HEARING TO REVIEW THE IMPACT OF THE INDIRECT LAND USE AND RENEWABLE BIOMASS PROVISIONS IN THE RENEWABLE FUEL STANDARD

HEARING

BEFORE THE

SUBCOMMITTEE ON CONSERVATION, CREDIT, ENERGY, AND RESEARCH

OF THE

COMMITTEE ON AGRICULTURE
HOUSE OF REPRESENTATIVES

ONE HUNDRED ELEVENTH CONGRESS

FIRST SESSION

MAY 6, 2009

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HEARING TO REVIEW THE IMPACT OF THE INDIRECT LAND USE AND RENEWABLE BIOMASS PROVISIONS IN THE RENEWABLE FUEL STANDARD

WEDNESDAY, MAY 6, 2009

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON CONSERVATION, CREDIT, ENERGY, AND RESEARCH,
COMMITTEE ON AGRICULTURE,
Washington, D.C.

The Subcommittee met, pursuant to call, at 11:10 a.m., in Room 1300 of the Longworth House Office Building, Hon. Tim Holden [Chairman of the Subcommittee] presiding.

Members present: Representatives Holden, Herseth Sandlin, Halvorson, Dahlkemper, Markey, Schauer, Kissell, Boccieri, Massa, Bright, Kratovil, Minnick, Peterson (*ex officio*), Goodlatte, Moran, King, Schmidt, Smith, Latta, Luetkemeyer, Thompson, Cassidy, and Pomeroy.

Staff present: Nona Darrell, Adam Durand, Craig Jagger, Tyler Jameson, Robert L. Larew, Anne Simmons, Cherie Slayton, Rebekah Solem, Kristin Sosanie, Patricia Barr, Brent Blevins, Tamara Hinton, Josh Maxwell, and Jamie Mitchell.

OPENING STATEMENT OF HON. TIM HOLDEN, A REPRESENTATIVE IN CONGRESS FROM PENNSYLVANIA

The CHAIRMAN. This hearing of the Subcommittee on Conservation, Credit, Energy, and Research to review the impact of the indirect land use and renewable biomass provisions in the Renewable Fuel Standards will come to order.

I would like to welcome our witnesses to today's hearing. In this hearing we hope to examine the impact of indirect land use and renewable biomass provisions in the Renewable Fuel Standard. As our economy continues to change, we will rely more and more on biofuels. Farmers can be at the forefront of this revolution by using the commodities they grow, and even the waste, that they now have to find ways to discard in innovative new ways to produce transportation fuels. Linking agriculture and renewable fuels is important to diversify our energy market, protect our environment, and revitalize rural America.

I am pleased to be from a state that is leading efforts to lessen our nation's dependency on imported oil. Pennsylvania is at the forefront of promoting renewable energy and will continue to be at

this helm, but only if its feedstock potential is eligible for use under the new Renewable Fuel Standard.

One concern in the new Renewable Fuel Standard as put forward in the Energy Independence Act and Security Act of 2007, is how lifecycle greenhouse gas emissions will be defined and regulated. The law calls for the total amount of greenhouse gas emissions, including direct and indirect emission sources, to be counted. But how do we define indirect emissions from land use changes. Indirect land use changes are not a case of, "we know it when we see it." We must use models to forecast what may occur and have to make assumptions that may not be correct. How do we ensure accuracy? How far do we go? How do we calculate an assumed ripple effect?

I would like to include in the record letters from a wide range of respected researchers, scientists, and economists and industry groups that oppose the supposed science behind the indirect land use changes and realize that they are something we cannot measure or quantify. And I would like the Ranking Member and the Chairman of the full Committee and other Members present just to look at the size of the comments we have received so far.

[The information referred to is located on p. 98:]

The CHAIRMAN. When the science is so uncertain requiring inclusion of indirect land use changes, it is really not the proper way to address international policy decisions on how to stop the clearing of the Amazon Rainforest.

Furthermore, the definition of *renewable biomass* contained in H.R. 6 is problematic because it could exclude a majority of the country's woody biomass. The definition would exclude much forestland because it was not clear cut and then replanted. Hardwood forestland in my home State of Pennsylvania, and much of the Northeast, as well as several other regions of the country, could be an important component in meeting the new Renewable Fuel Standard, but would be excluded by this definition.

Pennsylvania also has hundreds of thousands of acres of abandoned mine lands. These lands can be restored and planted with conserving grasses such as switchgrass, which could be used for cellulosic biofuel. Being able to use the abandoned mine land for growing feedstocks would create an economic incentive to restore the desolate landscape which now relies on inadequate Federal and state funds. But, under the new Renewable Fuel Standard the statute requires land to have been previously cultivated.

If we continue with these provisions in H.R. 6, we will shortchange a large part of the country before we even get started. It is the statute which was not created through regular order that is a problem, and it needs to be changed to allow for a greater flexibility. We need to expand the reach of biofuels, not hamper the farmer and forest owner. We need to increase biofuels production, not restrict our energy independence.

I am extremely interested in hearing what our witnesses say today. I hope we can then move forward to ensure agriculture's continued role in producing renewable fuels and reducing America's dependence on imported oil.

I thank our witnesses for being here today.

I now recognize the Ranking Member of the Subcommittee, the gentleman from Virginia, Mr. Goodlatte.

OPENING STATEMENT OF HON. BOB GOODLATTE, A REPRESENTATIVE IN CONGRESS FROM VIRGINIA

Mr. GOODLATTE. Well, thank you, Mr. Chairman, and you will find from my remarks that we are in considerable agreement about the state of affairs. I very much appreciate you holding his hearing today to review the impact of the indirect land use and renewable biomass provisions in the Renewable Fuel Standard.

The Energy Independence and Security Act of 2007, dramatically increased the RFS to 36 billion gallons by 2022. The expanded RFS also created an unrealistic mandate for conventional corn ethanol by prohibiting the use of feedstock from new crop acres. This restriction will make it difficult, if not impossible, for producers to meet the food and fiber demands of our consumers, while also meeting the mandate set in the RFS.

We also face a major problem in the transition from grain-based fuels to cellulosic biofuels because the Act restricts the cellulosic feedstocks from forests and agriculture lands that can be used to meet the RFS. Virginia has been in the business of agriculture for over 400 years. Much of the uncropped land in the 6th District has the potential to grow switchgrass and help meet the demands of cellulosic ethanol, if and when it becomes commercially available. However, the unnecessary land restrictions in the RFS will limit potential biomass to be used to meet the mandate.

The Act also discourages the production of cellulosic fuels from forests, one of the largest potential sources of cellulosic feedstock. The *renewable biomass* definition in EISA limits my home State of Virginia to 2 million acres of eligible forestland to meet the RFS compared to 15 million acres if we use the biomass definition in the 2008 Farm Bill.

The use of forest biomass for biofuels creates markets for byproducts of forest improvement projects. This can help solve our nation's energy, forest health, and wildfire problems and also help forest owners stay on the land. I am supportive of the development of renewable fuels, but more importantly, I am in favor of developing a policy that is technology-neutral and allows the market to develop new sources of renewable energy.

It has been over 2 years since the passage of the 2007 Energy Bill. Yesterday the EPA released the long-awaited proposed regulations for the expanded RFS. I wish I had had more time to review the 600 pages before today's hearing, however, I look forward to reviewing EPA's proposal, as I am sure many people are curious on how they determine their model for lifecycle greenhouse gas emissions and how indirect land change was involved.

I would also like to welcome all our witnesses for their testimony today. I am particularly pleased to welcome Ms. Anitra Webster, a tree farmer from Lynchburg, Virginia, with more than 20 years of experience in the field of forestry. Ms. Webster is a constituent of mine who brings a unique point of view to today's hearing as someone who owns a family tree farm. Ms. Webster understands the implications of the current definition of *biomass* in the Renewable Fuel Standard, and I look forward to hearing her testimony.

Mr. Chairman, thank you very much.

The CHAIRMAN. The chair thanks the gentleman and recognizes the Chairman of the full Committee, Mr. Peterson.

OPENING STATEMENT OF HON. COLLIN C. PETERSON, A REPRESENTATIVE IN CONGRESS FROM MINNESOTA

Mr. PETERSON. Thank you, Mr. Chairman. I thank the Ranking Member for your leadership. I have a statement I would like made part of the record, but I just have to say that we have been going back and forth on this stuff since this energy bill passed. I no longer have any confidence—and I shouldn't be going after you folks—that you people have any idea what is going on here. You are going to kill off the biofuels industry before it ever gets started, and you are in bed with the oil companies. You know, why would you put indirect costs on corn and soybeans and not put it on oil? What about all the indirect costs of protecting the oil shipping lanes in the Middle East? You know, that is not counted.

I mean, this is ridiculous what is going on here. You know, this stuff gets put in in the middle of the night, and over our objections. We have been trying to fix this for 2 years. I go down and meet with people. Nothing happens. We are off on some peer review. Why aren't we peer reviewing all these other things? Why are we picked out? Because people don't like corn ethanol.

Well, I will tell you something. You kill off corn ethanol, which is what you are going to do here, and what I am upset about is not so much what we are talking about today but the interaction of this with the climate change bill and what is going on over there. I am at the point where I don't even want to ask anybody any questions, because you are putting us into a position to talk about something we shouldn't even be talking about.

So I just want this message to be sent back down the Hill or down the street, that the way this thing is going on I am off the train. I will not support any kind of climate change bill. I don't care. Even if you fix this, because I don't trust anybody anymore. Okay? And I have had it.

Thank you, Mr. Chairman.

[The prepared statement of Mr. Peterson follows:]

PREPARED STATEMENT OF HON. COLLIN C. PETERSON, A REPRESENTATIVE IN CONGRESS FROM MINNESOTA

I thank the Chairman and the Ranking Member for their leadership on this issue.

More than 2 decades ago, when I would talk about renewable fuels, people thought I was nuts. Now ethanol is blended into all American gasoline to help it burn cleaner, and renewable fuels provide an unparalleled opportunity to create new jobs, decrease pollution and revitalize rural America—as long as Congress doesn't mess it up along the way.

Unfortunately, two provisions in the expanded Renewable Fuel Standard have the potential to do just that. That's what we're here to talk about today.

In the proposed rule that the EPA released yesterday, some biofuels are greatly penalized by the calculations on lifecycle greenhouse gas emissions that take into account indirect changes in international land use that may not even take place. The expanded RFS requires that all biofuels produced from facilities built after the enactment of the EISA achieve a reduction in lifecycle greenhouse gas emissions. The EPA calculates the lifecycle emissions of each fuel, relative to the gasoline or diesel fuel it would replace, and includes emissions from all stages of fuel production. Biofuels are uniquely charged with emissions from indirect sources, gasoline is not.

But the simple fact is that a great deal of uncertainty remains when we try to measure indirect effects. This isn't about pitting folks against one another. It's about making sure that in our efforts to increase America's energy independence, we don't do more harm than good. We've got some big policy decisions to make, and we've got to make sure we're asking the tough questions and receiving reliable information.

The EPA has promised to carry out a peer review process, and I wonder whether or not these reviews will be looking at more than just the numbers. It is my hope that in addition to reviewing whether EPA is using the best available models, that the experts will also review whether the best available models are good enough to be used in making these very important decisions. Modeling indirect land use is an extremely complex exercise with much room for error. And when several different models, from different groups of economists, are put together, errors can be compounded.

Our economic experts must be asked to weigh in on whether they have confidence that the results coming out of these models are reasonable representations of real-world impacts. It's been said many times in the course of this discussion that regulations need to be based on sound science, so let's not forget that economics is a science as well, and ensure that economists' concerns over accuracy and proper use of their work are not pushed aside.

The second provision of concern to those in American agriculture is the definition of *renewable biomass*. The definition excludes the cellulosic or woody biomass available in a majority of the country and includes stipulations that the land must be either "actively managed" or "fallowed", in addition to being "non-forested" for cropland. If we continue with this definition, Congress would be shortchanging a huge part of the country before we even get started, and hamper our efforts to meet the goals the President has laid out.

On both issues, we need to know more as we move forward and we need to make sure that we are not going to create new problems for renewable fuels as we continue on the road to a cleaner environment and energy independence.

I thank the Chairman for calling today's hearing and look forward to hearing the witnesses' testimony.

The CHAIRMAN. The chair thanks the Chairman for his remarks, and there is not much to say to follow up on that other than there are a lot of people off the train. They need a new conductor here, so we need to negotiate, and we have a lot of problems.

Mr. PETERSON. Mr. Chairman, I don't think we can negotiate.

The CHAIRMAN. I didn't even mean that, sir.

Mr. PETERSON. Because the people we are dealing with here, I don't think we can negotiate with. You know, I don't have any confidence. I mean, the only way I would consider supporting any kind of climate change bill, if it was ironclad that these agencies had no ability to do any rulemaking of any kind whatsoever. We had everything dotted and crossed, the T's crossed, and we could be absolutely guaranteed that these folks would not get involved. And I am not sure if that is possible, but if that could be done and if they could make me confident, then maybe we could talk about it. But, I am not in any mood for negotiating with anybody at this point.

The CHAIRMAN. Thank you, Mr. Chairman. I thought I was off the train first. The Chairman requests that other Members submit their opening statements for the record.

[The prepared statements of Ms. Herseth Sandlin and Mr. Smith follow:]

PREPARED STATEMENT OF HON. STEPHANIE HERSETH SANDLIN, A REPRESENTATIVE IN CONGRESS FROM SOUTH DAKOTA

Thank you Mr. Chairman for your leadership on these issues. Mr. Glauber and Ms. Oge, welcome.

If you look at my State of South Dakota from end-to-end, whether it is our vast fields of corn and soybeans in the eastern part of the state, the abundant wind resources across the state, or the great forests of the Black Hills in the West, South

Dakota embodies the idea that we need a diversified approach to our national energy policy—and in particular we need to take advantage of new opportunities for renewable energy.

So, as we strive to meet our national energy needs, we must continue to recognize that rural America, including my State of South Dakota, has much to offer. Rural states should be at the center of the solution as our national energy policy shifts and adjusts in ways that enhance our national and economic security; that promote both innovation and conservation; and that ultimately will ease the strain on families' and business owners' budgets.

With the passage of the original Renewable Fuel Standard in 2005 and the aggressive increase included in last year's energy bill, we have already taken initial key steps in the right direction, as we seek to take advantage of the contribution agricultural producers in rural states can make to reduce our dependence on foreign oil and overall carbon emissions through an increase in the production of biofuels, wind, and other types of renewable energy.

It's vitally important for economic development in rural states like South Dakota, and for achieving our nation's goal of energy independence, that the EPA correctly implement the Renewable Fuel Standard. The new Renewable Fuel Standard approved in 2007 was an important step in recognizing the important role that ethanol, biodiesel and other clean-burning, domestic biofuels will play in reaching these goals. While I'm still reviewing the proposed rule, it's clear that there are both good and bad takeaways. The rule does clearly show what many of us have said for quite some time—when direct emissions are compared to gasoline, ethanol burns far more cleanly. On the other hand, I have serious questions and concerns about the rule's findings on so-called indirect land use changes in other countries that some are attributing to biofuels production. I believe that on this issue the proposed rule is simply the beginning of the real debate.

I will push to ensure that no speculative indirect land use changes are included in a final rule, and that the final rule fairly recognizes the innovations of U.S. agricultural producers and biofuels producers. This is a key issue in the implementation of the RFS because, as Ms. Oge notes in her written testimony, under EPA's newly proposed rule, indirect emissions "comprise a significant portion of the total lifecycle emissions of biofuels."

I'd also like to touch quickly on the issue of renewable biomass. The EPA was required to promulgate rules for the use of renewable biomass under the RFS. As many of my colleagues here today know, I have introduced bipartisan legislation to improve the flawed definition of *renewable biomass* that was slipped into the RFS at the eleventh hour.

In January, the Energy Information Administration projected that "available quantities of cellulosic biofuels will be insufficient to meet the new RFS targets for cellulosic biofuels before 2022, triggering both waivers and a modification of applicable volumes . . . ."

