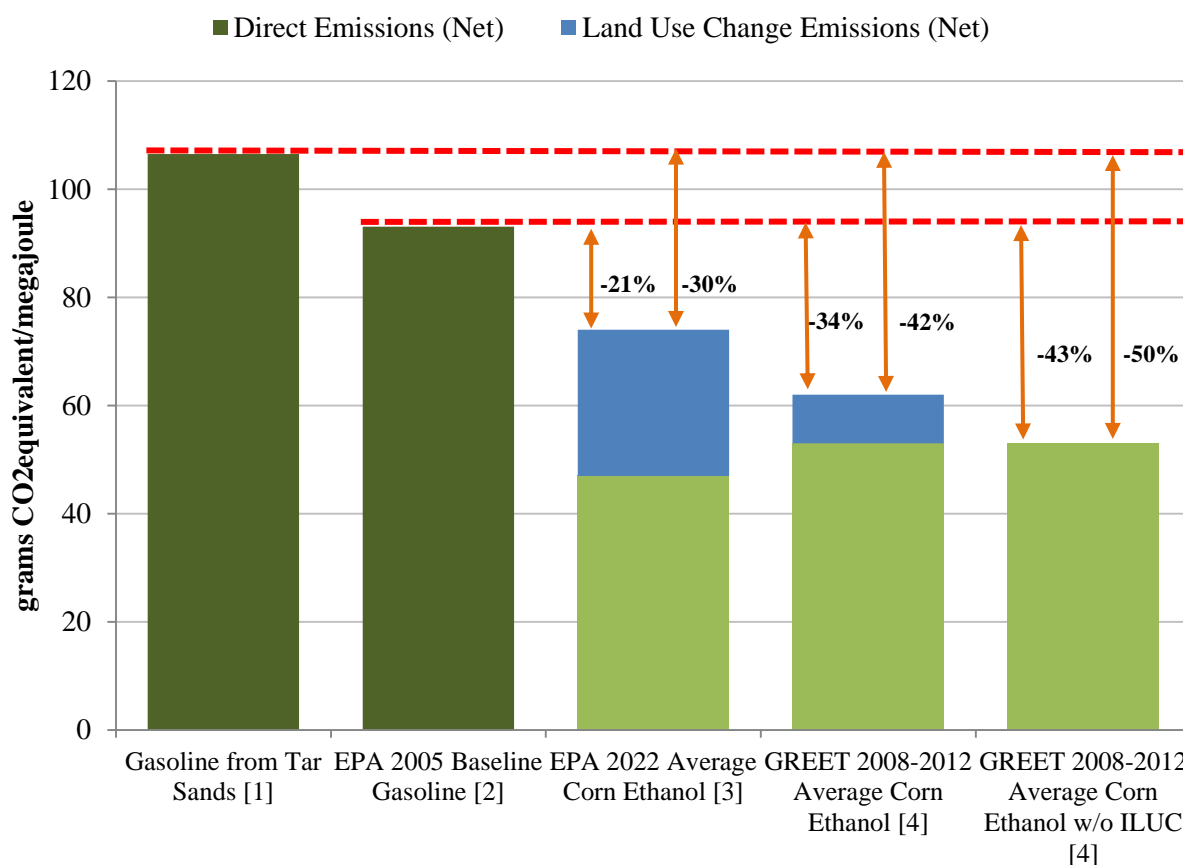
³ Liska, A.J., H.S. Yang, V.R. Bremer, T.J. Klopfenstein, D.T. Walters, G.E. Erickson, and K.G. Cassman (2009). “Improvements in Life Cycle Energy Efficiency and Greenhouse Gas Emissions of Corn-Ethanol.” *Journal of Industrial Ecology*. 13(1): 58-74.

⁴ O’Connor, D., for International Energy Agency (2009). “An examination of the potential for improving carbon/energy balance of bioethanol.” IEA Task 39 Report T39-TR1, 72 pp.

⁵ See CARB (2013). “Method 2A-2B Carbon Intensity Applications.” <http://www.arb.ca.gov/fuels/lcfs/2a2b/2a-2b-apps.htm>

⁶ See CARB (2013). “LCFS 2012 Q4 Data Summary.” http://www.arb.ca.gov/fuels/lcfs/20130329_q4datasummary.pdf

Figure 1. Lifecycle GHG Emissions: Corn Ethanol and Gasoline



[1] NETL (2009), An Evaluation of the Extraction, Transport and Refining of Imported Crude Oils and the Impact of Life Cycle Greenhouse Gas Emissions, March 27, 2009, U.S. Department of Energy, DOE/NETL-2009/1362.

[2-3] EPA (2010). RFS2 Final Rule.

[4] Wang et al. (2012). "Well-to-wheels energy use and greenhouse gas emissions of ethanol from corn, sugarcane and cellulosic biomass for US use." *Environ. Res. Lett.*, 7 (2012) 045905 (13pp).

