Ethanol Risk and Insurance Solutions
125 N First Street | Colwich, KS 67030
erisolutions.com

Sent via email to ksideco@arb.ca.gov

November 10, 2014

Michael Waugh
Chief, Transportation Fuels Branch
California Air Resources Board
1001 I Street
Sacramento, CA 95812

Katrina Sideco
Air Resources Engineer, Fuels Section
California Air Resources Board
1001 I Street
Sacramento, CA 95812

Dear Mr. Waugh and Ms. Sideco,

ERI Solutions Inc. provides risk management, environmental, health and safety products and services to 86 ethanol plants in the United States, California, Canada, South America and the European Union. To date, we have performed 66 carbon intensity carbon modeling projects for produced ethanol to be shipped within North America, California, Canada and the European Union.

Following are two specific comments regarding the restructuring and re-adoption of the Low Carbon Fuel Standard ("LCFS"). As the California Air Resources Board of Directors (CARB) moves toward re-adoption of the LCFS in the first quarter of 2015, we recommend that the program be strengthened in two ways that will increase and accelerate ethanol plant investment within the US and California, and more rapidly get low carbon ethanol gallons into the California marketplace. Therefore, we recommend that the following actions be made part of the re-adoption of the California LCFS.

1. LCFS low carbon intensity (CI) applications currently on file (pending) with CARB staff, or applications soon to be filed for a plant specific CI number become available for use by

the ethanol plant and obligated party immediately upon approval by CARB staff. Use of the staff approved plant specific CI number will be the actual posting date to CARB's LCFS web page. This will occur the date the LCFS re-adoption by CARB occurs (tentatively early 2015). This system is currently used by CARB and works for private industry. We believe this approach will avoid potential situations where further CARB review and approval would delay use of low CI plant numbers to as late February of 2016. This authorization will allow low CI ethanol to penetrate the California marketplace immediately.

2. Postpone use of an Indirect Land Use Change (ILUC) penalty number until carbon modeling science reflects actual U.S. Agricultural trends for the past 34 years of fewer acres and those acres producing higher yields for the eight major U.S. crops (including corn) for the past 54 years. The European Union has required tracking of ILUC but not included any such penalty in their CI calculations to meet their Renewable Energy Directive (RED). Attached find a paper that ERI was commissioned to write for the nonprofit non-partisan education campaign of the Clean Fuels Foundation sponsored by industry, government and private interests. This paper, in part, deals directly with the consequences of ILUC adders that have ranged from 0.00 grams CO2/MJ to 104.0 grams CO2/MJ. The paper also points out that modeling science is not sufficiently mature to determine the validity of any ILUC adder, and that ILUC should be at least zero (0) for the present.

Respectfully submitted,

Bill Roddy

Bill Roddy
Vice President, Sustainability
(316) 927-4268

Attachment: Carbon Modeling and ILUC – Separating Fact from Fiction

cc: Nate VanderGriend, President, ERI Solutions
Graham Noyes, Low Carbon Fuels Coalition

Carbon Modeling and ILUC —Separating Fact from Fiction

An Ethanol Across America White Paper

Winter 2011

So, What's My Carbon Number?

Marketing a plant's ethanol has become unnecessarily complex because of differing compliance obligations associated with greenhouse gas (GHG) regulations in the European Union (EU), United States (U.S.) and California (CA). Now there is another hurdle associated with non-grandfathered gallons under the U.S. Renewable Fuel Standard 2 (RFS2). No longer may an ethanol plant merely produce ethanol and contract to ship it to these markets. Now, ethanol produced must meet given fuel specifications by differing carbon intensity standards that depend on field-to-wheels (FTW) life-cycle carbon accounting by either a regulatory specific carbon model; or by a carbon model that meets specified calculation and peer reviewed database standards. These modeling calculations have resulted in ethanol having higher carbon intensity than the gasoline into which it is blended (in some cases). To make it more complex, gasoline carbon intensity is different in the EU, U.S., and CA. In the U.S. and CA ethanol is further burdened with a penalty for indirect land use change (ILUC) adder. Currently there is no ILUC penalty in the EU. This regulatory dilemma is a direct result of ILUC penalties (adders) now being applied to grain feedstocks, e.g., corn. The regulatory response in the United States to what is perceived by many experts as bad science, has been "the law requires an ILUC penalty." The EU has been driving carbon reductions by their own Renewable Energy Directive (RED), and has properly deferred any ILUC penalties pending further research. This paper will explain various fuel ethanol carbon numbers derived by different carbon models and will offer evidence that no crops grown in the United States have been displaced to the point they must now be grown in other countries. Thus, ILUC should be at least zero (0) if not a credit for a given plant's ethanol carbon intensity.