I believe a key to preventing this shortfall is to ensure cellulosic biofuels can be produced from the greatest possible diversity of renewable feedstocks in communities across the nation. This particularly affects any region of the country with significant tracts of forestland, including the Midwest, Northwest, Northeast and South.

The RFS definition of qualifying "renewable biomass" is flawed because:

- It excludes from the mandate almost all biofuels that use federally sourced biomass as a feedstock, thereby discouraging and disincentivizing their use in biofuels production,
- It also excludes all biofuels made from privately sourced biomass, unless it comes from trees that are "planted" in a "plantation" and "actively managed." This excludes a large percentage of woody biomass on private land from being used in biofuels production, and
- It inhibits sound forest management which is critical as forest managers work to improve the health of our forests and reduce the risk of catastrophic wildfire.

I am very pleased indeed to have strong bipartisan support for this legislation from Members representing districts that are geographically diverse, including Chairman Peterson.

Mr. Chairman, thank you again for focusing the Subcommittee on these issues of vital importance to South Dakota and other rural states.

PREPARED STATEMENT OF HON. ADRIAN SMITH, A REPRESENTATIVE IN CONGRESS FROM NEBRASKA

Thank you, Mr. Chairman.

Through the Energy Independence and Security Act of 2007, Congress charged the Environmental Protection Agency (EPA) with evaluating the "carbon footprint" of biofuels in order to meet Renewable Fuel Standard (RFS) requirements set forth in this statute. Under the EPA's recently proposed rule, biofuels such as cellulosic ethanol, biodiesel, and corn-based ethanol, which would otherwise have no difficulty meeting these greenhouse gas reduction requirements, could be targeted due to the estimated impact of indirect land use changes.

Currently, there are no widely accepted methodologies or models for calculating indirect land use changes resulting from increased biofuel production. The premature use of inaccurate or incomplete data could cause severe harm to the U.S. biofuels industry and potentially disqualify sustainable feedstock from being utilized. My home State of Nebraska has more than 45 million acres of farmland. It is simply not practical to draw broad conclusions across a large geographic region concerning the effects of particular land use changes on resulting greenhouse gas emissions. Different greenhouse gas emissions are caused by variations in soil, local climate, and different farming practices. The study of the environmental impact of agriculture operations is a comparatively new science, and should not undermine years of renewable energy research.

Again, thank you, Mr. Chairman. I appreciate the Subcommittee holding this hearing and look forward to discussing and reviewing this proposal in a bipartisan, productive manner.

The CHAIRMAN. I would like to call up our first panel of witnesses today. Dr. Joe Glauber, Chief Economist for U.S. Department of Agriculture, Ms. Margo Oge, Director, Office of Transportation and Air Quality, U.S. Environmental Protection Agency.

Dr. Glauber, you may proceed when ready.

STATEMENT OF JOSEPH GLAUBER, PH.D., CHIEF ECONOMIST, U.S. DEPARTMENT OF AGRICULTURE, WASHINGTON, D.C.

Dr. GLAUBER. Thanks very much, Mr. Chairman. I would like to thank you and the Members of the Subcommittee for the opportunity to discuss in the indirect land use provisions that are part of the Energy Security and Independence Act of 2007.

In my written testimony I discuss how biofuel production affects land use in the United States and the rest of the world, and discuss what is meant by emissions associated with land use change. I present findings from various studies on greenhouse gas emissions from renewable fuels and discuss some of the key uncertainties noted in these research efforts in estimating the land effects of land use change on greenhouse gas emissions.

Literature on biofuel production in international land use has developed largely over the past 5 years. Most of the focus has been on the effect of biofuel production in U.S. agriculture, however, several more recent studies attempt to also model the ripple effects that would occur in agricultural markets around the world due to increased biofuel use within the U.S., and the implications this might have on greenhouse gas emissions.

There is little question that increased biofuel production has had and will have effects on land use in the U.S. and the rest of the world. The more interesting question concerns magnitude. To the degree to which the supply response to increased biofuel production is met through increased yields, cropland expansion will be less. Land use change is more likely to occur where producers are more responsive to price changes.

How much pasture and forest is converted to cropland will ultimately depend on the region, national, and local land use policies, and the degree to which competing uses such as grazing and forest products impose constraints for expansion. While economic modelers have a long history of policy analysis in agriculture, most of the analyses have focused on the impact of various domestic or international trade policies, for example, farm bills, trade agreements, on cropland.

By contrast, the empirical literature on land use and greenhouse gas emissions is relatively young, with most studies appearing in the last 2 to 3 years. Sensitivity analysis suggests wide variation in results. In particular, much is to be learned about land conversion from forest to pasture and from pasture to cropland.

Modeling the change in land use resulting from the expansion and the production of cornstarch-based ethanol requires making projections about future values of parameters that obviously cannot be known with certainty. Therefore, judgments and assumptions must be made as to the likely values these uncertain data will take. Each assumption, whether made explicitly or implicitly in the structure and data of the model, will influence the outcome.

For example, two widely respected economic models estimate very different land requirements with respect to expanding ethanol production, and some of this I go into in my written testimony. These differences in land requirements shape the greenhouse gas profile associated with ethanol. In my written testimony I discuss some of the major assumptions that influence the estimate of greenhouse gas emissions from cornstarch-based ethanol and other biofuels.

Some of the more critical factors: assumption on yield growth. Most models assume some trend yield growth due to technological change, but how sensitive are yields to price changes? Should we expect yields to increase if prices are higher? Increased yields means smaller increases in total crop acres due to increased ethanol production.

Responsiveness to changes in prices: If world corn and soybean prices increase, where are we more likely to seek increases in plantings? Where is cropland conversion more likely to take place? The greenhouse gas emissions conversion of forest to cropland are far larger than emissions from pasture to cropland.

Substitutability of distiller dry grains: DDGs are an important byproduct of ethanol production. The more DDGs replace corn and soybean meal in feed rations, the smaller potential impact of ethanol production on feed prices, and enhanced land use change.

And accounting for future greenhouse gas emissions: Generally when comparing greenhouse emissions of renewable fuels to nonrenewable alternatives, studies assume increases in greenhouse gas from land use occur in the conversion, while reductions in greenhouse gas emissions due to the production and use of renewable fuels occur over several years into the future. Increasing the expected timeframe for renewable fuel production on converted lands reduces their net greenhouse gas emissions.

Last, Mr. Chairman, let me say that USDA has had a constructive and cooperative relationship with EPA as they have developed their renewable fuel proposal. Their proposal raises challenging

issues for public comment and will do much to advance the understanding of the lifecycle greenhouse gas emissions impact of biofuels, and in particular, the land use change impacts. USDA looks forward to continuing our relationship with EPA as they complete the work necessary to finalize the RFS rule.

Mr. Chairman, that concludes my statement.

[The prepared statement of Dr. Glauber follows:]

PREPARED STATEMENT OF JOSEPH GLAUBER, PH.D., CHIEF ECONOMIST, U.S. DEPARTMENT OF AGRICULTURE, WASHINGTON, D.C.

Mr. Chairman, Members of the Subcommittee, thank you for the opportunity to discuss the indirect land use provisions that are part of the Energy Security and Independence Act of 2007 (EISA). Renewable fuels produced from renewable biomass feedstocks are defined in terms of their impact on lifecycle greenhouse gas (GHG) emissions. EISA further defined lifecycle GHG emissions to mean "the aggregate quantity of GHG emissions (including direct emissions and significant indirect emissions such as significant emissions from land use changes), as determined by the Administrator of the EPA, related to the full fuel lifecycle, including all stages of fuel and feedstock production and distribution, from feedstock generation or extraction through the distribution and delivery and use of the finished fuel to the ultimate consumer, where the mass values for all greenhouse gases are adjusted to account for their relative global warming potential."

The feedstock limitations associated with the exclusion of some sources of renewable biomass as defined in EISA—particularly with respect to cellulosic materials from both private and public forestlands—may serve to limit the opportunity to replace fossil fuels. In the future, ethanol produced from cellulosic sources, including wood biomass, has the potential to cut lifecycle GHG emissions by up to 86 percent relative to gasoline (Wang *et al.* 2007).

Yesterday, the Administrator of the Environmental Protection Agency (EPA) signed a notice of proposed rulemaking for the Renewable Fuel Standard (RFS) included in the EISA. EPA's proposal reflects considerable input, guidance, and data from USDA. EPA's proposal also utilized many of the same data and assumptions that USDA uses regularly in near-term forecasting agricultural product supply, demand, and pricing. They further acknowledge the uncertainty associated with the various models and input assumptions involved in their lifecycle modeling, present a number of different sensitivity analyses, and seek comment on what, if any changes should be made for the final rule.

While the effects of biofuel production on GHG emissions are expected to increase land under cultivation, existing estimates of the magnitude due to land use conversion vary. Work such as that published in *Science* by Searchinger *et al.* (2008) concluded that if GHG emissions from indirect land use changes were taken into account, GHG emissions from biofuel production were potentially far larger than previously estimated. On April 23, 2009, the California Air Resources Board adopted a regulation that would implement a Low Carbon Fuel Standard (LCFS) for the reduction of GHG emissions from California's transportation fuels by ten percent by 2020. The LCFS would take into account the GHG emissions of indirect land use from biofuel production, potentially resulting in the exclusion of corn-based ethanol produced in the Midwest from California fuel markets.

Today, I would like to discuss how biofuel production affects land use in the United States and the rest of the world, and will discuss what is meant by emissions associated with land use change. I will defer to EPA to describe the results of their most recent research, but will present some various other research on GHG emissions from renewable fuels and discuss some of the key uncertainties noted in these research efforts in estimating the effects of land use change on GHG emissions.

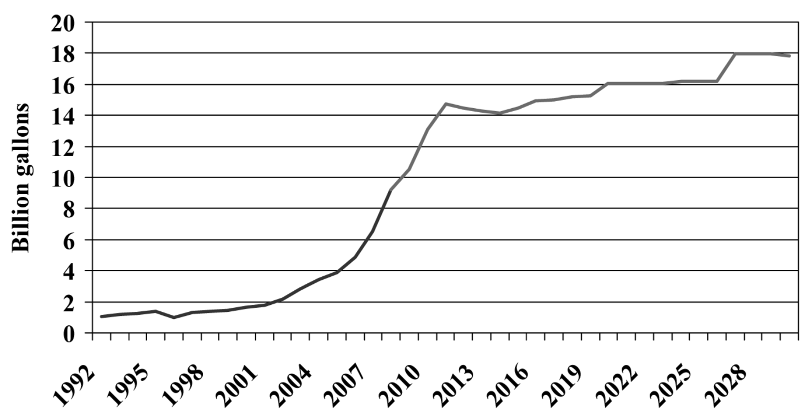
Historic Trends in U.S. Agricultural Land Use and Biofuel Production

Before getting into each of these issues, I would like to present some context for this discussion by presenting a brief overview of the historic trends in U.S. biofuel production and agricultural land use in the United States and the rest of the world. *Figure 1* shows the growth in corn and other starch based ethanol in the United States since 1992 as well as the forecasted growth in corn and other starch based ethanol to 2030 based on the latest long-term forecast from the Energy Information Administration (EIA). The chart shows that EIA forecasts much of the growth in corn and other starch based ethanol will occur in the next couple of years and then

stabilize at about 15 billion gallons per year into the future. The EIA projection of a plateau of 15 billion gallons of corn and other starch based ethanol reflects the limits placed on the volume of non-advanced ethanol that may qualify for credits under the RFS in the EISA, mandated minimum levels of cellulosic-based ethanol under RFS, and projected improvements in the profitability of cellulosic-based ethanol.

In 2008/09, corn use for ethanol production is projected to be 3.7 billion bushels and account for about 31 percent of total corn use in the United States (*figure 2*). By 2015/16, assuming current baseline assumptions remain constant, corn use for ethanol is expected to exceed 4.8 billion bushels, about 34 percent of total corn use in the United States. Corn production in the United States is expected to increase from 12.1 billion bushels in 2008 to 14.0 billion bushels in 2015, an increase of 15.7 percent. Corn plantings are expected to increase from 86 million acres to 90 million acres, up 4.7 percent, while yields are anticipated to increase by almost ten percent, from 154 bushels per acre in 2008 to 169 bushels per acre in 2015.

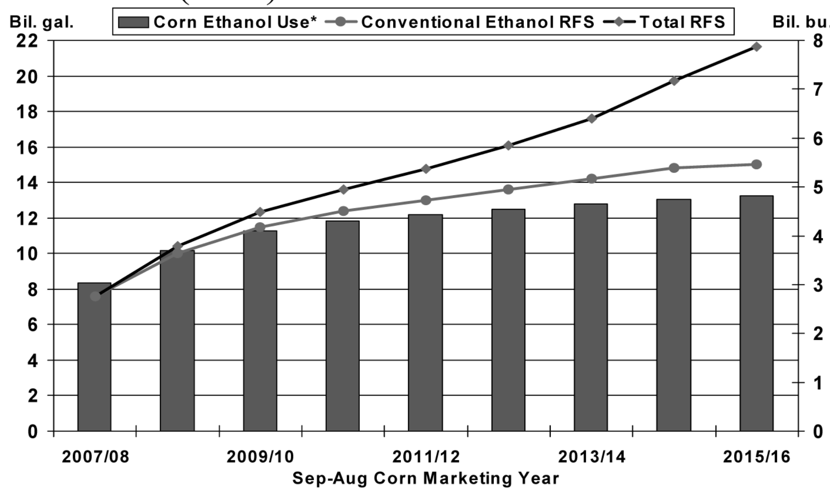
Figure 1--Corn-Starch Based Ethanol Production in the United States



Source: EIA

Primarily corn-starch based ethanol but also including minor amounts of ethanol from other crops.

Figure 2—The Renewable Fuel Standard (RFS) and Corn Ethanol Use



* 2008/09 is projected based on the *World Agricultural Supply and Demand Estimates*, April 9, 2009. 2009/10 is projected based on USDA's *Grains & Oilseeds Outlook*, Agricultural Outlook Forum, Washington, D.C., February 27, 2009. Projections for 2010/11-2015/16 are from USDA *Agricultural Projections to 2018*, February 2009.

What is the potential for expansion of cropland in the United States? Cropland use in the United States has varied considerably over the past 30 years. *Figure 3* shows planted acreage to the eight row crops (wheat, corn, barley, grain sorghum, oats, soybeans, rice and cotton) since 1975. Over 297 million acres were planted to these crops in 1981. Plantings fell off to less than 245 million acres in the late 1980s and generally remained between 245 to 255 million acres during the early 1990s as land was idled. The annual Acreage Reduction Programs authorized by the 1981, 1985 and 1990 Farm Bills, and Conservation Reserve Program (CRP) starting under the 1985 Farm Bill contributed significantly to this acreage reduction. Planted acres to the eight principal crops rose to almost 261 million acres in 1996, however, as grain prices spiked.

From 1996 to 2006, plantings to the eight row crops generally trended downward due to lower commodity prices, increased planting flexibility offered by the 1996 and subsequent farm bills which allowed producers to fallow land that had formerly been maintained in more permanent cultivation, and expansion of minor crops such as canola. With the return of higher prices in 2007, however, plantings to the eight row crops rose again, reaching 253 million acres last year. Based on producer planting intentions, NASS estimates that 246 million acres will be planted to the eight row crops in 2009.