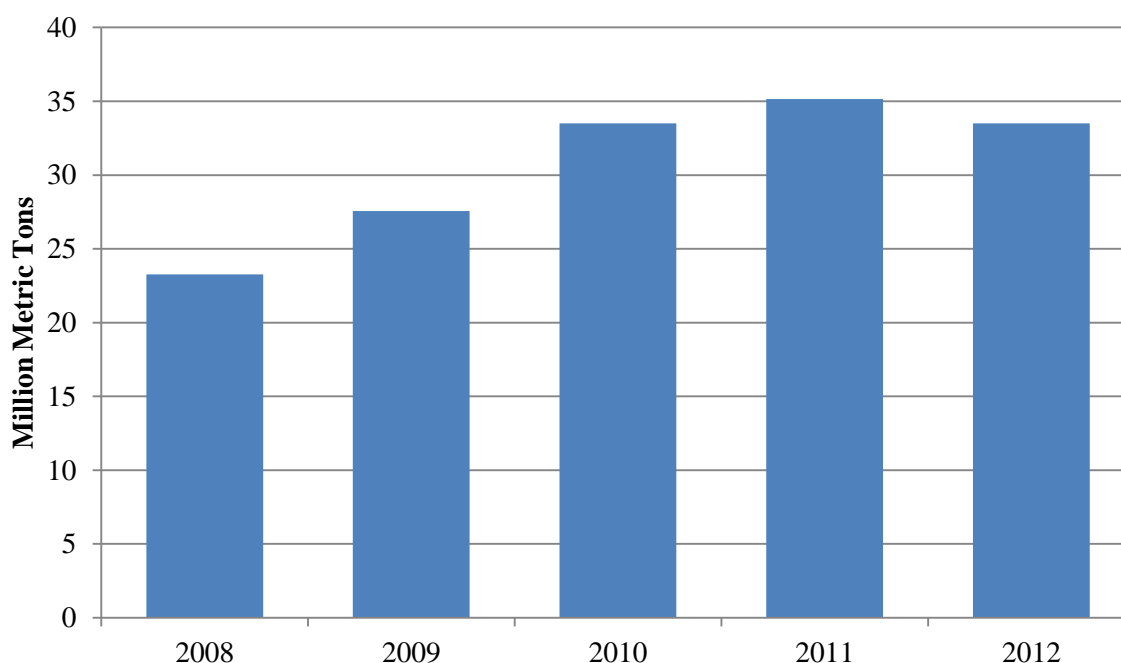
The latest results presented by Wang et al. were obtained from an updated and re-structured version of the Department of Energy's "GREET" model.⁷ Recent versions of the GREET model have incorporated updated data and assumptions from the 2008-2010 timeframe regarding emissions related to ethanol plant energy use, grain production, and land conversion. Unfortunately, these updates to the GREET model were conducted shortly after EPA finalized its RFS2 lifecycle analysis, meaning the versions of the GREET model used by the Agency were already obsolete by the time the RFS2 final rule was promulgated.

Based on the lifecycle emissions reported for ethanol and gasoline in the Wang et al. paper, substitution of corn ethanol for gasoline in the 2008-2012 time period has conservatively reduced GHG emissions from the transportation sector by 153 million metric tons of CO₂-equivalent (CO₂e), or an average of 30.6 million metric tons per year (Figure 2). The GHG emissions reduction associated with substituting

⁷ Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation Model. See <http://greet.es.anl.gov/>

ethanol for gasoline has been equivalent to removing an average of 6.4 million vehicles from America's roadways annually from 2008 to 2012.⁸

Figure 2. GHG Emissions Reductions From Substituting Ethanol for Gasoline, 2008-2012



Source: Argonne GREET 1 2012 rev2. Corn ethanol emissions = 62 g/MJ (incl. 9 g/MJ ILUC); gasoline emissions = 93 g/MJ. Note ILUC emissions are average values (i.e., variable timing of emissions not considered)

A recent study of 2012-era ethanol and corn production practices by the University of Illinois-Chicago (Attachment 2) reveals additional improvements that would further reduce corn ethanol's lifecycle GHG emissions beyond the levels reported in Wang et al. and shown in Figure 1. The study shows thermal energy use at a typical dry mill ethanol plant has fallen another 9% since 2008, as the amount of ethanol produced per bushel of grain increased 1.4%. Additionally, the study showed increasing adoption of new practices and technologies in the feedstock production phase. Importantly, current energy use by the average ethanol plant is *already* below the levels assumed by EPA for an average plant in 2022.