Bill Roddy

Bill Roddy brings 36 years of experience from the private and public sectors with ERI Solutions, as the Director of Environmental Compliance.

Bill and his ERI Environmental team have experience in 10 countries and 37 states providing air, water, and waste permitting services for ethanol plant customers. Bill has enabled ERI to provide turn-key environmental services for plant owners, including carbon modeling and life-cycle assessments necessary to ship ethanol to Europe and California. To date, the ERI team has performed carbon modeling for over 20 ethanol plants.

Bill's previous professional experience includes positions as Corporate Manager of Environmental Affairs for ICM, Inc., Director of Environmental Compliance and Director of Air Quality Management for Koch Industries, Inc., and Director of Kern Air Pollution Control District in California. He also earned his ISCC Auditor Certification in 2010 in Cologne, Germany.

Carbon Cycle....Quick Refresher

The carbon cycle is the process through which carbon is cycled and recycled through the air, ground, plants, animals and fossil fuels. New carbon is introduced to the atmosphere from human activities (e.g., fossil fuels) and recycled carbon is carbon that exists and is recycled (e.g., biogenic carbon).

Here's some history. At the beginning of 2010 the Earth's atmosphere had approximately 390 ppm CO_2, compared to 1958 where the CO_2 was measured at 315 ppm (both measurements were taken at Mauna Loa, Hawaii). Scientists have estimated that CO_2 in the Earth's atmosphere was approximately 284 ppm in 1832, based off Antarctic ice cores retrieved on June 12, 2007. This and other ambient data supports the theory that human activities are responsible for increasing global ambient CO_2 concentrations.

For the purpose of determining a plant's FTW carbon number, only new carbon is considered for carbon intensity calculations whereas recycled (neutral) carbon is not part of international carbon accounting calculations. GHGs (new carbon) directly emitted by human (anthropogenic) activities include:

- Carbon Dioxide (CO_2)
- Methane (CH_4)
- Nitrous Oxide (N_2O)
- Hydrofluorocarbons (HFC)
- Perfluorocarbons (PFC)
- Sulfur hexafluoride (SF_6)

Continued

Figure 1: The Carbon Cycle. This diagram shows New versus Recycled/Neutral carbon.

Lots of carbon models....pick one.

There are a number of peer-reviewed carbon models (architect in parenthesis) available that help determine the FTW carbon number for an ethanol plant:

- GREET (Wang)
- CA-GREET (CARB Modified)
- BEACON (Mueller)
- EBAMM (Ferrell)
- BESS (Liska)
- ICM/Econergy (Huisenga)
- ICM/Econergy EU (Huisenga)

These carbon models (except for ICM/Econergy models) are in the public domain and yield results that differ by as much as 40%. Because of this dramatic difference, in 2009 the U.S. Department of Energy (DOE) funded a modeling study by WSP Group to compare the outputs of the three leading carbon models (GREET, BESS and ICM/Econergy) by using common emission factors and calculation procedures. When these adjustments were made, the three models yielded carbon intensity results (without ILUC penalty) for Midwest corn ethanol that were within 1.0 gram CO_2e/MJ, or within 1.6%. This compares to a 34% difference in modeled results when the adjustments are not made. Thus, the DOE-funded study proves that the critical comparison of these three leading carbon models yielded comparable results based on FTW basis. The inference is that any legitimate carbon model (listed above) with common inputs will yield equivalent FTW carbon intensity outputs.