Figure 3--Area planted to 8 principal row crops

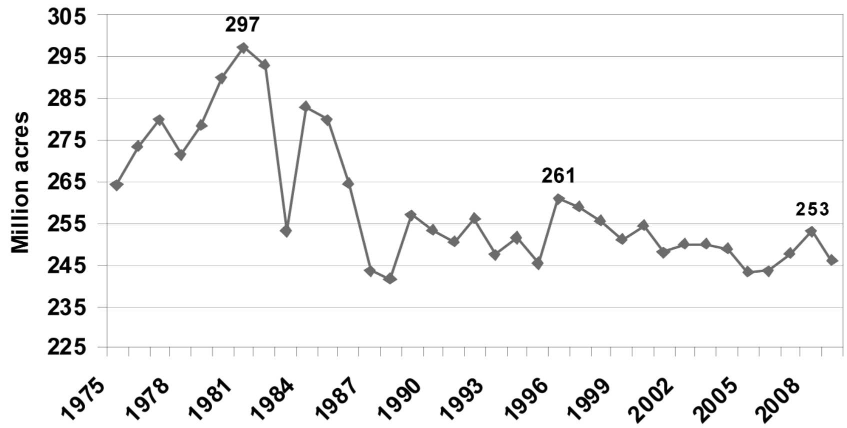


Table 1—U.S. Planted Acreage in 1996 and 2008

(million acres)

Crop	1996	2008	Change from 1996 to 2008
Wheat	75.1	63.1	−12.0
Corn	79.2	86.0	6.8
Other feed grains	24.8	15.7	−9.1
Soybeans	64.2	75.7	11.5
Rice and cotton	17.5	12.5	−5.0
8 row crops	260.8	253.0	−7.8
Hay[1]	61.2	60.1	−1.1
Other crops	11.7	10.9	−0.8
Principal crops	333.7	324.0	−9.7
CRP	34.5	34.5	0.0
Principal crops plus CRP	368.2	358.5	−9.7

[1] Harvested acreage.

Table 1 compares plantings in 1996 to plantings in 2008. Even though acreage enrolled in the CRP was unchanged between 1996 and 2008, total acreage planted to the eight row crops in 2008 was down nearly 8 million acres (about three percent) and acreage planted to principal crops was down almost 10 million acres from 1996 levels. Corn and soybean acreage were up by over 18 million acres in 2008 compared with 1996; however, this was more than offset by declines in wheat, small feed grains and cotton acreage. Thus, while it is clear that producers planted substantially more acreage as recently as 1996, most of the implied capacity is likely in areas more suitable for wheat and small grain production.

Estimated Land Use Effects of Biofuel Production

The literature on biofuel production and international land use has developed largely over the past 5 years. Most of the focus has been on the effects of biofuel production on U.S. agriculture (*see*, for example, USDA, ERS/Office of the Chief Economist 2007; FAPRI 2008; Biomass Research and Development Board 2008; de Gorter and Just 2009). However, several more recent studies attempt to also model the ripple effects that would occur in agricultural markets around the world due to increased biofuel use within the U.S., and the implications this might have on GHG emissions. *Table* 2 presents the results from several recent modeling efforts that estimate the effects of ethanol production on global land use. These studies attempt

to quantify the market response in the United States and in other countries to increases in commodity prices due to increases in biofuel production. These studies also quantify the GHG emissions from these market responses and attribute these emissions to biofuel production. The table is not meant to be comprehensive, but shows a selected range of central estimates. Other models, such as MIT's Emissions Prediction and Policy Analysis model, have also been used to examine indirect land use change impacts (Gurgel *et al.* 2007; Melillo *et al.* 2009). Key uncertainties are discussed below.

One of the first studies of the effects of biofuels on GHG emissions was published by Searchinger *et al.,* in the February 2008 issue of *Science*. That study used a worldwide agricultural model to estimate emissions from land-use change, and reached the conclusion that corn-based ethanol nearly doubles greenhouse emissions over 30 years, and increases greenhouse gases for 167 years. In contrast, when emissions from land use change were not included in their model, corn-starch based ethanol reduced GHG emissions by 20 percent compared to gasoline. Using the multi-market, multi-commodity international FAPRI (Food and Agricultural Policy Research Institute) model, Searchinger *et al.* assessed the land use change and GHG implications of increasing corn ethanol production in the United States by 14.8 billion gallons and found that an additional 26.7 million acres of land would be brought into crop production world-wide (1.8 million acres per billion gallons of ethanol). In terms of GHG emissions per unit of energy produced, Searchinger *et al.* estimated that the emissions from land use change alone (104 grams of CO_2 equivalent per MJ of energy in fuel) outweighed the emissions from gasoline (92 g CO_2-eq/MJ).

Using the 2007 FAPRI baseline, Fabiosa *et al.* (2009) estimated that a one percent increase in U.S. ethanol use would result in a 0.009 percent increase in world crop area. Most of the increase in world crop area is through an increase in world corn area. Brazil and South Africa respond the most, with multipliers of 0.031 and 0.042, respectively. Fabiosa *et al.* did not estimate the GHG implications of the lower land requirement.

Based on the 10 year averages of U.S. ethanol use and world crop area taken from the 2007 FAPRI international baseline, and using the world area impact multiplier from Fabiosa *et al.* (0.009), the results suggest an impact multiplier of 1.64 million acres per 1 billion gallons of additional ethanol use, which is lower than the acreage effect estimated in the Searchinger study.

The California Air Resources Board (CARB), as part of their recent proposed low carbon fuel standard, also estimated the GHG emissions associated with renewable fuels. CARB employed the Global Trade and Analysis Project (GTAP) model and also found significantly less land is required to produce ethanol than Searchinger *et al.* In the CARB study, each additional billion gallons of corn-starch based ethanol requires only 726,000 acres; about 60 percent less compared to Searchinger *et al.* Primarily as a result of this reduced acreage, CARB estimated the GHG emissions associated with land use change were 70 percent less than those estimated by Searchinger *et al.* The GHG emissions due to land use change were reduced from 104 grams of CO_2 equivalent per MJ of ethanol to 30 grams of CO_2 equivalent per MJ of ethanol.

A more recent article by Tyner *et al.* (2009), which like the CARB study, employed the GTAP modeling framework, differentiated between various levels of ethanol production. Their results show smaller GHG emissions impacts from corn-starch based ethanol than the CARB study and ¼ of those estimated by Searchinger *et al.* Tyner *et al.* note their results are significantly less than Searchinger *et al.* due to three factors: (1) the significantly smaller change in total land use, (2) differences in which part of the world the change in land use occurs, and (3) differing assumptions regarding the percent of carbon stored in forest vegetation that is emitted when forest is converted into cropland (Searchinger *et al.* assumes 100 percent of carbon stored in forest vegetation is emitted while Tyner *et al.* assumes 75 percent of the carbon stored in forest vegetation is emitted with the remaining 25 percent stored in long-term wood products).

Table 2—Land Use Change and CO_2 Emissions From Ethanol

Study	Modeling framework	Increase in ethanol production	Change in Global Land Use	Change in Global Land Use	CO_2 equivalent emissions
		Billion gallons	Million acres	Million acres per bil. gal	Grams CO_2-Eq. per MJ of Ethanol
Searchinger *et al.* 2008 [1]	FAPRI/CARD	14.8	26.73	1.81	104
Fabiosa *et al.* 2009 [2]	FAPRI/CARD	1.174	1.923	1.638	N/A
California (CARB) 2009	GTAP	13.25	9.62	0.726	30
Tyner *et al.* 2009 [3]	GTAP				
2001 to 2006		3.085	1.8	0.576	20.8
2006 to 7 BG		2.145	1.3	0.625	22.7
7 to 9 BG		2	1.3	0.658	23.8
9 to 11 BG		2	1.4	0.689	24.9
11 to 13 BG		2	1.4	0.722	26.1
13 to 15 BG		2	1.5	0.759	27.4
2001 to 15 BG		13.23	8.77	0.663	24.0

[1] Searchinger *et al.* reported their results in terms of a 55.92 billion liter increase in ethanol production which resulted in a 10.8 million hectare change in global land use.
[2] Based on a ten percent increase in U.S. ethanol use using 10 year averages of U.S. ethanol use and world crop area taken from the 2007 FAPRI baseline. Impact multiplier of 0.009 taken from Fabiosa *et al.*, table 2.
[3] Based on data from Table 7 and Table 8 and converted to MJ of ethanol by assuming each gallon of ethanol contains 76,330 Btu's of energy and each Btu is equal to 0.00105 megajoules (MJ).

Sources of Uncertainty

Modeling the change in land use resulting from the expansion in the production of corn-starch based ethanol, requires making projections about future values of parameters that cannot be known with certainty. Therefore, judgments and assumptions must be made as to the likely values these uncertain data will take. Each assumption, whether made explicitly or implicitly in the structure and data of the model, will influence the outcome. Here is a partial list of some of the major assumptions that influence the estimate of GHG emissions from corn-starch based ethanol and other biofuels.

Yields on converted lands. Estimating the yields on converted land is one of the most important aspects associated with the GHG emissions and land use change. In the CARB analysis, a small change in the expected yields on converted land had a large impact on the amount of land necessary to meet the added demand for renewable energy and, therefore, on GHG emissions. When yields on converted land were expected to be more similar to yields on existing land, only 500,000 acres of additional cropland were required to produce each billion gallons of ethanol and the emissions associated with land use change fell to 18.3 grams of CO_2 equivalent per MJ of ethanol; a reduction of almost 40 percent. Alternatively, when yields on converted land were expected to be lower than yields on existing land, 850,000 acres of additional cropland were required to produce each billion gallons of ethanol and the emissions associated with land use change increased to 35.3 grams of CO_2 equivalent per MJ of ethanol; an increase of about 18 percent. Unfortunately, as discussed in the CARB analysis, there is little empirical evidence to guide modelers in selecting the appropriate value for estimating the productivity of converted land. There is even experience to suggest that yields on converted land may be higher than yields on existing land. For example, when Brazil began expanding soybean production from the temperate South into the tropical Center-West, research led to the development of a soybean variety that flourished in the tropics. As a result, soybean yields in the tropical Center-West were double that of the national average. On the other hand, in many other regions, existing crops are already on the most productive agriculture land, so yields on newly converted lands would be lower than on existing cropland. On net, we would not expect to see significantly higher yields on converted land, but there is little information on how yields may change when land is converted.

Shifts between different land uses. Converting land from one land use to another can have dramatic impacts on the emissions associated with land use change. However, it is difficult to model the specific contribution of the many factors that determine land use, especially when changing between broad land use categories. It is one thing to try to estimate the movement of land allocation among different crops, such as switching between corn and soybeans. However, land conversion between land uses, such as from forest to pastureland or cropland can be very costly and therefore driven by longer-term economic factors. For example, Midwest farmers

can readily move cropland between corn and soybeans when the relative profitability of those crops change. In contrast, expansion of agricultural land into other areas will depend on the cost of conversion of that land and land supply availability. For land that is currently in active use there are decisions to be made on long term profitability, for example for land to be converted from forest to cropland, long term decisions must be made regarding the relative profitability between agricultural and forestry commodities for many years into the future. Conversion of land that does not have a current market use (grassland or unmanaged forest) would be based on costs of conversion, land availability, and in addition, there are several non-economic factors that may significantly affect land conversion decisions in a particular area or country, such as national conservation and preservation policies and programs.

Some studies have suggested that conversion of land into cropland would be associated with grassland conversion because it costs less to clear and prepare grassland than clearing and preparing forestland. In the Tyner *et al.* study, for example, 23 percent of the increase in cropland comes from conversion of managed forest. The remaining 77 percent of the increase in cropland is a result of the conversion of grassland to cropland. While a majority of the land conversion is from grassland to cropland, a majority of the emissions due to land use change result from the conversion of forests to cropland, due to the relatively larger GHG pulse associated with forest conversion. If we assume there is no forest conversion and only grassland conversion, the emissions associated land use change estimated by Tyner *et al.* would fall by 50 percent. In many studies, estimates of forest conversion surfaces as a key factor driving the lifecycle GHG results. In addition, the GTAP modeling framework used by CARB and Tyner *et al.* includes only managed lands. This could also influencing the type of land conversion predicted by the model.

Yield growth over time. Another important factor driving the amount of land required to produce biofuels is the growth in yields that are expected to occur over time. At USDA, we estimate that corn yields in the United States will grow at 2 bushels per acre. If we assume that global corn yield growth increases at the same rate as in the United States, by the 2015, the average corn yield in the rest of the world would be about ten percent higher than used in the CARB study. The increase in land productivity in the rest of the world would reduce the estimated amount of land converted into cropland in the CARB study from 726,000 acres to 663,000 acres for each additional billion gallons of corn-starch based ethanol, and the average GHG emissions due to land use change would fall from 30 grams of CO_2 equivalent per MJ of ethanol to 27 grams of CO_2 equivalent per MJ of ethanol.

In addition, higher commodity prices due to greater demand for renewable fuels would likely result in some increase in crop yields. In the CARB analysis, each one percent increase in the price of corn relative to the input costs associated with growing corn was assumed to increase corn yields by 0.4 percent. Varying that assumption from a 0.1 to a 0.6 percent increase in yields for each one percent in the price of corn relative to inputs costs altered the estimate of GHG emissions due to land use change by 49 percent.

Substitutability of Distillers Dried Grains (DDGs). DDGs are a co-product of corn-starch based ethanol production, and can substitute for corn as feed, thereby reducing the amount of corn which goes directly into livestock feed. Thus, the more DDGs that are assumed to be used in livestock feed, the fewer total cropland acres will be needed and therefore less GHG emissions. For example, each bushel of corn generates about 2.8 gallons of ethanol and almost 18 pounds of DDGS. In the CARB study, each pound of DDGs is assumed to displace one pound of corn. However, DDGs have attributes that may allow a greater than a one-for-one displacement of corn in animal feed. DDGs have higher protein and fat content compared to corn. Tyner *et al.* assume each pound of DDGs replaces 1.16 pounds of corn as animal feed. Arora *et al.* recently found that 1 pound of DDGs displaces 1.271 pounds of conventional feed ingredients. However, DDGs cannot completely replace traditional feed.

Other Sources of Uncertainty. In addition to the uncertainties discussed above, many other modeling assumptions will influence the predicted impact of added renewable fuel production on GHG emissions, (*e.g.,* the level of disaggregation in the underlying crop data, assumptions about international trade in agricultural commodities, assumptions about changes in fertilizer use, *etc.*). There are also simplifying assumptions that relate to accounting for future GHG emissions. Generally, when comparing the GHG emissions of renewable fuels to nonrenewable alternatives, studies assume that increases in GHG emissions from land use conversion occur in the year of conversion, while reductions in GHG emissions due to the production and use of renewable fuels occur over several years into the future. For example, the results from the studies referenced in this testimony assume the reduc-

tion in GHG emissions from expanded ethanol production occur over a period of 30 years. Increasing the expected time frame for renewable fuel production on converted land reduces their net GHG emissions, because the total emissions reductions associated with producing and using renewable fuels will be greater.

Conclusions

There is little question that increased biofuel production will have effects on land use in the United States and the rest of the world. The more interesting question concerns magnitude. To the degree to which the supply response to increased biofuel production is met through increased yields, cropland expansion will be less. Land use change is more likely to occur where producers are more responsive to price changes. How much pasture and forest is converted to cropland will ultimately depend on the region, national and local land use policies and the degree to which competing uses (grazing, forest products) impose constraints for expansion.

While economic modelers have a long history of policy analysis in agriculture, most of the analyses have focused on impact of various domestic or international trade policies (*e.g.,* farm bills, trade agreements) on cropland. By contrast, the empirical literature on land use and GHG emissions is relatively young, with most studies appearing in the last 2 or 3 years. Sensitivity analysis suggests wide variation in results. In particular, much is to be learned about land conversion from forest to pasture and from pasture to cropland.

We have had a very constructive and cooperative relationship with EPA as they have developed their RFS2 proposal. Their proposal raises challenging issues for public comment and will do much to advance the scientific understanding of the lifecycle GHG emission impacts of biofuels, and in particular the land-use change impacts. USDA looks forward to continuing our relationship with EPA as they complete the work necessary to finalize the RFS2 rule.

Mr. Chairman, that concludes my statement.

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The CHAIRMAN. Thank you, Dr. Glauber.

Ms. Oge.

STATEMENT OF MARGO T. OGE, DIRECTOR, OFFICE OF TRANSPORTATION AND AIR QUALITY, OFFICE OF AIR AND RADIATION, U.S. ENVIRONMENTAL PROTECTION AGENCY, WASHINGTON, D.C.