While the renewable fuels used for RFS compliance today are clearly reducing GHG emissions relative to 2005 baseline petroleum, the comparison to a 2005 petroleum baseline understates the actual GHG savings associated with using renewable fuels. As corn ethanol's lifecycle GHG emissions have trended downward over the past decade, the lifecycle GHG emissions associated with petroleum have increased. A 2009 study by DOE's National Energy Technology Laboratory showed that gasoline from tar sands has

⁸ Assumes annual average CO₂e. emissions of 4.8 metric tons per light duty vehicle (EPA). See www.epa.gov/cleanenergy/energy-resources/refs.html

lifecycle GHG emissions of 106.4 g CO₂e/megajoule (MJ).⁹ This is 14% higher than the lifecycle GHG emissions assumption of 93.1 g/MJ for EPA's 2005 baseline gasoline. Because unconventional crude oil sources like tar sands and tight oil from fracking make up a much larger share of the U.S. crude oil slate today than in 2005, ethanol's true GHG benefits are significantly understated by EPA's analysis. When ethanol is compared directly to the unconventional petroleum sources it is displacing in the margin of today's fuel market, the actual GHG savings are much greater than when ethanol is compared to a static gasoline baseline from eight years ago.

b. Is the RFS incentivizing the development of a new generation of lower greenhouse gas emitting fuels?

Yes, the RFS is providing the economic incentive and market certainty necessary for development of the next generation of feedstocks and biofuels. Based on various lifecycle analyses, advanced and cellulosic are likely to provide even greater GHG savings than first-generation biofuels. According to Wang et al., for example, cellulosic ethanol derived from feedstocks like switchgrass, corn stover, and miscanthus will reduce GHG emissions by 77-115% compared to gasoline.¹⁰ The first commercial-scale gallons of biofuel from these feedstocks and others are likely to be produced in 2013, while several additional commercial-scale cellulosic biofuel facilities are slated to begin operations in 2014. The RIN credits associated with production and consumption of lower-emitting advanced biofuels have consistently carried superior value to RINs for conventional biofuels, thus providing a strong economic incentive for development and commercialization. Already, 40 companies have submitted petitions to EPA for approval of 42 new and unique renewable fuel production pathways, the majority of which are related to second-generation feedstocks and biofuel technologies.¹¹ Unfortunately, only 10 of the 42 new pathways have been approved by EPA so far, meaning the uncertain and lengthy petition process is hindering commercialization of new, lower-emitting advanced and cellulosic biofuels.

c. Will the RFS produce further greenhouse gas emissions reductions when it is fully implemented?

Yes, GHG emission reductions will be accelerated as the RFS requires increased consumption of advanced and cellulosic biofuels. As described above, GHG emissions reductions associated with the use of corn ethanol have averaged 30.6 million metric tons CO₂e annually over the past five years. EPA conservatively estimates that the annual GHG reductions associated with full implementation of the RFS in 2022 will be on the order of 138 million metric tons CO₂e.

2. Could EPA's methodology for calculating lifecycle greenhouse gas emissions be improved, including its treatment of indirect land use changes? If so, how?

Yes, EPA's lifecycle GHG methodology and key assumptions could be greatly improved. As noted earlier, much of EPA's lifecycle GHG analysis is now obsolete based on the availability of better modeling tools and methodologies, as well as more current and robust data sets. Better methods and data

⁹ NETL (2009), An Evaluation of the Extraction, Transport and Refining of Imported Crude Oils and the Impact of Life Cycle Greenhouse Gas Emissions, March 27, 2009, U.S. Department of Energy, DOE/NETL-2009/1362.

¹⁰ Wang et al. (2012). "Well-to-wheels energy use and greenhouse gas emissions of ethanol from corn, sugarcane and cellulosic biomass for US use." *Environ. Res. Lett.*, 7 (2012) 045905 (13pp).

¹¹ See <http://www.epa.gov/otaq/fuels/renewablefuels/compliancehelp/rfs2-lca-pathways.htm>

are now available for assessment of both hypothetical indirect emissions (e.g., ILUC) as well as direct (supply-chain) emissions. RFA outlined many of the important new developments in corn ethanol lifecycle GHG analysis and ILUC estimation in a letter to former EPA Administrator Lisa Jackson (Attachment 3) dated Nov. 30, 2012 (note that the letter was submitted before the aforementioned study by Wang et al. was made available). The RFA letter demonstrates that improved modeling and better data show that the corn ethanol process is more efficient and producing less GHG emissions *today* than EPA assumed would be in the case *in 2022*.

In the pre-amble for the RFS2 final rule, EPA acknowledged that lifecycle GHG analysis is an evolving science, and that updates to the Agency's analysis would be undertaken as better data and methodologies became available. Further, EPA recognized that technology adoption and efficiency improvements in biofuel production may also necessitate periodic reassessments of the RFS2 lifecycle analysis. For example, EPA wrote that it "...recognizes that as the state of scientific knowledge continues to evolve in this area, the lifecycle GHG assessments for a variety of fuel pathways will continue to change."¹² The Agency further stated that it "...plans to continue to improve upon its [lifecycle] analyses, and will update it in the future as appropriate..."¹³ and "...the Agency is also committing to further reassess these determinations and lifecycle estimates."¹⁴ Unfortunately, EPA has so far failed to follow through on its commitment to update its analysis to reflect the most current data and studies, despite the breadth of new information available. This failure has resulted in the ongoing mischaracterization of ethanol's actual GHG impacts.