Compare this to a simple hand held calculator, one using reverse polish and the other arithmetic inputs to make calculations, where 2 x 2 = 4, regardless of the type calculator. The point being, any carbon model must be allowed by a regulatory agency (EPA and CARB) provided the carbon model meets a certain set of criteria. The EPA requires GREET (for RFS2) and California Air Resources Board (CARB) requires CA-GREET in order to determine carbon

Figure 2: WSP Comparisons of Model Outputs shows the three models that were run as part of WSP's DOE analysis.

Anhydrous ethanol	Units	GREET	GREET*	BESS	BESS*	ICM	ICM*
Corn production	g CO_2e/MJ	37.5	38.1	29.6	37.6	39.2	38.7
Biorefinery	g CO_2e/MJ	40.8	36.2	30.8	36.0	28.7	36.0
Co-product credit	g CO_2e/MJ	-17.4	-16.9	-16.9	-16.9	-14.7	-16.9
TOTAL	g CO_2e/MJ	60.8	57.4	43.5	56.7	53.1	57.8
Denatured ethanol							
Ethanol contribution	g CO_2e/MJ	56.6	53.3	40.4	52.8	49.4	53.7
Denaturant contribution	g CO_2e/MJ	6.5	6.5	6.5	6.5	6.5	6.5
Denatured EtOH GWI	g CO_2e/MJ	63.0	59.8	46.9	59.2	55.9	60.2
Fuel distribution							
Distribution	g CO_2e/MJ	1.4	1.4	1.4	1.4	1.4	1.4
TOTAL	g CO_2e/MJ	**64.5**	**61.3**	**48.3**	**60.7**	**57.3**	**61.7**

*Adjusted inputs for GBAMM model comparison.

Conclusion: With common emission factors and calculation procedures the range between the 3 model outputs (*) is reduced to only 1.0 g CO_2/MJ, or a difference of 1.6%.

intensity values. On the other hand, in Europe, the International Sustainability and Carbon Certification (ISCC) #205 authorizes use of any carbon model as long as the model contains a prescribed set of emission factors and calculation procedures..... exactly what the U.S. DOE comparison study has proven to be accurate. Why has the U.S. EPA and CARB complicated carbon accounting by prescribing specific carbon intensity models that are proven to yield results that are not comparable? The U.S. DOE has recognized this dilemma; still the U.S. EPA and CARB have failed to amend their regulations to make carbon accounting by any model simpler for business. From a practical point of view, this EPA and CARB bureaucracy results in up to nine month delays in EPA and CARB pathway applications. To correct this problem, it is recommended that the U.S. EPA and CARB amend their regulations to follow the EU's example. The end result will be better science being used to yield more comparable carbon numbers.

Indirect Land Use Change Penalty

The U.S. and CA regulations all require ILUC be included in modeled carbon intensity. ILUC is best defined as "human induced" land use change on a global basis. There continues to be significant scientific debate that land use changes related to ethanol production in the United States may, or may not, result in increased global carbon emissions that could be indirectly attributed to increased corn production in the United States. To conclude that the growing of corn in the United States indirectly results in increased acres of soybeans grown in Brazil or Argentina, or that deforestation of rainforests in Brazil is indirectly related to corn production in the United States is presently without merit. In 2008 the EU recognized that ILUC modeling science was not sufficiently mature to determine the validity of any ILUC adder and subsequently postponed use of an ILUC penalty to ethanol carbon intensity. The United States has not taken any such position and EPA and CARB continually claim that ILUC adders must be included in the calculation. Until resolved, ILUC variability is as follows:

SOURCE	ILUC ADDER
Searchinger	104.0 grams CO_2/MJ
CARB (CA)	30.0 grams CO_2/MJ
EPA (U.S.)	28.4 grams CO_2/MJ
Purdue University	13.9 grams CO_2/MJ
Jones	6.9 grams CO_2/MJ
European Union	0.0 grams CO_2/MJ

ERI Solutions, Inc. has pointed out to both the EPA and CARB that corn ILUC should be at least zero (0), if not a negative (minus). In support, United States corn acres have been steadily decreasing from 94 million acres in 2007 to 92 million in 2011, while yields are fluctuating between 153 bu/acre and 148 bu/acre from 2007–2011. Based on this data, grain or soybeans are not grown in South America due to corn displacing any U.S. crops.