Ms. OGE. Good morning. Thank you, Mr. Chairman and Members of the Subcommittee. I truly appreciate the opportunity to testify today about the Renewable Fuel Standard required by the Energy Independence and Security Act of 2007. My name is Margo Oge. I am the Director of the Office of Transportation and Air Quality. I am a career civil servant, and I am proud that I have been with EPA for almost 30 years, my whole career.

I am very pleased also to share that, yesterday, Administrator Lisa Jackson signed a proposal to implement EISA's Renewable Fuel Standard, commonly called RFS2. This proposal is a critical step towards achieving energy independence, creating jobs in the United States, and reducing the greenhouse gas emissions that cause global warming.

As you know, EISA requires a substantial increase in the volume of renewable fuels that is blended into the U.S. transportation fuel pool. The total volume of renewable fuel must reach 36 billion gallons by 2022.

EPA estimates that the potential climate and energy security benefits of this program will be significant. We estimate that these greater volumes of biofuels will reduce greenhouse gas emissions from the transportation sector by approximately 150 to 160 million tons of CO_2 equivalent per year. That is equal to removing approximately 24 million cars from the road. That is pretty significant.

We also have calculated that this program when it is implemented will bring about $3 billion in total energy security benefits and could displace 15 billion gallons of gasoline and diesel fuel from the transportation sector.

Finally, we estimate that the net U.S. farm income would increase by about $7 billion.

Clearly a central future of this proposal is its focus on lifecycle greenhouse gas impact of renewable fuels. Congress established through EISA the first mandatory lifecycle greenhouse gas reduction thresholds for each of the four categories of renewable fuels. They must perform better when it comes to greenhouse gas emissions from the fuels that they are displacing.

To implement these thresholds it has required EPA to look broadly at lifecycle analysis and to develop a methodology that accounts for all factors that may significantly influence this assessment. This includes both direct and indirect impacts, including indirect land use.

Mr. Chairman and Members of the Subcommittee, we do recognize the potential implications of this work. To that end we have spent the last year and a half creating what we believe represents the best scientifically-supported methodology. This methodology uses the best tools and science available today and identifies both direct and indirect emissions, including those resulting from international land use change.

Also, EPA has worked extensively with experts across the Federal Government. Clearly we have worked with Dr. Glauber and his colleagues at the USDA, but also we have reached out to the outside experts, both domestic and international stakeholders. The resulting methodology is an important first step in advancing the science behind greenhouse gas emissions from biofuel production and use, and meets EPA's statutory obligations under EISA.

Clearly there are some, as you know, that have expressed concerns that the science of assessing greenhouse gas emissions, related especially to international land use changes, is very immature and subject to uncertainty; actually, significant uncertainty. They have suggested that EPA should disregard such emissions.

There are two problems with this approach. First, it would be inconsistent with EISA's statutory provisions passed by Congress. Second, ignoring such a large contributor of greenhouse gas emissions would render the concept of lifecycle analysis, which was mandated by Congress, scientifically less credible.

Mr. Chairman, the proposal that was announced yesterday is the beginning of a very important dialogue. We recognize that there are varying degrees of uncertainty in different aspects of the analysis, especially with indirect land use. To address the uncertainties surrounding the analysis, EPA is actively soliciting peer review comments from the scientific community, and also from the public at large.

In closing, I believe EPA has put forward a proposal that is responsive to Congressional intent. The proposal offers an important opportunity for EPA to present this work and to have an open and transparent dialogue with all stakeholders during the public comment period.

Thank you again for the opportunity to present this testimony. I am looking forward to answering your questions.

[The prepared statement of Ms. Oge follows:]

PREPARED STATEMENT OF MARGO T. OGE, DIRECTOR, OFFICE OF TRANSPORTATION AND AIR QUALITY, OFFICE OF AIR AND RADIATION, U.S. ENVIRONMENTAL PROTECTION AGENCY, WASHINGTON, D.C.

Mr. Chairman and Members of the Subcommittee, I appreciate the opportunity to appear before you today to testify on the renewable fuel provisions of the Energy Independence and Security Act of 2007 (EISA). I am pleased to state that EPA has signed a notice of proposed rulemaking for the Renewable Fuel Standard included in EISA, commonly called RFS2. Signature of the proposed rule is an important step toward achieving the significant energy security and greenhouse gas (GHG) emission reduction benefits of this program. It also provides EPA an opportunity to

present our work to the public and formally incorporate the advice and input we will receive over the coming months.

This proposed rule would revise the current RFS program, established by the Energy Policy Act of 2005, and implement several important changes to these renewable fuel requirements. EISA requires a substantial increase in the volume of renewable fuel and extends the timeframe over which this volume grows. The total volume of renewable fuel must reach 36 billion gallons by 2022. Several specific volume targets must also be met by 2022, including 21 billion gallons of advanced biofuels, comprised of 16 billion gallons of cellulosic biofuel, 4 billion gallons of "other" advanced biofuels, and a minimum of 1 billion gallons of biomass-based diesel. We estimate that these greater volumes of biofuels will reduce GHG emissions from transportation by an average annualized emissions rate of 150–160 million tons of CO_2 equivalent per year—reductions estimated to be equivalent to annual emissions produced by 23 to 24 million vehicles. EPA also has calculated that the RFS2 rule could bring about more than $3 billion in total energy security benefits, displacing an estimated 15 billion gallons of petroleum-based gasoline and diesel, as well as provide an expanded market for agricultural products and open new markets for the development of cellulosic feedstocks.

A central aspect of the RFS2 program is its focus on the lifecycle greenhouse gas impact of renewable fuels. EISA created the first U.S. mandatory lifecycle greenhouse gas (GHG) reduction thresholds for renewable fuels used in the U.S. The statute assigns specific emission reduction thresholds for each of the four categories of renewable fuels required by the Act—requiring a percentage improvement compared to the baseline lifecycle emissions value for gasoline and diesel used in 2005. EISA requires EPA to look broadly at lifecycle analyses and to develop a methodology that accounts for each of the important factors that may significantly influence this assessment, including both direct and indirect emissions, such as significant emissions from land use changes.

EPA, working with experts from across the Federal Government, including experts from the Departments of Agriculture and Energy as well as outside experts, has spent the last year and a half creating a robust and scientifically supported methodology that identifies direct and indirect emissions, including those resulting from international land use change. This methodology meets our statutory obligations under EISA. Just as importantly, it recognizes that to account for the climate-related effects of renewable fuels, the direct emissions associated with fuel production and combustion as well as the indirect emissions must be taken into account. The United States is committed to combating climate change both at home and abroad. President Obama has called for a domestic cap and trade program which would reduce U.S. emissions by 80% by 2050. We are also actively engaged in working towards a successful outcome at the climate negotiations later this year in Copenhagen. This process will be supported by the President's Major Economies Forum, which seeks to inform and complement the UNFCCC process. The EPA proposed rule provides an important step in advancing the science behind measuring greenhouse gas emissions from biofuels production and use. Comprehensive and science-based lifecycle analysis provides the very foundation upon which the climate benefits of the RFS program are realized.

Another reason why indirect emissions are important to identify is that, according to our analysis in the proposed rule, these impacts comprise a significant portion of the total lifecycle emissions of biofuels. Not including or addressing indirect emissions due to land use changes would ignore a large part of the greenhouse gas emissions associated with different fuels, and would result in a greenhouse gas analysis that bears little relationship to the real-world emissions impact of the fuels. Nevertheless, we understand that some have concerns that the state of the science regarding the assessment of GHG emissions related to international land changes is so immature, and potentially subject to error, that EPA should disregard or deemphasize such emissions, and calculate renewable fuel lifecycle GHG emissions assuming that there are no GHG emissions associated with predicted international land use changes. We believe such an approach would introduce far more error into lifecycle GHG assessment than the EPA proposal, which is based on reasoned application of the best available science and data. The result of disregarding land use changes would be to ignore the developing science in this area, and to overstate, perhaps dramatically, the GHG benefits of renewable fuels.

However, we recognize that it is important to address questions regarding the science of measuring indirect impacts, particularly on the topic of uncertainty. For this reason, we have developed a methodology that uses the very best tools and science available, utilizes input from experts and stakeholders from a multitude of disciplines, and maximizes the transparency of our approach and our assumptions in the proposed rule.

On the first point, our analysis relies on peer-reviewed models, including comprehensive agricultural sector models such as the Food and Agricultural Policy Research Institute (FAPRI) model that have been used widely to analyze the impacts of numerous agricultural sector policies including recent farm bills. We also have used the most current estimates of key trends in agricultural practices and fuel production technologies and have reviewed the growing body of literature on lifecycle analysis and indirect land use change.

Our work with experts and stakeholders has involved extensive coordination in the development of our methodology and selection of inputs and models. For example, my staff met frequently with the Departments of Agriculture and Energy to share our analytical plan, request feedback on our key assumptions, and provide preliminary results as they became available. In many cases, we adopted the inputs and assumptions suggested by these Departments. For example, we have used Department of Agriculture models and corn yield forecasts. To coordinate key components of our work, we have met on a regular basis with other key constituents including renewable fuel producers, petroleum refiners and importers, agricultural associations, lifecycle analysis experts, environmental groups, vehicle manufacturers, states, gasoline and petroleum marketers, pipeline owners and fuel terminal operators. We also have worked closely with staff from the California Air Resources Board as they have been developing their low carbon fuel standard program.

To maximize transparency, EPA's proposal highlights the assumptions and model inputs that particularly influence our assessment and seeks comment on these assumptions, the models we have used, and our overall methodology. For example, we have particularly highlighted and sought comment on our use of satellite imagery data to model land use changes. We also conducted a number of sensitivity analyses which focus on key parameters and demonstrate how our assessments might change under alternative assumptions. For example, the proposed rule presents results for scenarios with higher crop yields, stricter land use policies in other countries, and other plausible scenarios suggested by experts and stakeholders.

Through this process, EPA has learned a great deal about each stage of the lifecycle of renewable fuels. We have learned that the time horizon over which emissions are analyzed and the application of a discount rate to value near-term *versus* longer-term emissions are critical factors in determining the ultimate GHG impact of biofuels. Thus our proposal highlights two options. One option assesses emissions impacts over a 100 year time period and discounts future emissions at 2% annually. The second option assumes a 30 year time period for assessing future GHG emissions impacts and values equally all emission impacts, regardless of time of emission impact (*i.e.,* uses a 0% discount rate). The proposed rule goes into considerable detail explaining the conceptual argument informing the use of a particular time horizon and discount rate, while also specifically seeking comment on this issue, and also discusses several other variations of time period and discount rate. We also have greatly expanded our understanding of renewable fuel production processes and have identified several technologies available today (*e.g.,* membrane separation) that can significantly reduce process-related GHG emissions. At the same time, we have identified specific areas where additional information and input would be useful. For example, the proposed rule asks for guidance on our assumptions about future corn yields.

Recognizing that lifecycle analysis is a new part of the RFS program and much of our methodology represents groundbreaking science, I have directed my staff to create multiple opportunities to solicit public and expert feedback on our proposed approach. In addition to the formal comment period on the proposed rule, EPA plans to hold a 2 day public workshop focused specifically on lifecycle analysis during the comment period to assure full understanding of the analyses conducted, the issues addressed, and the options that are discussed. We expect that this workshop will help ensure that we receive submission of the most thoughtful and useful comments to this proposal and that the best methodology and assumptions are used for calculating GHG emissions impacts of fuels for the final rule. Additionally, although our lifecycle analysis relies exclusively on peer-reviewed models and data, between this proposal and the final rule, we will conduct additional peer-reviews of key components of our analysis, including use of satellite data to project the type of future land use changes, methods to account for the variable timing of GHG emissions, and how the several models we have relied upon are used together to provide overall lifecycle GHG estimates.

In the same way that EISA has introduced lifecycle analysis to the RFS program, the statute has introduced restrictions on what feedstocks may be used to produce renewable fuel. For example, the new law limits the crops and crop residues used to produce renewable fuel to those grown on agricultural land cleared or cultivated prior to enactment of EISA, that is either actively managed or fallow, and non-for-

ested. EISA also requires that forest-related slash and tree thinnings used for renewable fuel production pursuant to the Act be harvested from non-Federal forestlands.

However, the new renewable biomass provision also presents definitional and implementation challenges that we did not have to consider when designing the original RFS program. To address these challenges, we coordinated with and sought input from a wide range of stakeholders, including renewable fuel producers, private forest owners, and members of the agricultural and environmental communities, as well as with our colleagues in several USDA offices and agencies. Based on this extensive outreach and our own additional research, we have developed a proposal for public comment that we believe will position us to finalize and implement a practical and enforceable program.

With respect to the definitional challenges, there are a number of terms used in the renewable biomass definition that are subject to interpretation and need to be clarified, such as the terms "agricultural land" and "actively managed." With input from our colleagues at USDA and other stakeholder groups, we have proposed definitions for these specific terms that are meaningful in the context of the RFS program and that match existing industry definitions to the extent feasible. We also seek comment on alternative interpretations of these terms.

To fully understand the implementation challenges and opportunities presented by the new renewable biomass definition, we held extensive discussions with stakeholders. We also investigated existing Federal reporting programs and third-party certification programs for agricultural and forest products, and for biofuel feedstocks, in the hopes of leveraging such programs to avoid redundancy for our regulated parties. As described in our proposal, we determined that no single existing program or certification system could be relied on to ensure compliance with the renewable biomass definition. Therefore, we developed our proposal, which would make renewable fuel producers responsible for ensuring that feedstocks used to produce renewable fuel for credit under the RFS program meet the definition of renewable biomass. We expect that renewable fuel producers will work with their feedstock producers and suppliers to determine whether or not their feedstocks are in compliance. We also seek comment on a wide variety of alternative implementation approaches, including establishing an EPA-specified chain-of-custody tracking system for feedstocks as they move through the supply chain, and working with industry to establish an industry-wide quality assurance program. Our proposed and alternative approaches reflect many of the suggestions we received from stakeholders during the drafting process.

In closing, I believe EPA has put forward a proposal that is responsive to Congressional intent and fulfills the economic, energy, and environmental goals of the RFS program. We have developed the most comprehensive, current and scientifically supported approach undertaken to date to assess the lifecycle GHG impacts of renewable fuels. We look forward to continuing the dialogue on our approach through the public comment process on the proposal and through peer review of the specific items I have mentioned. Likewise, I believe our proposed approach for interpreting and implementing the EISA definition of renewable biomass successfully balances practicality with enforceability to meet the intent of Congress in promoting environmentally sound feedstock production for renewable fuels. The proposed rule offers an important opportunity for EPA to present this work and incorporate the input we receive over the coming months.

In the end, I am confident that we will be able to finalize a RFS2 rule that will achieve the benefits envisioned by Congress—to reduce our dependence on foreign sources of crude oil, diversify our energy portfolio, and provide important reductions in greenhouse gas emissions.

The CHAIRMAN. Thank you, Ms. Oge.

Following up on Ranking Member Goodlatte's comments in his opening statement, it is unfortunate we did not have more time to review your proposal, which was almost 600 pages of notice of proposed rule making and 822 pages of regulatory impact analysis. I don't believe, and I believe the Ranking Member agrees with me, that that is sufficient time for comments.

So we are going to be sending a letter down to the Administrator asking her to extend that comment period by 120 days to make it a total of 180 days, and I would encourage Members of the Sub-

committee and all our colleagues in the Congress to consider signing onto that.

Mr. GOODLATTE. Mr. Chairman, let me be the first.

The CHAIRMAN. Dr. Glauber, you mentioned in your comments that you work closely together on this proposal. Could you be more specific how much time was spent, what details, how far down into the weeds did you get?

Dr. GLAUBER. No. Thanks very much, and I think that shortly after passage of the Act and as EPA put a working group together several Federal agencies were brought in, including USDA, DOE, and others, to help in sort of an advisory capacity on various aspects of this. And so EPA solicited input on technical aspects of work that had been going on within USDA, both in terms of our economic modeling, and also in terms of issues like the extensive work we have been doing on distiller dried grains. We have provided comments to EPA, and what they have typically done is briefed us in terms of where they are in development of the rule, and we have given comments.