Additionally, the analysis of indirect GHG emissions remains highly controversial. As the Committee noted in its white paper, there remains a substantial lack of consensus in the scientific and regulatory communities about the proper methodologies, appropriate analytical boundaries, and suitability of model input data for assessment of indirect GHG effects. According to Parish et al. (2012), "...little consensus exists on how to quantify the indirect effects or even on how to determine whether such effects might be positive or negative."¹⁵ Further, retrospective analyses of land use patterns since adoption of the RFS have concluded that there is little or no evidence that the program has induced ILUC.¹⁶

While predictive ILUC analysis remains highly uncertain and assumption-driven, the methods and data associated with ILUC estimation have somewhat improved since EPA finalized the RFS2. These improvements have resulted in corn ethanol ILUC emissions estimates that are much lower than EPA's estimate for the RFS2. The improved estimates primarily result from better data and enhanced understanding of: the types of land most likely to be converted, the most likely location of predicted conversions, crop yields on newly converted lands, crop yield responses to changes in prices, carbon stocks and emissions from land conversion, the effects of animal feed co-products on land use, and crop switching/cross-commodity effects. New and improved methodologies for accounting for land use

¹² 75 Fed. Reg. 14,765

¹³ 75 Fed. Reg. 14,677

¹⁴ *Id.*

¹⁵ Parish et al. (2012). "Comparing Scales of Environmental Effects from Gasoline and Ethanol Production." *Environmental Management*, 50 (6): 979-1246.

¹⁶ See, for example, Oladosu et al. (2011). "Sources of corn for ethanol production in the United States: a decomposition analysis of the empirical data." *Biofuels, Bioprod. Bioref.* 5:640-653 (2011).

emissions over time (i.e., “time accounting”) have also been established.¹⁷ EPA’s time accounting method was a particularly controversial element of its ILUC analysis.

Important revisions have been made to Purdue University’s GTAP model, which was used by EPA to “cross-check” its LUC results from the FASOM/FAPRI framework. Specifically, improvements were made to the model’s energy elasticities, treatment of distillers grains, land conversion factors for new cropland, treatment of endogenous yield for cropland pasture, handling of cropland switching, and availability of cropland pasture and CRP. The result of these improvements was a reduction in estimated LUC emissions for corn ethanol from 30 g/MJ to 14.5-18.2 g/MJ.¹⁸ Subsequent work by Purdue researchers lowered corn ethanol LUC emissions further to 12.9-17 g/MJ.¹⁹

Meanwhile, LUC modeling conducted in 2011 by the International Food Policy Research Institute (IFPRI) for the European Commission estimated corn ethanol LUC emissions at 10 g/MJ.²⁰ IFPRI utilized the MIRAGE model for this research. In a report released in May 2012, researchers at Argonne National Laboratory and University of Illinois Chicago built upon Purdue’s recent GTAP work to develop a Carbon Calculator for Land Use Change from Biofuels Production (CCLUB) that is included in the newest version of the GREET model.²¹ The CCLUB estimates corn ethanol LUC emissions at 8-9.1 g/MJ. Most recently, Kim, Dale, and Ong estimated corn ethanol LUC emissions at 3.9-8.6 g/MJ using a new allocation method that more accurately assigns LUC emissions among the various drivers of conversion.²² Thus, based on newer data and improved methodologies, the independent estimates of corn ethanol LUC produced since the RFS2 was finalized have generally trended in the range of 7-15 g/MJ (Figure 3). This compares to EPA’s net LUC emissions estimate for corn ethanol of 28.4 g/MJ. Because the FASOM/FAPRI modeling system used by EPA is not readily available to stakeholders, it is unclear whether these models have been similarly updated to reflect more current data and advanced scientific understanding of LUC.

¹⁷ See, for example, Kloverpris, J. & Mueller, S. (2012). Baseline time accounting: Considering global land use dynamics when estimating the climate impact of indirect land use change caused by biofuels. *Int J Life Cycle Assess*, online Sep. 11, 2012.

¹⁸ Tyner, W., Taheripour, F., Zhuang, Q., Birur, D., & Baldos, U. (2010). Land Use Changes and Consequent CO2 Emissions due to US Corn Ethanol Production: A Comprehensive Analysis, Final Report. Available at: <http://www.transportation.anl.gov/pdfs/MC/625.PDF>