In response to further ILUC debate that United States grain production in general causes crops, like soybeans, to be grown outside of the United States, Figure 3 charts the 8 major United States crops (7 grains and 1 soybean) over the past 51 years. Not only do historical trends show a decrease in hectares (acres), but an overall increase in yields. Thus, none of the 8 major United States crops have been grown outside of the United States for any reason, except farming economics, over the past 31 years. All carbon models will result in lower FTW ethanol carbon intensity when crop yields increase and acres farmed decrease. Current ILUC models must be modified to show decreasing U.S. acres and increasing U.S. yield trends. The end result must be an ILUC credit (minus) not an ILUC adder.

In contrast to the United States where acres are decreasing; it is a common belief in Europe that only "idle land" (in the EU) is being used for increases in cereal (grain) crop production, and that cereal demand is not shifting to South America for EU's protein needs. Thus, there should continue to be no ILUC penalty. There is a shared belief by many in the EU (like in the United States) that ILUC carbon modeling science does not yet exist to support any ILUC number (positive or negative). In fact, there are cases where producing more grain in the EU would, in fact, reduce demand for protein imports. In this case, there would be an ILUC credit not a penalty.

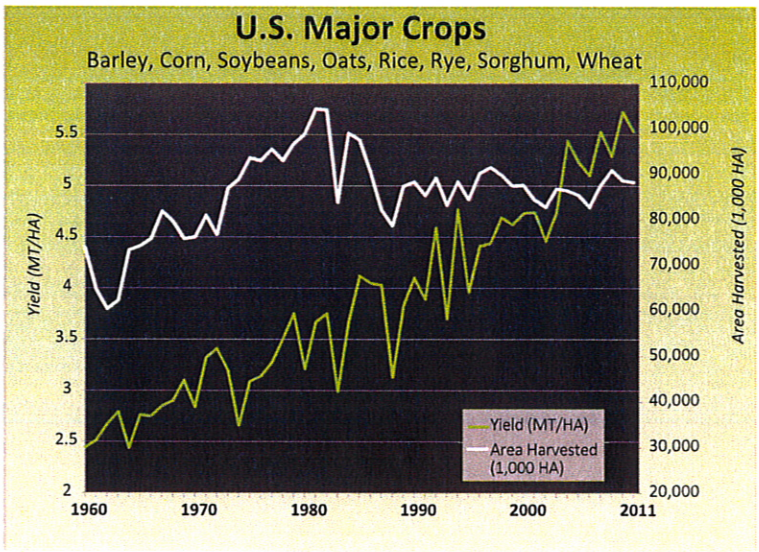

Figure 3: Major U.S. Crops. This graph (prepared by a research team at ICM, Inc.) shows the 8 major U.S. crop yields vs. hectares (acres) harvested. Higher crop yields on fewer hectares (acres) is believed to be sufficient to allow the U.S. and CA to conclude that no crops over the past 51 years have been displaced to any other country for any reason except farming economics.

Finally, if the average carbon intensity of corn-based ethanol in the United States is 70.4 grams CO_2e/MJ (GREET model) and the ILUC corn adder according to CARB is 30 grams CO_2e/MJ (or U.S. EPA 28.4 grams CO_2e/MJ), then corn-based ethanol would have a carbon intensity between 98.8 and 100.4 grams CO_2 e/MJ. This contrast leads one to conclude that ethanol will have higher carbon intensity than gasoline, and can lead to the erroneous conclusion that gasoline should be blended with ethanol in order to reduce motor vehicle fuel carbon content. In the United States, gasoline on a well-to-wheels basis is 92.6 grams CO_2e/MJ (GREET) and 95.9 grams CO_2e/MJ (CA-GREET) in California. It is interesting to note, that the EU pegs gasoline at 83.8 grams CO_2 e/MJ per their Renewable Energy Directive (RED).