Obviously they are using data of ours, but they are the ones who are running the models, and they are the ones who are putting these things together and with their own cooperators. They have been sharing a lot of the results with us, and we have responded to those results with questions.

The CHAIRMAN. Well, how confident are you in moving forward with the inclusion of indirect emissions, given the current science that is available?

Dr. GLAUBER. Well, as I pointed out in my testimony, there is a great deal of uncertainty. There is no question about—let me back up and just say that is true. We do a 10 year baseline every year. We have economic models that project what the corn price will be over the next 10 years. There is uncertainty related to that. On top of those models we are putting international land use models that, frankly, I personally have a lot less experience with, but all that literature was developed over the last few years, and so that is very new, a view that is very uncertain. I know there is work, and on the next panel there are people who have done work and some currently looking at international land use.

But that is where the big source of uncertainty is. You know, we do forecasts all the time, and people take that uncertainty with the forecast in one sense. The difference here is, of course, you are regulating on it, regulating on the outcomes of this modeling effort, and that is the big question.

As the Administrator said, I think EPA is very clear on what they feel the Act requires them to do in terms of setting standards or estimating the effects of land use change to do estimates of greenhouse gas emissions.

The CHAIRMAN. There are competing definitions for *renewable biomass* currently in the law; one in H.R. 6 and one in the recently passed farm bill and now there are various definitions in introduced bills and proposals. How do you think the competing definitions will impact on the future of biofuel development?

Both of you.

Dr. GLAUBER. Okay. Let me just say that we have heard comments earlier, and I would agree wholeheartedly. I think unfortu-

nately the definition in EISA is a very, very restricted definition, and one, it precludes biomass from, in most cases from Federal lands. There are a lot of good cases for thinnings and other sorts of practices that we maintain on Federal lands that are very important. And then insofar as private lands are concerned, frankly most of the biomass we are talking about are things from tree plantations, where you plant rather than naturally regenerated forests and the sorts of good management practices that we might want to encourage in private forests. Congressman Goodlatte made those points very eloquently.

The CHAIRMAN. My time has expired, but Ms. Oge, if you want to comment briefly.

Ms. OGE. Clearly, Mr. Chairman, we have worked very closely with USDA. I would say that when we sat down to figure out how do we go about addressing this very challenging issue of doing a lifecycle analysis for all stages of biofuels, we sat down with USDA and Department of Energy, and we agree upon all the inputs that went into the models and the type of models that we used.

Clearly, as I said in my testimony, both oral and written testimony, there is a lot of uncertainty. We are looking forward to the comment period that is in front of us to have that dialogue with the scientific community in an effort to narrow the gap on the uncertainties.

As far as the various definitions, as you said, there are distinct differences between EISA, the farm bill, and other definitions that USDA is using. We have attempted to the best of our efforts to try to harmonize the definitions, but, again, we have to stay true in implementing EISA. We have to stay within the EISA framework, the legal framework, and that is what we have done.

We have attempted to seek comments how we can better harmonize the EISA definitions with the farm bill, and we are looking forward to the comments from the public.

The CHAIRMAN. Thank you.

The chair recognizes the Ranking Member, Mr. Goodlatte.

Mr. GOODLATTE. Thank you, Mr. Chairman.

Ms. Oge, Dr. Glauber's testimony talked about the uncertainty of modeling the change in land use, among other issues. The EPA uses several different models together to develop the greenhouse gas lifecycle analysis. This is a process that EPA admits has never been done before.

I am curious as to why the proposed regulations came out before a peer review had been completed.

Ms. OGE. This is the first time that formal lifecycle analysis has been done. So EPA, about a year and a half ago when EISA was passed into law, we sat down with those experts to understand what is the best methodology that we could use to meet the requirements of the statute.

We are using peer reviewed models, and a lot of peer reviewed data.

Mr. GOODLATTE. Ms. Oge, once you have produced this brand new methodology, so that we all could see it, not just take your word for it that you used experts in putting together, why wouldn't you do that peer review process after you had it done. So, you would effectively be looking before you leaped, because you have

leaped into a bold new area here that has drawn a pretty negative reaction on both sides of the aisle here.

And my follow-up question to you about this is are you going to do a peer review process now?

Ms. OGE. May I——

Mr. GOODLATTE. And if so, are you going to allow the public to comment on those peer reviews, because we are not having any opportunity to see what other respected scientists, which you may or may not have consulted. Or you may have consulted folks on one side of this debate and not on the other, but we are not getting a look into how you came upon this very novel methodology. We are not able to comment on the views of respected scientists in this area whose views we might like to have as we comment in this 60-day period that we have. And I fully agree with the Chairman that it should be extended dramatically, at least to 180 days so we can figure out what is going on here.

Ms. OGE. To your first question, why we didn't go ahead with a peer review. The first thing that we had to do is to have a broad discussion in a pretty open and transparent way with all the experts in this field. The two models that we are using are models that Congress has used, USDA has used. They are the best models available to us to do the work that Congress has tasked us to do.

In order to peer review the results, you have to have results. The results were not available to us until fall of last year. That was the time that we sent a package to the Office of Management Budget. But we did have a very transparent process. We were talking with USDA or the——

Mr. GOODLATTE. The question is why would you rush to judgment without having the benefits of other experts looking at your finished product?

Ms. OGE. We didn't have a finished product. The finished product, sir, is available now. You cannot have a small piece of the model being peer reviewed. You have to look at the whole record.

Mr. GOODLATTE. I understand that.

Ms. OGE. And the whole record is part of what we are putting out today. This is the proposal, we have 500 pages explaining the methodology and another 300 pages of the technical inputs of the model.

Mr. GOODLATTE. Well, let me move on to another question since my time is limited, but I will say that the process is very accelerated here and is not giving people an opportunity to see what you are doing, or to have the benefit of the well-established thoughts of other experts in the area.

But let me move onto another area. You mentioned in your testimony that what you are hoping to accomplish with the Renewable Fuel Standard is to reduce the carbon emissions of 24 million vehicles, which is obviously a respected standard. But it is ironic that the authors and supporters of this legislation tout the benefits of the RFS as a way to reduce greenhouse gas emissions, yet because of the feedstock restrictions, it will do little to help with one of the largest sources of emissions; wildfires.

Have you considered that? Last year alone, 9 million acres of forests burned, emitting roughly 60 million tons of carbon. That is roughly the equivalent of 12 million vehicles for 1 year. How could

the RFS help with this problem? In implementing the provisions relating to greenhouse gas emissions is the EPA considering ways to curb these emissions?

Ms. OGE. The 160 million metric tons of CO_2 equivalent to removing 24 million cars from the road is based on the 36 billion gallons of renewable fuel as mandated for 2022. The statute does allow biomass to be used if it comes from areas that are posing fire hazards. So the preamble has a discussion, a pretty significant discussion, again, that we hope that we can have dialogue with the general public, how to best implement that provision of the statute.

Mr. GOODLATTE. Would you agree with me that it would be a good idea to expand the available acreage of forestland that could be thinned to reduce the risk of forest fires, improve the health of the forest, and reduce greenhouse gas emissions at the same time?

Ms. OGE. Sir, I am here to tell you the steps that we have taken to implement the EISA laws passed by Congress. If Congress is interested of providing additional provisions or changes to that law, I would——

Mr. GOODLATTE. Well, many of us in Congress are interested in doing that. We wonder if you think that would be helpful.

Ms. OGE. I cannot talk about future provisions that potentially Congress would like. The only thing that I can tell you is that we would be more than glad to provide whatever technical assistance that you or other Members of the Subcommittee are interested in this issue.

Mr. GOODLATTE. Well, thank you. We would welcome that.

Ms. OGE. Thank you.

The CHAIRMAN. The chair thanks the gentleman and recognizes the gentleman from Michigan, Mr. Schauer.

Mr. SCHAUER. Thank you very much, Mr. Chairman, and thanks to you both. I am a new Member of this Committee and specifically of the Subcommittee, represent a rural district in southern Michigan. I have two ethanol plants, a biodiesel plant that is now closed. I specifically chose to be on this Subcommittee because of the opportunity to grow bioenergy jobs, particularly in my state and my district. I have one county in my district with an unemployment rate of over 18 percent, and what is happening with the auto industry. We have incredible promise to grow this area in our economy to not only protect the environment, but also support farmers and the auto industry.

Just specifically asking for your advice for what message I can send to farmers in my district, what promise do they have for opportunities to grow new products that can get into the biomass energy stream.

Ms. OGE. Well, first of all, I strongly believe that the EISA requirements provide tremendous opportunity for the country to stop its dependence on foreign oil and to help us address greenhouse gas emissions. The statute, as you probably know, allows for a broad grandfathering of facilities all the way to the 2010, which we believe is approximately 15 billion gallons of corn ethanol, which is the requirement under EISA.

So regardless, at the end of the day, whatever the Administration is going to decide on the lifecycle and threshold for corn ethanol—15 billion gallons of corn ethanol, that is the requirement

under EISA, is grandfathered under the proposed rule that we published yesterday.

Clearly, the second generation of biofuels is where we believe you are going to have the greatest opportunity to reduce the carbon footprint of the transportation sector. And, again, the President yesterday with the Department of Transportation and the USDA made announcements of providing additional assistance across the board to the farming community, but especially to the second generation of biofuels.

So we are very optimistic, and we are talking to many organizations that are involved in this area. We are very optimistic about the future of the second generation of biofuels.

Mr. SCHAUER. If I could follow up, Mr. Chairman, and I wasn't here when the 2007 legislation was written. It sounds like there are some concerns about rules and implementation and draft rules that were just presented, apparently, yesterday.

Is the Department of Agriculture in a position, given all of that, to meet now with farmers that are looking to grow new crops for the new biofuel economy? Or would that be, based on what I am hearing in this Subcommittee, premature? My hope is that the answer would be that now we can start meeting with those farmers, but I also want to be realistic. I am really looking for your help in how we can provide some hope to farmers that are looking for new opportunities.

Dr. GLAUBER. No, absolutely, it is not premature. We should be meeting with them. I think part of the announcement yesterday, in fact, was the President was very clear that he wants engagement on this. USDA, of course, has several provisions that we are in the course of implementing now, in the 2008 Farm Bill, that would encourage production of biofuels, and so, no, absolutely. This is the time.

Mr. SCHAUER. Well, you will be hearing from my office then.

Thank you.

The CHAIRMAN. The chair thanks the gentleman and recognizes the gentleman from Nebraska, Mr. Smith.

Mr. SMITH. Thank you, Mr. Chairman.

Ms. Oge, if you could elaborate on in your modeling on the land use, indirect land use, can you explain why you included the foreign lands within that proposal?

Ms. OGE. EISA requires that we look at all stages of the production all the way to the time where the consumer uses the fuel, look at both direct and indirect impacts and include significant indirect impacts specifically with land use. So we have to include international activities, and given the fact that setting aside the uncertainty with international land use, all this points that indirect land use is significant.

So clearly by excluding that activity we would not be able to fulfill the statute as passed by Congress.

Mr. SMITH. Is there any reflection in the report that reflects what we have more control over than what we don't regarding domestic or foreign lands?

Ms. OGE. Well, the land use lifecycle issues are new for biofuels. There are guidelines going back to 25, 30 years on how to do lifecycle analysis. So the lifecycle analysis includes all activities.

For example, when we did lifecycle analysis of petroleum, which is the baseline for gasoline and diesel, we had to look at significant actions when you produce petroleum. For example, extraction. Extraction very often happens in countries outside of the United States. Distribution: So for the petroleum baseline we had to look at all those significant activities producing petroleum.

So we had to do the same when it comes to addressing the lifecycle methodology for biofuels, and there is no question that we should include it. I think the issue that is in front of us, which EPA agrees, is the uncertainty associated including this significant impact that comes from international indirect land use.

So the issue is not really not to include it. Without including this international land use you would not be able to fulfill the holistic approach that the statute requires us to look at the lifecycle.

Mr. SMITH. Thank you. I found it very interesting as I have reviewed further sugarcane-based biofuels compared to corn based, and there is a lot of rhetoric and perhaps some demagoguery out there that is mischaracterizing and spreading some misinformation. I am not saying that you are responsible for that, but I think that this report adds fuel to the fire, no pun intended, and it is a very problematic situation. And I would hope that the agency could set the record straight. I think you have probably seen some frustration up here, and I share that frustration in my attempt to set the record straight.

So thank you, Mr. Chairman.

The CHAIRMAN. The chair thanks the gentleman and recognizes the gentleman from North Carolina, Mr. Kissell.

Mr. KISSELL. Thank you, Mr. Chairman, and thank the witnesses for being here.

I quickly want to say, like my colleague from Michigan, I am new on this Committee, and one of the reasons I requested this Subcommittee is North Carolina has a lot of forests and fields and capabilities of biomass fuel production, and I would want to add my voice to the list of expanding that definition.

But also, Ms. Oge, the 500 pages that are in this report, for someone new to the Committee, for what purpose was that report written, what should we be looking for there, and why was it presented?

Ms. OGE. Sir, in order to implement EISA we have to develop implementing regulations. So it is pretty routine that the agency has to look at all the elements of the EISA law that passed and interpret those elements and lay forward an approach that will allow us to implement this law.

Clearly there are a lot of complex issues anywhere from the four different standards that the statute requires, various definitions of biomass, various definitions of land that is excluded and included for the purpose of EISA, and also the lifecycle analysis. So what we have done is to lay forward a set of options and analyses for the purpose of public comments. We have asked the public to review the work that the agency has done, and we have given 60 days for that review process.

We are also planning to have a public hearing, a workshop to talk about the science associated with this program, and then after the public comment period closes, the Administrator would look at

the comments received. Clearly, there will be many comments associated with this proposal that we lay forward, and then the Administrator working with other agencies, the Department of Agriculture, Department of Energy, will make final decisions for this regulation. And the final decisions will be placed, hopefully, in sufficient time so we can see the 2010 implementation for next year.

So, again, the purpose of the public proposal yesterday is to provide comment, to provide the agency with the opportunity to have this public dialogue. We are starting with your Committee this morning, broadening to the community and all interested stakeholders, and then take those comments and help the Administrator to finalize this regulatory program.

Mr. KISSELL. Thank you, and that gives me insight to what the 500 pages are. Doesn't it seem somewhere, not to be overly cynical, was this law so complicated? Five hundred pages? It would seem like that would intimidate the public not to comment instead of inviting comment. Was it that far-ranging, that much new ground that we are attempting to unravel?

Ms. OGE. Well, sir, I have been with EPA for many years, and I would note that a preamble of 500 to 600 pages is extensive. This is pretty typical of regulatory programs that we put in place in order to be able to explain the work that was done and seek comments. So in order to be transparent and open of the thinking that was used to put forward the science, we have to go forward and outline all these issues. If we don't do that, then we don't give the opportunity for comments.

But we would be more than glad to have dialogue with any of your constituents, anybody that is interested, to talk to the agency and get a better sense about the proposal that was published yesterday. We would be more than glad to reach out to small business, farmers, renewable fuel producers and help them understand what is in this proposal so they can provide us meaningful comments.

The CHAIRMAN. The chair thanks the gentleman and recognizes the gentleman from Ohio, Mr. Latta.

The gentleman from Missouri.

Mr. LUETKEMEYER. Thank you, Mr. Chairman.

Ms. Oge, a quick question for you here. We are talking about the impact of renewable fuels on CO_2 levels. Have you done any studies to see—once we had biofuels in place and in usage now for quite some time—what is the impact at this point on CO_2 levels with the usage of biofuels?

Ms. OGE. The analysis that we published yesterday shows that 36 billion gallons of the use of renewable fuels as the EISA requires will have significant reductions of greenhouse gas emissions. So——

Mr. LUETKEMEYER. You haven't measured it, though?

Ms. OGE. Excuse me?

Mr. LUETKEMEYER. You haven't measured it?

Ms. OGE. The analysis is based on lifecycle approach.

Mr. LUETKEMEYER. You haven't measured. Have you measured it? Yes or no? We have had biofuels for a long. I have two biofuel, four biofuel plants in my district up and running.