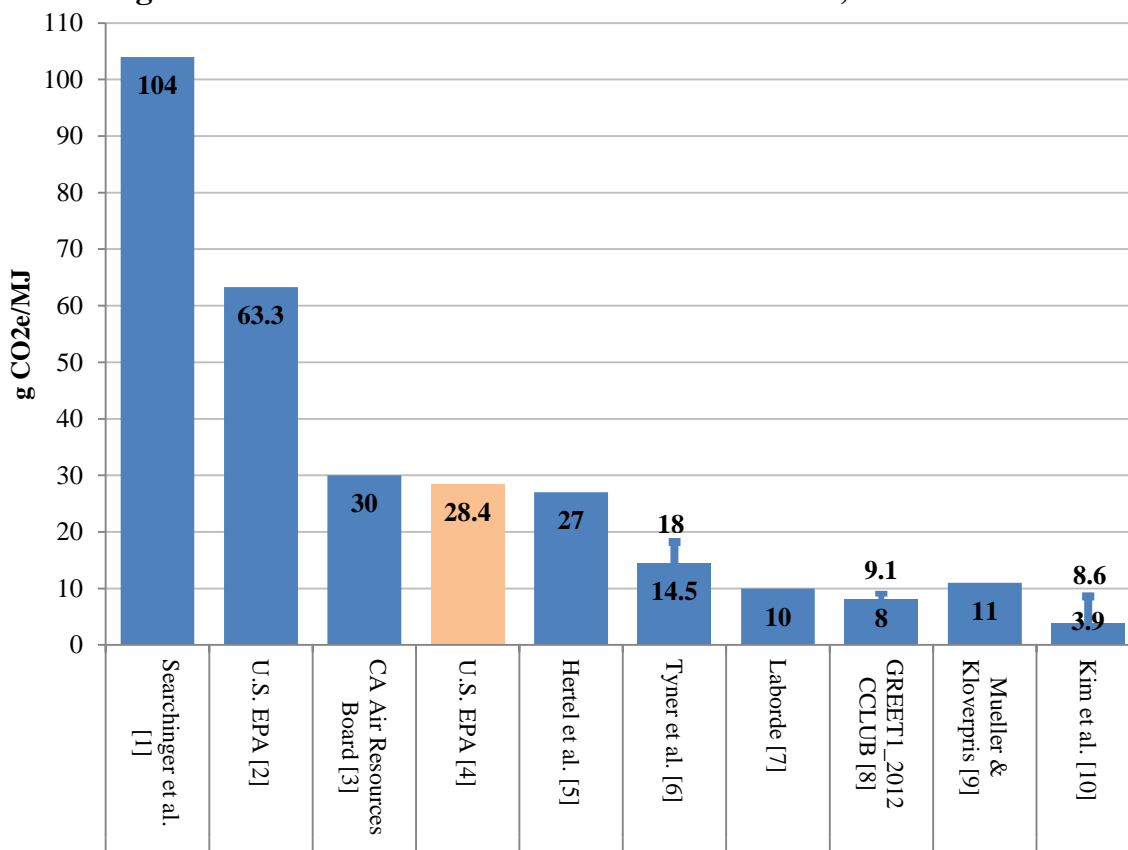
¹⁹ Taheripour, F. & Tyner, W. (2012). Induced land use emissions due to first and second generation biofuels and uncertainty in land use emissions factors. Agricultural & Applied Economics Association’s 2012 Annual Meeting, Seattle, Washington, August 12-14, 2012. Available at: http://ageconsearch.umn.edu/bitstream/124407/2/AAEA_2012%20paper-taheripour%20tyner2.pdf

²⁰ Laborde, D. (2011). Assessing the Land Use Change Consequences of European Biofuel Policies, Final Report. Available at: http://trade.ec.europa.eu/doclib/docs/2011/october/tradoc_148289.pdf

²¹ Mueller, S., Dunn, J., & Wang, M. (2012). Carbon Calculator for Land Use Change from Biofuels Production (CCLUB): Users’ Manual and Technical Documentation. ANL/ESD/12-5. Available at: <http://greet.es.anl.gov/publication-cclub-manual>

²² Kim, S, Dale, B.E., & Ong, R.G. (2012). An alternative approach to indirect land use change: Allocating greenhouse gas effects among different uses of land. *Biomass & Bioenergy*, 46, 447-452.