Therefore, it is recommended that the U.S. EPA and CARB postpone any ILUC determination for many of the same reasons that led the EU to postpone ILUC.

Ethanol Carbon Numbers

Based on ICM/Econergy Modeling outputs, the following are FTW ethanol carbon intensity numbers for various feedstocks using CARB's ILUC of 30 grams CO_2e/MJ (corn) and 46 grams CO_2e/MJ (Brazilian cane ethanol). Non-corn feedstocks are assumed to have zero (0) ILUC:

Source (comparison purposes):	w/o ILUC gCO2/MJ	w/ ILUC gCO2/MJ
Dry Grind Corn Coal:	72.8	102.8
Regular Gasoline (GREET):	**92.6**	**92.6**
Dry Grind NG Corn (100% DDGS):	60.1	90.1
Dry Grind NG Corn (100% wet cake):	49.4	79.4
Brazilian Bagasse Cane (Sao Paulo inputs):	29.4	75.4
Dry Grind NG Milo:	60.5	60.5
Dry Grind Corn Stover (Biomass, CHP) :	30.4	60.4
Dry Grind NG Milo + Wheat Starch Water (Russell Plant):	45.9	45.9
Switch Grass Cellulosic with Biomass Gasification:	29.2	29.2

Figure 4: Typical ICM/Econergy Model Outputs (with and without ILUC)

Depending on feedstock and energy source, and without ILUC, all plants producing ethanol—even plants using high carbon coal—will yield a carbon intensity number that is less than gasoline. The only unproven technology that remains is cellulosic ethanol. Various technology providers are constructing and testing cellulosic ethanol pilot plants with the goal of it being an add-on technology for standard dry-grind plants that will substantially reduce ethanol's carbon intensity. If ILUC is added to any existing ethanol pathway, only the coal fired plant would produce ethanol that has higher carbon content than gasoline.

Conclusions

1. In all cases, carbon modeling yields a far lower carbon intense ethanol when compared to gasoline (the single exception being coal with ILUC adder).
2. Ethanol (except Brazilian cane ethanol) is domestic in origin and directly displaces higher carbon intense gasoline. More ethanol in the market place results in reduced dependence on imported crude oil.
3. ILUC adders must be postponed by CARB and EPA until ILUC modeling science reflects actual U.S. agricultural trends since 1980 of fewer acres, and those acres producing higher yields for the eight major U.S. crops (including corn) for the past 51 years. Otherwise, carbon models will continue to yield results showing ethanol with a higher carbon intensity number than that of gasoline – a very serious error that would undermine the low carbon benefits of ethanol.
4. To minimize delays due to government bureaucracy in establishing approved pathways, both the EPA and CARB must amend their regulations to allow the use of any carbon model that meets a common set of standards. For example, the EU ISCC #205 GHG Emissions Calculation Methodology details exactly how full life-cycle carbon emission calculations must be performed in determining carbon intensity of ethanol.

Nebraska Ethanol Board

This ***"Carbon Modeling and ILUC"* White Paper** was produced and is distributed as part of a continuing series sponsored by the Ethanol Across America education campaign with support from the Nebraska Ethanol Board. The ***Ethanol Across America*** White Paper series provides an opportunity for public officials, industry, academia and others to express their views on issues relating to the development of ethanol and other alternative fuels. Interested parties are encouraged to submit papers or ideas to **cfdcinc@aol.com**.

ETHANOL ACROSS AMERICA

Ethanol Across America is a non-profit, non-partisan education campaign of the Clean Fuels Foundation and is sponsored by industry, government, and private interests. U.S. Senators Ben Nelson (D-NE) and Richard Lugar (R-IN), Co-Chairmen. For more information, log on to **www.ethanolacrossamerica.net** or contact Douglas A. Durante, Director.

ethanol