Ms. OGE. We understand very well by talking to the biofuel producers the type of fuel that they are using, energy they are using.

They are using natural gas *versus* using coal, what the profile of the greenhouse gas emissions will be from those sources. You are asking us if we have gone to the plant and measured. No, we have not done that, but there is very little uncertainty of what the CO_2 levels will be from those production facilities. And that is the input that we are using for this analysis.

Mr. LUETKEMEYER. But you haven't measured it. Is that correct?

Ms. OGE. That is correct.

Mr. LUETKEMEYER. So if we haven't measured it in the past, how can we measure it in the future? Do we have that information at hand?

Ms. OGE. Well, again, the lifecycle analysis asks us to look at the production of biofuels. There are a lot of studies that have measured. I have not personally gone out and measured the greenhouse gas emissions, but there are a lot of studies that have.

Mr. LUETKEMEYER. Yes, but do we not have a situation in place right now where we are using some of these things already so that we can take the models of existing usages of these things and then project it?

Ms. OGE. Okay. Sir, we have used over 80 studies on lifecycle analysis available where measurements have taken place anywhere from the feedstocks, planting the feedstocks, transporting the feedstocks, producing them, to using them. In our own facility, in our own lab in Ann Arbor, Michigan, we measure the greenhouse gas emissions that comes out of cars if they use gasoline, if they use biofuels, or they are using biodiesel.

So personally we haven't gone to every plant and measured, but there is enough data and clinical data——

Mr. LUETKEMEYER. So we don't know how much effect biofuels have on our CO_2 levels at this point. Is that what you just said?

Ms. OGE. No. I am not saying that. I am saying——

Mr. LUETKEMEYER. Well, yes, it is, ma'am, because you haven't measured it.

Ms. OGE. No.

Mr. LUETKEMEYER. You just told me that.

Ms. OGE. Okay. This is what I am saying.

Mr. LUETKEMEYER. What was the CO_2 levels 5 years ago before we started using biofuels at the level we are at today?

Ms. OGE. Sir, let me finish your first question. We have——

Mr. LUETKEMEYER. I have a second question to ask. I am sorry.

Ms. OGE. Okay. We have sufficient studies of clinical data of all the stages of the lifecycle analysis of renewable fuels to know what the impacts are. We know if you burn biofuel in a car, we know, we have measured it. We have measured it in our lab. How much greenhouse gas emissions comes out. We know from facilities that produce biofuels what is the CO_2 impact. So we know that.

Five years ago there was less biofuel used. I am sorry I don't have the data with me but we would be glad to provide that information to you in what were the CO_2 reductions from the usage of biofuels 5 years ago.

Mr. LUETKEMEYER. Okay. Dr. Glauber, real quickly here. How has the usage of marginal land increased as a result of biofuel technology that has put more feedstocks into production or biofuels?

Dr. GLAUBER. You are talking historically over, say if we look over the last 5 years, clearly we have more corn in production. I think that is——

Mr. LUETKEMEYER. No. My question is marginal ground. I know we have taken the good——

Dr. GLAUBER. And I was building towards that answer. I am sorry.

Mr. LUETKEMEYER. I am sorry.

Dr. GLAUBER. And what I would look at, and in my testimony I present total land planted in the U.S., cropland, and there land has gone down over time if you look at the principle crop acreage. Total planted area has largely gone down since about 1996, which would suggest there, now, again, to ascribe that all to biofuels is inaccurate, but certainly there is a lot of the more marginal lands in the plains, in what I would characterize as a more rational rotation now. Those acres are not planted every year. You are fallowing more area.

So if you look at that in terms of what has gone on, there has been more corn area that now goes towards ethanol production. That is unquestioned. Initially we saw a decrease in oilseed area. That has come back up, but if you look at the principle crop area, that has been fairly flat over the last few years.

Mr. LUETKEMEYER. Okay. Thank you, Mr. Chairman.

The CHAIRMAN. The chair thanks the gentleman and recognizes the gentleman from North Dakota, Mr. Pomeroy.

Mr. POMEROY. I thank the Chairman for yielding. I have a number of questions, more than we can get through in 5 minutes. I would say that the concerns expressed by Chairman Peterson, as well as Ranking Member Goodlatte, reflect the thinking that certainly I have as one Member and shared by an awful lot of Members of this Committee. And I would probably note this is the beginning of a substantial and vigorous dialogue between the Committee and the agency on these matters.

Mr. Subcommittee Chairman, I certainly applaud you for what has turned out to be a very timely hearing in light of yesterday's proposed rule.

As I understand it, is your last name pronounced Oge?

Ms. OGE. Oge.

Mr. POMEROY. Oge?

Ms. OGE. Yes.

Mr. POMEROY. Not Oger. Oge. Okay. The grandfathering would basically contemplate much of the ethanol, corn-based ethanol, plants that have presently been constructed, would virtually include all of the plants constructed?

Ms. OGE. Yes, sir. Based on the analysis that we have done and the way that we have gone about interpreting the provision of grandfathering under EISA, we believe that all 15 billion gallons of corn ethanol will be grandfathered, and this is the volume that is required under the EISA statute for corn-based ethanol.

Mr. POMEROY. I mean, it is terribly important, this investment made in good faith, not be just relegated to rusting hulks of steel on the prairie, that we do, indeed, accommodate their production.

Ms. OGE. Yes.

Mr. POMEROY. Now, another type of biofuel, biodiesel, also has had substantial ramp up in capacity and a statutory goal of 500, a target of 500 million gallons, yet there is no grandfather proposed for biodiesel plants. Why wouldn't you treat biomass-based diesel programs like ethanol?

Ms. OGE. We believe that the statute is very clear on the grandfathering provision. It is intended for corn-based ethanol and not biodiesel.

Mr. POMEROY. Do you believe that the 500 million gallon statutory provision for biodiesel production could be met under your proposal?

Ms. OGE. Again, in the proposal we have laid out a set of different scenarios to address all feedstocks, including biodiesel from both sources, soy and waste. There is at least one approach that the agency is exploring as part of this proposal that would allow facilities to average the use of waste biodiesel and soy biodiesel. And if that is the approach that at the end of this process the agency will finalize, then there is the potential of biodiesel to meet the greenhouse gas threshold.

Mr. POMEROY. This 500 million gallon is a statutory provision.

Ms. OGE. Yes, it is.

Mr. POMEROY. And I hear you saying, well, maybe there is a possible way if there is a blending of different sources, perhaps, which would be permissible, maybe. And that is really not satisfactory at all in my opinion. There has been very considerable investment made in biodiesel production that you would wipe out, and this potential hypothetical maybe alternative is not fleshed out. What is clear is what wouldn't be allowed. What wouldn't be allowed is what has been established, so this is an extraordinarily consequential, I might say extraordinarily unacceptable proposed rule. It would have really a devastating impact to any investor in those plants that now have a production capacity, I am informed, of better than 2 billion gallons.

Do you propose to deal with that at or, or is that just kind of out of your scope of review?

Ms. OGE. We understand the issues and the concerns that you are raising about biodiesel. As I said earlier, there is a proposal that, if it gets finalized, we believe will allow the biodiesel market to meet the 500 million. The purpose of this process is to have the public dialogue and get input, and we appreciate your comments. We are seeking ways, again, within the statutory requirements of EISA with the greenhouse gas thresholds required and the work that we need to do to put forward a legally-defensible program to address the issues that you are raising. We are looking forward to having dialogue with you, the biodiesel sector, and see how we can address this very important issue.

We agree and we understand the issue that you are raising.

Mr. POMEROY. Dr. Glauber, is USDA comfortable with the direction of the proposed EPA rule?

Dr. GLAUBER. Again, as I have said, we have worked with EPA on this, providing comments. Certainly our concerns are exactly what you have pointed out. As far as corn-based ethanol is concerned, the Act covers that in the sense of the grandfathering

would allow it to meet that potential cap of 15 billion gallons of cornstarch-based ethanol.

The more difficult issue is the effects on biodiesel of this analysis, and in particular soy-based biodiesel. I think it is very clear at least from the analysis that biodiesel from waste products, for example, or from waste grease and from animal products would qualify.

And so because of that here you have a criteria laid out in the Act that they have to meet a 50 percent reduction in greenhouse gas emissions, and then through this analysis it falls short of that. That is where one worries about, okay, did you get the right number, and I think that is the thing we are all trying to grapple with here, is make sure we have the best number possible for this.

As I pointed out, I think there is great uncertainty around these numbers.

Mr. POMEROY. I know I am out of time, Mr. Chairman. I just conclude that it appears as though the vigorous discussions ahead are not just between Congress and EPA. They are within EPA and other elements of the Administration, and I am happy to hear that there is other, vigorous input, particularly from the U.S. Department of Agriculture continuing on this matter.

Dr. GLAUBER. And EPA to their credit has asked for our input several times, and we will be there every time we are asked.

Mr. POMEROY. Well, it is fine to ask, but I want more consideration of the input received in the final product.

Thank you, Mr. Chairman. I yield back.

Dr. GLAUBER. We will be vocal.

The CHAIRMAN. The chair thanks the gentleman and recognizes the gentleman from Kansas, Mr. Moran.

Mr. MORAN. Mr. Chairman, thank you and to Mr. Goodlatte for hosting this hearing.

In my stereotypical way I guess I would expect this kind of rule from the Environmental Protection Agency, but I am troubled by Dr. Glauber's response to the gentleman from North Dakota's response about comfortability. What I would expect from a Department of Agriculture is an advocacy for agriculture, for rural America for a bioenergy industry, and what I hear is we are providing information. I would think you would be here today on behalf of USDA or someone from USDA would be here raising real concerns with this proposed regulation, this policy.

And while I can understand that we can have a discussion about the indirect land use, I do not understand why we would have any level of comfortability with indirect land use from foreign countries. I certainly don't understand why the Department of Agriculture would have any level of comfortability in regard to indirect land use applied against biofuels, but not against other sources of fuel in the United States.

So in my stereotypical world I can understand the Environmental Protection Agency being here. That is not something that I would find unexpected, but I would hope that the Department of Agriculture would be an advocate for something that we have heard year after year from Secretaries of Agriculture under all Administrations about the value of biofuels and what it means to this country. We have heard that from Department of Energy officials,

and I share the Chairman of the full Committee's sentiments that he expressed, I was going to say eloquently. I don't know that he was eloquent, but he was certainly forthright about the direction that this kind of regulation will have, what affect it will have upon an industry that is really struggling today to survive. This is just one more proverbial nail, and we have seen the consequence of what has happened with California's decision in regard to indirect land use, and what that means to the ability for Kansas ethanol industry to export ethanol to another state. We are now headed down a path in a way that is totally contrary to the goals that we have set forth, not just those of us on the Agriculture Committee who look out for rural America and profitability, opportunities for success in rural America, but as a Member of Congress who cares greatly about our national security and what effects our demand for foreign oil places upon our circumstances.

And so Dr. Glauber, I would hope that with further thought a different answer to Mr. Pomeroy's question about the willingness to provide advice, let us see USDA set forward and be a spokesman for something that is very important in this country. I am today introducing legislation that is comparable, although not identical, to legislation that a Senator from South Dakota, Senator Thune, introduced, and I would encourage my colleagues to join me. It will restrict the ability to utilize indirect land use in regard to EPA's calculations. The bill strikes that referenced indirect land use and directs EPA to focus on direct lifecycle greenhouse gas emissions.

Therefore, leveling that playing field between renewable fuels and regular gasoline allows individual ethanol producers with unique production methods to apply to the EPA for a lower carbon score, therefore: encouraging innovation within the ethanol industry to try to find out how we can produce ethanol in a less carbon-intensive way, a waiver process in regard to greenhouse gas reduction requirements similar to what we have in the Renewable Fuel Standard. If a state chooses to apply a state-level low-carbon fuel standard, this bill would require states to use lifecycle greenhouse gas emissions instead of the process of indirect land use.

So I am not sure that was a question, but certainly I am raising the flag that this rule is creating tremendous challenges for an industry that is important, not just to agriculture but to the United States economy and particularly to our national security.

Mr. Chairman, I would encourage my colleagues, if they are interested in our legislation, to join us today in sponsoring it, and I certainly would add my signature to your letter encouraging a longer period of time for public comment. And I thank the Chairman and yield back the balance of my time.

The CHAIRMAN. The chair thanks the gentleman and recognizes the gentlewoman from Pennsylvania, Mrs. Dahlkemper.

Mrs. DAHLKEMPER. Thank you, Mr. Chairman. Thank you for this very timely hearing.

I would like to ask Dr. Glauber a question. If you owned a biodiesel or ethanol facility, what three items would cause you the most concern about the proposed EPA regulations?

Dr. GLAUBER. Well, on the corn ethanol side the concerns I have had about the bill, the one concerns the certification of requiring that all corn comes from ag use, and EPA is soliciting comments

in the rule on that. The last thing you want is a certificate for every bushel of corn that I am moving around the country, that it has come from an ag use. I think that as was mentioned, or as the Congressman raised the question about marginal lands, I would pretty much say that all this is coming from agricultural lands.

The biodiesel thing, I think the clear thing there is whether or not soy-based biodiesel qualifies. Obviously if it doesn't qualify, that part of the industry is dealt a big blow, and in terms of that there may be an opportunity to mix that with animal waste as, again, EPA is soliciting comments on that. But frankly, there the issue is the pricing relative to animal waste, and I think that that is the big problem. And as we know and has been pointed out by others, biodiesel right now, if you are a soybean-based biodiesel producer, the margins are negative. They have been largely negative this year. That is true even, of course, with corn-based ethanol. So these are tough times, and to get the sort of investments necessary in those, they have to have some assurance that there is a future.

Mrs. DAHLKEMPER. Why do you think the European Union has not used indirect emissions as part of their programs?

Dr. GLAUBER. I am sorry?

Mrs. DAHLKEMPER. Why do you think the European Union has not used indirect emissions as part of their programs as you are looking at direct and indirect?

Dr. GLAUBER. Well, frankly, they have been looking at, they are considering looking at indirect emissions, and up until this point you are right. They have just been using strictly direct emissions, as were we. And that, of course, is the big difference here. If you look at biodiesel on just a direct emissions basis, it has a very large reduction in greenhouse gas emissions relative to gasoline. It is only when these indirect effects are put in that it doesn't meet the targets under EISA.

Mrs. DAHLKEMPER. And what is your confidence in measuring indirect?

Dr. GLAUBER. Well, as I said before, we have concerns about the overall uncertainty of this, and, again, if I look at what is going on in the U.S., I feel pretty confident with our models. The international models, I am confident, to a degree, but even there we know less. The real source of uncertainty, in my own view, is the land conversion, and it matters. It matters a great deal whether or not you are converting new land. Whether or not it is coming from other cropland, obviously there is very little effect there. If it is coming from pasture, there is some effect, but if it is forests, those are the big concerns. If those emissions all come from forests, you have a huge pulse at the beginning when you cut down those forests, and then you have to recoup that over a number of years. And that is where the real source of uncertainty in my view lies, because if there is an error of 20 percent, 50 percent, or whatever, then that is where the variance really is in that.

And just let me say. The last thing I want is for Congressman Moran to think that I was being too glib with Congressman Pomeroy. We are concerned, and we are working trying to be very constructive in this, and believe me, we are being advocates for the biofuel industry.

Thank you.

Mr. MORAN. Would the gentlelady yield?

Mrs. DAHLKEMPER. I yield.

Mr. MORAN. Thank you, Dr. Glauber, and I feel badly that I yielded back my time without giving you an opportunity to respond. I do appreciate your efforts, and I recognize you are the Department's Economist. My comments are directed broader than just you, sir, but I appreciate your response. Thank you.

Thank you, ma'am.

Mrs. DAHLKEMPER. I yield back my time.

The CHAIRMAN. I thank the gentlewoman and recognize the gentleman from Iowa, Mr. King.

Mr. KING. Thank you, Mr. Chairman, and I thank the witnesses for your testimony. I have, sitting here, picked up a perspective, and maybe I could ask some questions and perhaps redirect that perspective a little bit.