Figure 3. Corn Ethanol LUC Emissions Estimates, 2008-Present



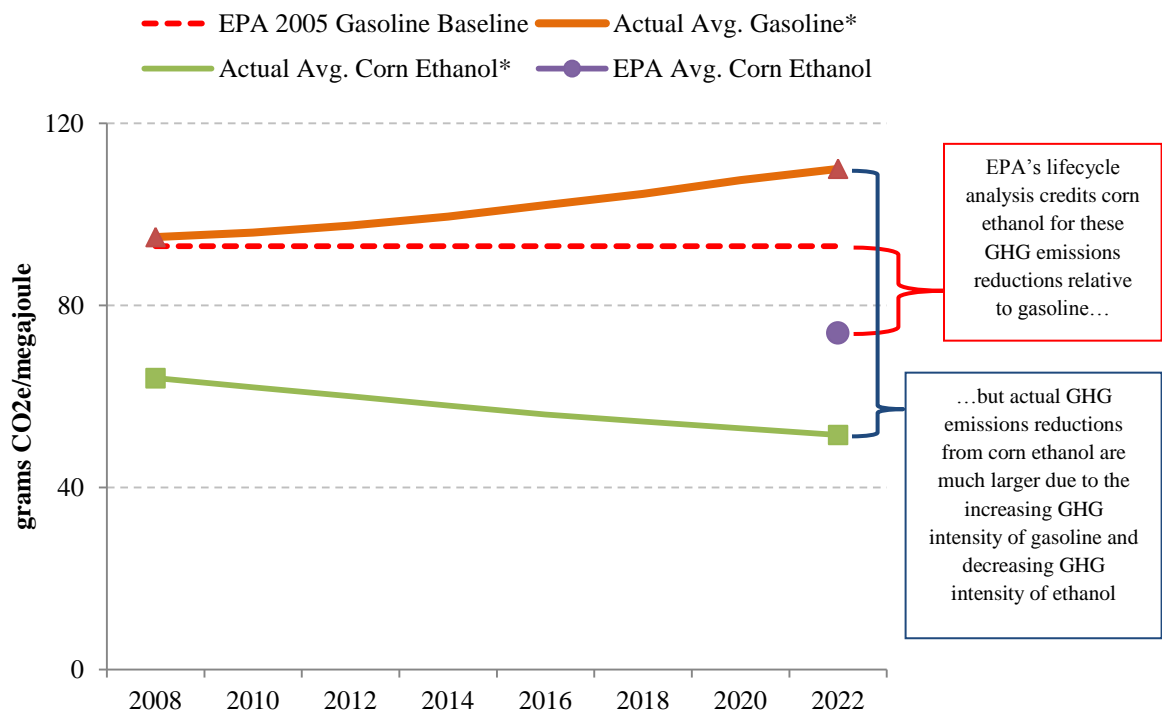
1. Searchinger, T., Heimlich, R., Houghton, R.A., Dong, F., Elobeid, A., & Fabiosa, J. (2008) Use of U.S. croplands for biofuels increases greenhouse gases through emissions from land-use change. *Science*, 319, 1238-1240.
2. U.S. EPA (2009). Notice of Proposed Rulemaking: Changes to Renewable Fuel Standard Program
3. California Air Resources Board (2009). California's Low Carbon Fuel Standard, Final Statement of Reasons.
4. U.S. EPA (2010). Regulation of Fuels and Fuel Additives: Changes to Renewable Fuel Standard Program; Final Rule.
5. Hertel, T.W., Golub, A.A., Jones, A.D., O'Hare, M., Plevin, R.J., & Kammen, D.M. (2010). Effects of US Maize Ethanol on Global Land Use and Greenhouse Gas Emissions: Estimating Market-mediated Responses. *BioScience*, 60, 223-231.
6. Tyner, W., Taheripour, F., Zhuang, Q., Birur, D., & Baldos, U. (2010). Land Use Changes and Consequent CO₂ Emissions due to US Corn Ethanol Production: A Comprehensive Analysis, Final Report.
7. Laborde, D. (2011). Assessing the Land Use Change Consequences of European Biofuel Policies, Final Report.
8. Mueller, S., Dunn, J., & Wang, M. (2012). Carbon Calculator for Land Use Change from Biofuels Production (CCLUB): Users' Manual and Technical Documentation. ANL/ESD/12-5.
9. Klopper, J. & Mueller, S. (2012). Baseline time accounting: Considering global land use dynamics when estimating the climate impact of indirect land use change caused by biofuels. *Int J Life Cycle Assess*, published online. [Value shown is from Hertel et al., corrected for time accounting]
10. Kim, S., Dale, B.E., & Ong, R.G. (2012). An alternative approach to indirect land use change: Allocating greenhouse gas effects among different uses of land. *Biomass & Bioenergy*, 46, 447-452

Another area of significant concern in EPA's existing lifecycle analysis is the use of a static 2005 petroleum baseline. As indicated earlier, the petroleum used in the U.S. today is far more GHG intensive than the 2005 petroleum slate. Thus, comparing today's biofuels to yesterday's petroleum results in a skewed assessment that misrepresents the actual GHG benefits of using renewable fuels in place of petroleum today. This problem is illustrated in Figure 4. We fully understand EPA is bound by the statute

to use a 2005 petroleum baseline as the basis for its lifecycle GHG comparisons; however, we believe it is within EPA’s authority to treat avoidance of high-emitting unconventional petroleum sources as an indirect effect of using renewable fuels and assign marginal petroleum GHG “avoidance credits” to the lifecycle analysis results for biofuels. A method for estimating avoidance credits was proposed in a 2009 analysis (Attachment 4) by RFA:

...substituting biofuels for marginal fossil-based liquid fuels results in the avoidance of significant GHG emissions that are not currently accounted for in lifecycle analysis. These avoided emissions are *in addition to* the emissions reductions relative to average petroleum fuels that are already counted in traditional analysis. In this analysis, avoided emissions resulting from displacement of unconventional liquid fuels range from approximately 8 to 22 grams of CO₂ equivalent per mega joule (g CO₂e/MJ) of energy delivered by biofuels.