I would first ask Ms. Oge, are you familiar with Dr. Pimentel's study that evaluates the energy required to produce ethanol?

Ms. OGE. Personally I am not familiar. The lady behind me is the director of the program, and she tells me that that analysis is reflected in the work that we have provided and was published yesterday.

Mr. KING. I just want to compliment her on great staff work to give you a little sound signal from back there.

Ms. OGE. Well, thank you.

Mr. KING. And so Dr. Pimentel's study is reflected there, and then I would take that thought, and you recognize that Dr. Pimentel's study also includes 4,000 calories per day consumed by the farm worker and seven trips across the field and the cost of the energy that it takes to produce the tractor, the combine, and the equipment?

Ms. OGE. That is part of the work I am told by my colleague that we are looking at now.

Mr. KING. Okay, and I am probably going to end up doing this second-hand, and I will perhaps submit some questions after the hearing to try to drill into this a little further, but for the record of this hearing then I will just make a statement on this. Dr. Pimentel's study does do those things, and it calculates the energy required to produce the tractor and the combine, the planter, the farm equipment. It calculates the energy consumed by the farm worker, 4,000 calories a day. That is more than I get, by the way. I don't work that hard, though. And it compares the energy use and makes a statement that it takes more energy to produce ethanol than you get from it.

I would ask if you are familiar with the study done by Dr. Wong at the Argonne National Lab in Chicago that calculates the energy that goes into producing a gallon equivalent of BTU energy of ethanol *versus* that of gasoline?

Ms. OGE. Yes. Sir, let me tell you a little bit what we are doing with the lifecycle. We are using the international standard organization boundaries, so we are using the same boundaries and the same elements——

Mr. KING. I am sorry. I am watching the clock tick, and I don't mean to interrupt. I really apologize for that, but out of the ur-

gency then, if we are using the same boundaries, are you also calculating the energy that it takes to produce the drill rig and the pump?

Ms. OGE. No, we are not. Let me tell you what we are doing. We are looking at the energy that it takes to extract oil, but we don't look at the energy to produce the drill extracting the oil. We are not looking at the energy that it takes to build a tractor. These are not the activities that we are including in the lifecycle analysis.

Mr. KING. Yes, but if Dr. Pimentel's study is incorporated into this what is the implication, I will ask for a broader answer to that.

Ms. OGE. What I am saying is that we have looked at his study. I am not suggesting that we are accepting the premise that to do lifecycle analysis we have to look at the energy that goes into using a tractor.

Mr. KING. Okay. Thank you, and I will ask for a broader analysis of that.

But I would ask this. Have you also looked at the amount of CO_2 equivalent that is sequestered by an acre of corn *versus* an acre of old-growth forest?

Ms. OGE. I believe we have.

Mr. KING. And would you have a response for this Committee as to——

Ms. OGE. We would be glad to provide it when I go back to the office. Unfortunately, there is a lot of data, thousands and thousands of pages of data.

Mr. KING. Okay.

Ms. OGE. I don't remember all of it, but I would be glad to——

Mr. KING. Okay.

Ms. OGE.—give you the information.

Mr. KING. That is okay. I turn to Dr. Glauber and pose the question in a different fashion, and let me submit that the information that I have says that corn sequesters more carbon than an old-growth forest does. Now, you can argue what you do with that corn after the fact, but as I look at this ethanol situation that we have, and looking at the 15 billion gallon RFS standard we have by 2015, which the lady has testified we will reach with corn ethanol, and I believe we will, have you also calculated that with trend relying yield increases that we will arrive at that without using any more acres of corn?

Dr. GLAUBER. Well, that is right. When we look at our baselines, and I believe EPA looked at or used our own analyses on yield growth over time, you are right. You are adding about 2 bushels per acre per year on that, and over time that means a lot of acres. I think, sort of growth over say a 10 year period is probably equivalent to bringing in about—I am doing the math quickly in my head, but 4½, 5 million acres at current yields.

And so over the longer run, you are absolutely right. With the more yield growth you are essentially being able to account for that increase in biofuel production.

Mr. KING. Okay, and then if I would just run some numbers out of my head, when I was a kid, 80 bushels of corn was a respectable crop. Today 240 bushels is a respectable crop. Monsanto put out some numbers that they project three to four percent increase in yields annually up to 300 bushels. Beyond that they don't predict.

So what do we have? Triple the yields that we had in the last, let us say, 50 years.

And so under this assumption I see no assumption made for acres consumed for cotton or non-food crops, and I hope that the rural population growth is factored into this as well. But we have about 3.2 billion bushels of corn that we have committed to corn ethanol, and I am looking at the language coming out of the CARB operation in California, it looks like its protectionist language to me for a state to set up protectionism.

And, this presumption that has to underlie what I am hearing here today, and is in the report presumably and in some of this testimony, is that if we took those acres out of production that we are using to produce the 3.2 billion bushels of corn that will soon be up to perhaps 5 billion bushels of corn to reach our 15, that there would be old-growth forests that would be reforested in Brazil.

I mean, isn't that the antithesis of this presumption that trees are being taken out in Brazil if we use corn to convert to ethanol? Isn't the inverse of that then you have to also have a presumption in your calculation that there would be forest growth that would regrow if we took it out of production?

And I just think there are too many factors involved here, but I would like to hear what you have to say.

Dr. GLAUBER. Well, let me just say about the carbon sequestration or the growth of carbon in old-growth forests. I don't have the numbers in front of me either, I might add, but you are right. Old-growth forests add very little carbon from year to year.

The real issue is whether or not those forests are cut down, and then that is the real issue that is behind the analysis, that once the forests are harvested, there is a huge pulse of carbon by virtue of that harvest.

But you are absolutely right in terms of it is that issue that really makes the difference here in terms of these estimates. In terms of the greenhouse gas emissions are the emissions on any sort of increase in land. I think that is behind the analysis presented in their proposal.

Mr. KING. I thank you, Dr. Glauber and Ms. Oge. I appreciate your testimony.

Mr. Chairman, I appreciate the extra minute.

The CHAIRMAN. The chair thanks the gentleman and recognizes the gentleman from Pennsylvania, Mr. Thompson.

Mr. THOMPSON. Thank you, Mr. Chairman, Mr. Ranking Member. I appreciate the opportunity to have this discussion.

I come from an energy-rich district. Actually, we drilled for oil the first time commercially in the world 150 years ago this August, but we are sitting on the third largest, world's largest play of natural gas, coal, ethanol plants, and timber, and specifically 513,000 acres, the Allegheny National Forest. So actually at the risk of replowing ground that was covered by the Ranking Member, I wanted to just follow-up, Ms. Oge, on the *biomass* definition within the RFS2 that excludes material taken from Federal lands specifically, and I have significant concerns about that. I have 513,000 acres, and we are not talking about standing timber. You know, there is a lot of timber that is just rotting on the ground that would be

great fuel stock. And frankly, it is good fuel stock because it is contributing across the nation to wildfires.

And as the Ranking Member made reference to, I mean, the data, the scientists are pretty clear that humans are contributing, I guess, four percent human activity towards CO_2 emissions, and wildfires I have seen data that shows it at ten percent.

And so the exclusion of the Federal lands, actually, really appears to be contributing towards the CO_2 emissions and completely contrary. And so just briefly my question is in your analysis and responsibility to protect the environment, what is the rationale for that provision within this rule?

Ms. OGE. Sir, again, what we are trying to do under EISA is to interpret the Congressional intent and do it in a way that would forward that regulatory proposal that is legally defensible. So if EISA excludes Federal land, biomass from Federal land, we have to respect that exclusion and interpret that the way that Congress intended.

Now, I understand the issues that you are raising, but, again, that goes beyond the work that we have to do in implementing what Congress passed, the President signed to a law, and we have to interpret it into regulations.

Mr. THOMPSON. And as it applies to this specific rule, now, in terms of the overall responsibility and the mission of the EPA. However, in terms of protecting the environment, it would appear to me and what would be your analysis that should have that been a provision within this rule in terms of accessing that biomass resource that is accumulating on the forest floor. It is contributing towards wildfires and in the end contributing significantly well beyond what humans contribute to CO_2 emissions?

Ms. OGE. On the issue of potential wildfires, we had an extensive discussion on that issue, and we are seeking public comments to what extent those areas that potentially pose risks from fire should be included as part of this, and we are looking forward for the public comments.

Mr. THOMPSON. I am looking forward to weighing in on that conversation myself.

Dr. Glauber, just very briefly, the USDA and the Department of Forest Services manages that resource with our national forests. It comes under that jurisdiction. Does the USDA support that this proposal represents the proper management and use of available national forests biomass resource?

Dr. GLAUBER. Well, thanks. First let me just say I agree with what you say in terms of the implications of excluding Federal lands and the narrow definition on private forests. I think both of those miss an opportunity, both in terms of promoting biomass from those areas, but also encouraging better forest management policies.

The problem, as Director Oge was mentioning, is the definition in the Act, and I think there is a question of how broadly can you interpret a definition that is fairly narrow frankly, and it is a concern. And as you know, there was a great debate over it during the energy bill itself, and I am pleased that when we did the farm bill at least that the farm bill did include a much broader definition.

But the real problem is the definition in the Act itself.

Mr. THOMPSON. I would agree with that.

I yield back my time. Thank you.

The CHAIRMAN. The chair thanks the gentleman and recognizes the gentlewoman from South Dakota.

Ms. HERSETH SANDLIN. Thank you, Mr. Chairman, and I would like to say to my colleague from Pennsylvania, I enjoyed working with your predecessor on this issue and will look forward to work closely with you. The only exception I would take to what Dr. Glauber just said is that there wasn't a debate on that definition during the energy bill. That was the problem. It was a narrow definition stuck in the 11th hour—right. Controversies surrounded it in the days following and we have a bill that we will share with you that seeks to change the definition. Certainly the definition in the farm bill is better than what we had in the energy bill. We think the definition in my bill is even better, and so we will continue to work with Members in a bipartisan way on this Committee to make that change to allow both EPA and USDA to go forward as well as Department of the Interior with the analysis that we think should be done as it relates to biomass resources across the country.

Ms. Oge, there have been a lot of questions on the indirect land use changes, and I want to focus on the domestic *versus* the international analysis. It is my understanding that producers asked EPA to clearly separate in its proposed rule the domestic and the international indirect affects attributed to corn ethanol and biodiesel, but in the end the rule doesn't provide that transparency that was requested.

Is it correct that EPA did not break out the domestic and international indirect effects?

Ms. OGE. No, it is not correct. We did provide for that transparency. Again, this regulatory package is extensive. I don't remember exactly the page that this information appears, but we have provided it for the purpose to be transparent, which we believe is very important——

Ms. HERSETH SANDLIN. Well, let me——

Ms. OGE.—the percent of greenhouse gas emissions that come from domestic activities *versus* the international land use impact.

Ms. HERSETH SANDLIN. Okay. Well, we are still in the process of reviewing the lengthy proposed rule and that analysis. So we will keep looking for that information, and if you do have a page that you can point us to that clearly sets forth how you broke out the domestic and international analysis, that would be helpful.

Ms. OGE. I would be glad to do that.

Ms. HERSETH SANDLIN. Thank you. Can you also, based on the charts that the EPA released yesterday, we have calculations of emissions for grain-based ethanol over both a 100 and a 30 year period. Now, Dr. Glauber notes in his written testimony that the scientific literature on biofuels production and international land use has been written basically in the last 5 years, and I would add in a very highly-politicized environment with a lot of misinformation circulating.

And so if you could answer, and you may want to take these for the record because my time will be down here shortly, but I want to understand how EPA resolved some key issues relating to calculating land use changes. And specifically I would like to point to

Dr. Glauber's testimony and the section entitled, *Sources of Uncertainty* so that you could provide, Ms. Oge, specifically how the EPA decided yields on converted lands, shifts between different land uses, yield growth over time, the substitutability of dry distiller grains, and how to treat a variety of modeling assumptions, including assumptions about changes in fertilizer use.

So, again, many of us are concerned, and we appreciate that the EPA is going to subject its own analysis to peer review, and in the time I have remaining, if you could just take those for the record, if you could explain in more detail how the peer review process for these models is going to work.

Ms. OGE. Yes.

Ms. HERSETH SANDLIN. How will members be named, based on what criteria, and what timeline will it have for reaching conclusions, and how often do you anticipate a review of the models?

Ms. OGE. I would be glad to do that. But very briefly on your first question, a lot of the inputs, the yield improvements, the acres that we expect to be used in the United States, and there was a question earlier, we believe very few new acres will be needed for the 15 billion gallons of corn ethanol. All this input comes from USDA for these models but we would be glad to respond back to you in writing.

On the peer review there are four broad elements that we are seeking peer review for. One of the most important elements of this analysis that brings along the controversy is the use of satellite data for the international land use. We have used NASA satellite data from 2001 to 2004 timeframe that provides historic empirical data of how countries like Brazil have made decisions to move to forestland *versus* pastureland.

So that is a very critical element of the analysis. So we will do peer review of that, along with the peer review of how we have put together the three models; actually, four models.

The peer review process is the guidelines that we are using, EPA guidelines, Office of Management and Budget guidelines as how to have a third party make decisions of what experts that need to be brought into the peer review process. We hope now that the public record is in place, we have started the process for peer review, and we hope that the peer review process will be completed hopefully by the end of June. And we will be publishing the peer review results of that effort.

The CHAIRMAN. The chair thanks the gentlewoman and recognizes the gentleman from Louisiana, Mr. Cassidy.

Mr. CASSIDY. Great thing about going last is that most of your questions are answered.

That said, I do want to learn some more on this, and some of this you may not be able to tell me. For example, obviously what you decide could have tremendous impact, potentially, upon cap-and-trade. If you say you are taxed for the amount of emissions that your industry creates in the cap-and-trade system effectively. If it is an international issue, okay, so we don't have to plant more farmland, but they have to deforest the Amazon to produce more sugarcane or corn or whatever. Does that impact the tariff paid by our producers under the proposed cap-and-trade system? You may not know that but that comes to mind.

Ms. OGE. Another office of EPA has been responsible in evaluating the overall cost to our domestic industry from all sectors for the Congressman Waxman bill, so I cannot speak to the methodology that they have used. But, I am pretty certain that the oil industry, the refiners, including the input now that we are getting from the renewable fuel producers, they will have another cap as part of the industry-wide cap-and-trade. To what extent the cost of that has been addressed with what is going to happen in the global way, I really cannot answer that question for you.

Mr. CASSIDY. Second, the California standards, have they been peer reviewed?

Ms. OGE. We have worked very closely with the State of California in their efforts for their low-carbon fuel. The methodology that we are using in looking to the other phases of the lifecycle is the same methodology that they are using. However, they are using different economic models than we have used.

I cannot answer to what extent their work has been peer reviewed. I do know that they had a board meeting about a week ago in California where the board reviewed the work that was done by the State of California. And my understanding is that they will continue looking at a number of issues that came up from the review process that they have undertaken for the next couple of years.

Mr. CASSIDY. And so I understand, obviously, fertilizer is part of taking increasing yields, so in your modeling if they use increased fertilizer, I presume that that would be included among your indirect costs?

Ms. OGE. Well, the use of fertilizer is used not merely just for cost but as part of the greenhouse gas emissions.

Mr. CASSIDY. Yes.

Ms. OGE. We are using what we believe is the best data today, but this is another component of the analysis that we are going to peer review in the next 60 days.

Mr. CASSIDY. I am also a freshman that never really looked in detail at how you report, but you mentioned that there is variability with things such as land use and *et cetera*. But I presume that you report with confidence intervals. Correct? A range of values that on a low end and a high end, depending upon these variables. Is that a correct assumption?

Ms. OGE. The analysis as we have done, we are calling them uncertainty or sensitivity analysis so we have a number of scenarios, especially on elements of the analysis that have the most important impact for the greenhouse gas emissions, which is the international land use. So we have made a lot of sensitivity analysis.