Figure 4. A Static Gasoline Baseline Misrepresents Actual GHG Savings from Corn Ethanol



*Actual avg. gasoline and actual avg. ethanol values are illustrative only

EPA’s analysis also fails to assign any indirect GHG emissions whatsoever to baseline petroleum; only biofuels are penalized for potential indirect GHG emissions. As a result, EPA’s analysis is comparing apples to oranges. Recent research and analysis have underscored that all energy options engender

indirect effects.²³ Therefore, if indirect effects are included in the lifecycle assessment for one particular energy source (e.g., ILUC emissions for ethanol), then potential indirect effects also should be included in the assessments for competing energy options (e.g., petroleum). According to a landmark 2009 report by Lifecycle Associates, "...to the extent that economic effects are considered a part of the life cycle analysis of alternative fuels, as is the case with iLUC for biofuels, their effect vis-à-vis petroleum is also of interest."²⁴ The Lifecycle Associates report identified a number of potential indirect effects associated with petroleum that should be considered in the context of lifecycle analysis. Further, a comprehensive paper by Liska & Perrin (Attachment 5) published in *Environment Magazine* argued that military emissions related to securing and transporting oil from the Persian Gulf region should be included in assessments of petroleum's GHG impacts.²⁵ Military emissions tied to securing and transporting Persian Gulf oil are in the range of 78 million metric tons CO₂e, the report found. When these emissions are properly attributed to crude oil imported from the Persian Gulf, the lifecycle GHG emissions of gasoline rise by 19% over baseline gasoline. EPA's current analysis ignores these and other important indirect effects related to petroleum consumption.

3. Is the definition of renewable biomass adequate to protect against unintended environmental consequences? If not, how should it be modified?

Yes, the statutory definition of "renewable biomass" and EPA's implementation of the statutory provisions have adequately guarded against adverse environmental consequences. As proven by USDA data, agricultural land use has not expanded as a result of the RFS. The definition should not be modified.

With regard to planted crops and crop residues used as feedstocks for RFS-qualifying renewable fuels, the Energy Independence and Security Act allows only feedstocks from agricultural land cleared or cultivated at any time prior to Dec. 18, 2007 that is either actively managed or fallow, and nonforested. In consultation with USDA, EPA determined that there were 402 million acres of agricultural land under active management or fallow as of Dec. 18, 2007. Thus, the Agency determined if agricultural land use remains below the 2007 "baseline," regulated parties are compliant with the renewable biomass provision. This provision, along with numerous existing conservation and agricultural laws designed to protect sensitive lands, has ensured that agricultural land use has not expanded in response to the RFS. Indeed, agricultural land use since 2007 has been below the baseline every year, demonstrating that farmers have not expanded cropland in response to demand for biofuels under the RFS. In 2012, for example, agricultural land use was determined to be 384 million acres, 18 million acres (4.5%) below the 2007 baseline.²⁶

Further, all biofuel producers must submit a renewable biomass report on a quarterly basis to ensure ongoing compliance with the program's requirements. For feedstocks that do not qualify for EPA's "aggregate compliance" determination, quarterly reports must be submitted individually for each separate

²³ See California Air Resources Board LCFS Expert Work Group sub-group report on indirect effects for other fuels: <http://www.arb.ca.gov/fuels/lcfs/workgroups/ewg/010511-final-rpt-alternative-modeling.pdf>

²⁴ Unnasch, S., et al. (2009). "Assessment of Life Cycle GHG Emissions Associated with Petroleum Fuels." Life Cycle Associates Report LCA-6004-3P. Prepared for New Fuels Alliance.

²⁵ Liska, A., & Perrin, R. (2010). "Securing Foreign Oil: A Case for Including Military Operations in the Climate Change Impact of Fuels." *Environment* 52:4, pp. 9–22.

²⁶ 78 Fed. Reg. 9287.

plot of land from which feedstocks were harvested, and additional electronic files that identify each plot of land by coordinates of the points defining the boundaries of each plot simultaneously submitted.

4. What are the non-greenhouse gas impacts of the RFS on the environment relative to a comparable volume of petroleum-derived fuels? Is there evidence of a need for air quality regulations to mitigate any adverse impacts of the RFS?

In addition to reducing GHG emissions, the renewable fuels used for compliance with the RFS offer many other environmental benefits relative to petroleum use. In particular, ethanol has long been recognized for its substantial air and water quality benefits relative to gasoline. Unlike gasoline, ethanol is non-toxic and biodegradable.

Ethanol has been used over the past two decades as a gasoline oxygenate to reduce smog formation and low-level ozone pollution in urban areas across the country. Ethanol reduces tailpipe carbon monoxide emissions by as much as 30%, toxics content by 13% (mass) and 21% (potency), and tailpipe fine particulate matter (PM) emissions by 50%. Further, ethanol is the cleanest and most affordable source of octane on the market today, displacing toxic and carcinogenic aromatics such as benzene and toluene.

Ethanol is also rapidly biodegraded in water and soil, and is the safest component found in gasoline today. A study conducted for the Massachusetts Department of Environmental Protection concluded that "...biodegradation [of ethanol] is rapid in soil, groundwater and surface water, with predicted half-lives ranging from 0.1 to 10 days. Ethanol will completely dissolve in water, and once in solution, volatilization and adsorption are not likely to be significant transport pathways in soil/groundwater or surface water."²⁷

Moreover, the previously cited study by scientists at Duke University, Oak Ridge National Laboratory, and the University of Minnesota directly compared the lifecycle environmental effects of ethanol and gasoline, taking into consideration a broad range of potential impacts on air, water, land, and human and animal welfare. The authors found that gasoline has significantly more negative impacts on the overall environment than ethanol. Further, the potentially adverse impacts associated with ethanol use are "more easily reversed" and "of a shorter duration" than effects associated with gasoline use. Additionally, the authors found:

Effects of the gasoline pathway have distinctive spatial extents involving remote and fragile ecosystems, the significant subterranean dimension of disturbances, and the temporal shifting of huge volumes of GHGs from prehistoric times to today's atmosphere. Ethanol expansion has the potential to reduce environmental impacts when compared to current gasoline production and its support systems...²⁸

In comparing the overall environmental impacts of gasoline to ethanol, the authors performed an extensive literature search and identified nearly 70 distinct adverse environmental effects related to the gasoline production supply chain (Attachment 6). The temporal duration of many of the identified

²⁷ <http://www.mass.gov/eopss/docs/dfs/emergencyresponse/special-ops/ethanol-spill-impacts-and-response-7-11.pdf>

²⁸ Parish et al. (2012). "Comparing Scales of Environmental Effects from Gasoline and Ethanol Production." *Environmental Management*, 50 (6): 979-1246.

gasoline impacts is *centuries to millennia*, while the geographic scale of several of the impacts is regional to global. By comparison, potential environmental impacts associated with ethanol use were found to be far fewer, of shorter temporal duration, and of a narrower geographic scope.

In regard to air quality regulations, the weight of evidence shows the renewable fuels used for the RFS improve air quality relative to comparable volumes of petroleum-derived fuels. Additionally, both mobile source and stationary source emissions are already tightly regulated by EPA and state regulatory agencies.

5. Has implementation of the RFS revealed any environmental challenges or benefits not fully anticipated in the statute?

We do not believe RFS implementation has revealed any environmental challenges that were not anticipated. The statutory GHG reduction requirements and renewable biomass provisions have effectively safeguarded against adverse environmental impacts. In terms of unanticipated benefits, we believe the GHG reductions resulting from the RFS have been greater and have occurred more quickly than was anticipated by EPA's analysis.

6. What is the optimal percentage of ethanol in gasoline? What is the optimal percentage of biomass-based diesel in diesel fuel?

The optimal percentage of ethanol in gasoline has yet not been definitively determined. It will depend on numerous factors, including light duty vehicle engine design, refueling infrastructure certification and compatibility, emissions performance, and other considerations. Recent research conducted by automakers has shown ethanol's unique properties—including its exceptionally high octane content—may be best utilized by modern internal combustion engines at a blend of 20-30% vol. ethanol (E20-E30). A recent paper published by Ford Motor Company (Attachment 7) concludes that one means of meeting new and increasingly rigid CAFE/GHG standards is through the use of direct injection and higher compression ratio engines. Such engines would require a higher octane motor fuel, and the most cost effective octane booster available today is ethanol. According to the Ford paper:

- “The physical properties of ethanol provide important benefits when added to gasoline. Ethanol has both a higher octane rating and a higher heat of vaporization than typical gasoline.”
- “Ethanol improves octane ratings when added to gasoline. The RON and AKI of pure ethanol are approximately 109 and 99, respectively, much higher than regular or premium-grade US gasoline.”
- “Higher minimum octane ratings for regular-grade fuel would enable higher compression ratios in future vehicles and is an opportunity to provide greater engine efficiency and meet increasingly stringent fuel economy regulations and expectations.”
- “...it appears that substantial societal benefits could be obtained by capitalizing on the high octane rating of ethanol through the introduction of higher octane number ethanol-gasoline blends to the US marketplace.”

Additionally, if ethanol accounts for most of the renewable fuel used to meet the long-term RFS requirements (as assumed by EPA in its “high ethanol” case in the RFS2 Regulatory Impact Analysis), the average blend rate will need to be in the range of E22-E27. This means the approximate level of

ethanol in gasoline needed to comply with the long-term required RFS2 volumes generally coincides with the level of ethanol in gasoline that is thought to be optimal based on initial research by automakers.

7. What are the best options for substantially further reducing greenhouse gas emissions from the transportation sector? Is the RFS an important component of such efforts?

The RFS is absolutely the best policy option available for further reducing GHG emissions from the transportation sector—but such reductions will only be achieved if the RFS is left intact and investors are assured that there will be a lasting market for renewables. The RFS program has already demonstrated its ability to encourage widespread use of lower-emitting renewable fuels. As discussed above, it is generally believed that the next generation of biofuels from cellulosic feedstocks will further reduce GHG emissions relative to gasoline. Broad commercialization of these cellulosic biofuels likely will not be possible in the absence of the RFS and the market certainty it provides.

* * * * *

Thank you again for the opportunity to comment. If there is any additional information you would like RFA to provide, please do not hesitate to ask.

Sincerely,

A handwritten signature in black ink, appearing to read "Bob Dinneen", with a stylized flourish at the end.

Bob Dinneen
President & CEO