For example, we assume based on satellite data that about four percent of forests will be the land that Brazil is going to use. Four percent will come from forests. The remaining will come from pastureland, to make up for the difference of the corn exports that will not leave from the states and another country would have to make it.

As Dr. Glauber said, that four percent, although it is very low, it is extraordinary crucial because that is where you get most of the increases of greenhouse gas emissions. So we have that sensi-

tivity analysis. What if it was zero percent of forest? What would that land use impact be?

So all this sensitivity analysis have been laid forward for public comments.

Mr. CASSIDY. Thank you very much.

The CHAIRMAN. The chair thanks the gentleman and also would just like to say to our witnesses that Chairman Peterson told me that he was riled up, and he wanted to make a statement, and he certainly did that. And Ranking Member, Mr. Goodlatte and I have been serving on this Committee with Chairman Peterson for over 16 years, and he has never been shy about what has been on his mind. But, that is about the most direct frustration that I have seen in over 16 years coming out of his mouth.

And I would just like to say that I share his frustration, and from the comments and questions that you received here today from Members on both sides of the aisle, because this is a very bipartisan full Committee and very bipartisan Subcommittee, that we are very concerned about the path that we are going down, and we want you to take that message back loud and clear.

We thank you for your testimony.

If the Ranking Member has something to add?

Mr. GOODLATTE. No. I would just add one thing, and that is in addition to the frustration about how this process has evolved and what has come forward, I would have to say that the many arbitrary restrictions in the RFS, including those that would allow use of planted trees or crops from land if it was cropped prior to passage of EISA, would seem to create an implementation nightmare. And if it becomes necessary to track what lands crops came from, or whether a tree was planted or naturally regenerated, and I just believe that both USDA and EPA are going to have an implementation problem with these regulations if you pursue the path that you have set yourself on to this point.

So I hope, again, that you will not only listen to our comments but the multitude of comments I am sure you are going to receive from others and listen to them before you implement anything that is going to be Orwellian; as the process you are embarked upon right now in trying to determine where and how something was generated to create the fuels that are necessary for our country.

We want to be encouraging production of all sources of energy in this country, not discouraging them through regulatory nightmares.

Thank you, Mr. Chairman.

The CHAIRMAN. The chair thanks our witnesses and will call panel two.

Dr. Bruce A. Babcock, Director, Center for Agricultural and Rural Development, Iowa State University; Mr. R. Brooke Coleman, Executive Director of New Fuels Alliance, Boston, Massachusetts; Mr. Nick Bowdish, General Manager, Platinum Ethanol, Arthur, Iowa; Mr. Manning Feraci, Vice President of Federal Affairs, National Biodiesel Board; Mr. Michael Pechart, Deputy Secretary for Marketing and Economic Development, Pennsylvania Department of Agriculture; and Ms. Anitra Webster, family forest owner on behalf of American Forest Foundation, Lynchburg, Virginia.

Dr. Babcock, when everyone is seated, you may begin your testimony.

STATEMENT OF BRUCE A. BABCOCK, PH.D., PROFESSOR OF ECONOMICS AND DIRECTOR, CENTER FOR AGRICULTURAL AND RURAL DEVELOPMENT, IOWA STATE UNIVERSITY, AMES, IA

Dr. BABCOCK. Thank you, Mr. Chairman, Mr. Goodlatte, for the opportunity to participate in today's hearing.

During the last 18 months my research center has worked with EPA to enhance their ability to determine if biofuels meet the greenhouse gas performance thresholds of the new RFS. EPA needs to estimate how diversion of corn and vegetable oil to fuel, biofuels will change agricultural production around the world. Thus, EPA naturally sought out researchers who could help them answer this question, since they had little expertise in this area.

Diversion of corn from feed to fuel increases the price of corn. One response to this price increase is that more corn will be produced. In the United States increased corn comes primarily from a reallocation of land away from other crops. In addition, some land that was not previously landed for corn has been brought into production.

Other countries will also alter their crop mix, and the cultivation of new land will also increase, and this cultivation of new land does release CO_2 from the stock of carbon in the soil and on the plant biomass. This release of CO_2 in response to higher corn prices is logically attributable to expansion of the U.S. corn ethanol production.

Thus, Congress and the California legislature have some justification for wanting to account for the CO_2 emissions caused by price-induced changes in land use when determining whether expansion of biofuels increases or decreases CO_2 emissions.

The key question is whether we can accurately predict how U.S. biofuels policy will affect land use both here and abroad. Our ability to estimate changes in acreage devoted to U.S. crops due to price changes is reasonably good because we have been doing this for about 30 years. Our ability to estimate changes in agricultural production overseas is less precise. The reason is that there is the sheer number of agricultural sectors around the world that need to be well understood and modeled.

The ability to estimate the dynamics of agricultural land use is even more limited. For example, the model that California uses to estimate land use changes from biofuels predicts that about half of the expansion in cropland from corn ethanol in the U.S. comes from cutting down forests. The other half comes from conversion of pasture.

However, over the last 3 years we have seen little evidence that U.S. trees are being cut down to produce ag land. Rather than conversion of forests and existing pasture, U.S. cropland has increased primarily through some reduction in CRP and through increased double-cropping of soybeans after wheat.

Our ability to accurately measure how other countries will expand their agricultural land is limited by a lack of available data and a lack of knowledge about what is actually going on in those

countries. For example, both California and EPA conclude that increased crop prices from biofuels' expansion will increase deforestation in the Amazon. This seems logical because increased demand for cropland is largely met by pasture conversion, and unless the Brazilian cattle herd shrinks, it would seem that the decrease in pasture would have to be made up somehow. Well, where is Brazil going to get more pasture? Well, by converting Amazon forest in savanna. Thus, the argument goes. Any increase in Brazilian cropland leads to deforestation and a loss of savanna.

But there is scant evidence that increased production of crops has been the primary culprit in the loss of Amazon forest. Certainly cattle and pasture have both increased in the Amazon since 1996, but was that due to the 36 percent increase in Brazilian cropland or to the 30 percent increase in the cattle herd in Brazil?

With help from a research center in Brazil we are only now beginning to sort that out. Preliminary data suggests that a significant portion of the increase in cropland since 1996, in the major crop-producing regions of Brazil, was accommodated by increasing the cattle stocking rates. Further analysis is needed before we can state with confidence how much of the pasture created in the Amazon was created by crop pressure rather than by increased herd size.

Well, why does this matter? Well, nobody believes that expansion of U.S. corn ethanol is going to increase cattle herd in Brazil. Rather, higher crop prices will probably lead to some increase in cropland. If the Amazon forest was cut down to accommodate increased cattle numbers and increased stocking rates accommodate increased cropland, then the primary impact in Brazil of increased crop prices will be intensification of cattle production, not loss of savanna and Amazon forest.

The precision with which lifecycle analysts can estimate greenhouse gas emissions associated with growing, transporting, and processing feedstock is high. The precision with which models can estimate CO_2 emissions associated with price-induced land use change is low.

If Congress and individual states want to be able to estimate how expanded production of biofuels changes greenhouse gas emissions, then significant improvements are needed in our understanding of the dynamics of crop and livestock production outside the United States. My center is investing heavily in improving our understanding of Brazilian agriculture to better enable EPA to conduct this analysis.

I anticipate we will be replicating this effort for other major producing countries. Without this kind of effort it is impossible to conclude with any certainty the extent to which increased emissions from land conversion offset the decrease in emissions from using renewable fuel in our transportation sector.

[The prepared statement of Dr. Babcock follows:]

PREPARED STATEMENT OF BRUCE A. BABCOCK, PH.D., PROFESSOR OF ECONOMICS AND DIRECTOR, CENTER FOR AGRICULTURAL AND RURAL DEVELOPMENT, IOWA STATE UNIVERSITY, AMES, IA

Thank you, Mr. Chairman, for the opportunity to participate in today's hearing.

My research center has worked on the economics of biofuels for the last 4 years. During the last 18 months, we have worked with the Environmental Protection

Agency (EPA) to enhance their ability to determine if biofuels meet the greenhouse gas performance thresholds of the new RFS. We have a global production and trade model that has been used for analysis of farm and trade policies for the last 25 years. The model tracks the impacts of policy changes on world agriculture, including estimates of the change in supply and demand for agricultural products. Because EPA is charged with estimating the extent to which increased diversion of corn from feed to fuel will cause changes in agricultural production around the world, they naturally sought out researchers who could help them answer this question.

Increased use of corn to produce ethanol causes the price of corn to be higher than it otherwise would be. Both U.S. and foreign producers will respond to this price increase. Economic theory and the reality of the market suggest that one response to the price increase will be increased production of corn. In the United States the primary mechanism for increasing corn production has been through a reallocation of land. A secondary mechanism has been to convert land that was not previously planted and to plant corn or some other crop on it. Other countries will also alter their crop mix and will use more land to increase production in response to higher prices. The conversion of grassland or forests that would not have been cultivated but for higher corn prices releases CO_2 from the stock of carbon both in the soil and in the biomass. This release of CO_2 in both the United States and around the world in response to higher corn prices is logically attributable to expansion of U.S. corn ethanol production. Thus, Congress and the California legislature have good justification for wanting to account for emissions caused by market-induced changes in land use when determining whether expansion of biofuels will increase or decrease global greenhouse gas emissions. The key question is whether we can accurately predict how an expansion of U.S. biofuels will affect land use both here and abroad.

Our ability to estimate changes in agricultural land use in the U.S. due to a change in biofuels policy is reasonably good because we have been doing this for about 30 years. For example, another model called GTAP that is used to estimated land use changes from biofuels predicts an expansion of 250,000 acres per billion gallons of corn ethanol. My center's model predicts 300,000 acres per billion gallons of ethanol.

Our ability to estimate land use changes overseas is less precise. For example, my center's estimates are currently about 700,000 acres per billion gallons overseas. GTAP estimates about 400,000 acres per billion gallons. One reason why it is more difficult to estimate changes in foreign land use is the sheer number of agricultural sectors in all countries that need to be well understood and modeled. A second reason is that lower quality and availability of data in other countries relative to U.S. data makes it more difficult to estimate how land use will change.

The ability to estimate how countries would expand their agricultural land is quite limited. My center does not yet estimate land conversion from forest, but GTAP estimates that about half of the predicted expansion in cropland from corn ethanol in the United States comes from cutting down existing forests. However, over the last 3 years, we have seen little evidence that U.S. trees are being cut down to produce more agricultural land despite the fact that U.S. cropland has expanded by 8 million acres. We have also seen no evidence that significant acres of pasture have been converted, other than a drop in Conservation Reserve Program acres in the Dakotas. Rather than conversion of forest, as predicted by GTAP, U.S. cropland has increased primarily through a reduction in CRP acres and through increased double cropping of soybeans after wheat.

Our ability to accurately measure the extent of land use changes outside the United States is limited because of a lack of reliable data and a lack of knowledge about what is actually going on in other countries. For example, the California Air Resources Board (CARB) and EPA conclude that increased crop prices from biofuels expansion will increase deforestation in the Amazon in Brazil. This conclusion seems logical because increased demand for cropland in Brazil is largely met by converting pasture to cropland. Unless the Brazilian cattle herd shrinks, it would seem that the decrease in pasture would have to be made up somehow. Where is Brazil going to get more pasture? By converting Amazon forest and savanna. Thus, the argument goes, any increase in Brazilian cropland leads to deforestation and a loss of savanna.

EPA and CARB both heavily penalize biofuels because of the presumed loss of the carbon stocks in forests and savannah in Brazil. The existing scientific literature also concludes that expansion of biofuels in the United States will lead to deforestation. But what evidence is there that increased production of crops has led to expansion of pasture in the Amazon? There is evidence that cattle numbers and pasture have both increased in the Amazon region since 1996. But was that due to the 30 percent increase in the Brazilian cattle herd or due to the 36 percent increase

in Brazilian cropland under cultivation? We are only now beginning to sort that out, and preliminary data suggest that a fairly large proportion of the increase in cropland in the major crop-producing regions of Brazil was accommodated by increasing cattle stocking rates. Further analysis is needed before we can state with confidence how much of the pasture created in the Amazon was created by crop pressure rather than by increased herd size in Brazil. Why does this matter? Nobody believes that U.S. biofuels policy is going to lead to increased cattle numbers in Brazil. Rather, increased crop prices will increase cropland. If Amazon forest is getting cut down to accommodate increased cattle numbers, and increased stocking rates accommodate increased cropland, then the primary impact in Brazil of increased crop prices will be intensification of cattle production: not loss of savanna and Amazon forest.

The precision with which lifecycle analysts can estimate the greenhouse gas emissions that are associated with the growing, transporting, and processing of the feedstock is relatively high, although the estimates are quite sensitive to the assumptions being used. The precision with which models can estimate emissions associated with market-induced land use changes is low. If Congress and individual states want to be able to estimate with any degree of confidence how expanded production of biofuels changes greenhouse gas emissions, then significant improvements are needed in our understanding of the dynamics of crop and livestock production around the world. My center is investing heavily in improving our understanding of Brazilian agriculture to better enable the EPA to conduct its analysis. I anticipate that we will be replicating this effort for other major producing countries. Without this kind of hard labor and data-intensive work, it is impossible to conclude with any certainty the extent to which increased emissions from land conversion offset the decrease in emissions from using a renewable fuel in our transportation sector.

The CHAIRMAN. Thank you, Dr. Babcock.

Mr. Coleman.

STATEMENT OF R. BROOKE COLEMAN, EXECUTIVE DIRECTOR, NEW FUELS ALLIANCE, BOSTON, MA

Mr. COLEMAN. Mr. Chairman, Members of the Subcommittee, thank you for the opportunity to speak today. I submitted a written testimony that is longer in length, and I am going to change from that script a little and do something that is either incredibly unambitious or ambitious, and that is just to describe to you what the difference between a direct and indirect effect is, because that is a critical part of moving forward with this debate.

First, a little bit of framing. What are we talking about here? I think we have been over the fact that this was a clause that was in the Renewable Fuel Standard, but a lot of other agencies have taken the ball and run with it, and I want to make sure to properly frame it.

The California Air Resources Board added indirect land use change to the biofuel score in California. That increased biofuels anywhere from 40 to 200 percent in the relative carbon score to other fuels that did not pay for indirect effects. If you want to know why the biofuels industry is concerned about this number, that is it.

Just yesterday the preliminary rule was released at EPA. You might notice one particular thing. Corn ethanol, just taking one fuel out of the mix there, corn ethanol is about 60 percent better than petroleum based on direct effects. When you add indirect land use change, that benefit shrinks to 16 percent better. And so we are talking about very real changes that could have very real commercial implications.

So I want to talk about direct *versus* indirect emissions. One of the things that we skipped over is what is included in a direct effect. Direct effect basically means well to wheels, cradle to grave, whatever you want. It is all of the carbon emissions that are emit-

ted during the production and use of a fuel. So for biofuels that means that the land, the pasture cleared to produce corn, the fertilizer used and the gasoline used to cultivate the land, moving the product to the biorefinery, emissions at the biorefinery, moving the finished product to the retailer, wholesale site, and then combusting it in a car.

And so if that is a robust sort of analysis of what carbon emissions come from production and use, what the heck is an indirect effect? And, proponents that have been including indirect effects in the carbon score of a fuel argue that these effects are also part of the carbon footprint of a gallon of fuel, and whether you are for or against indirect effects, that is not true. Because any time you are talking about indirect effects, you are talking about market-mediated, economically-derived, behaviorally-induced effects that are often occurring far in the distance somewhere else in the marketplace. It is basically a fancy term for ripple effects.

And there are two examples that are perhaps over-simplistic but frame the difference. The first is let us say you buy a Prius. You go out, and what is the direct effect of buying a Prius? Well, you are going to use less fuel, and you are going to have less carbon emissions that come out of the tailpipe. That is the direct effect. No one is arguing over that.

What you are also going to have is you may drive slightly more because it is cheaper for you to drive, you might spend your extra money on something else like a trip to Paris or a flat screen TV that emits more carbon emissions. And then it gets really complicated when you think to yourself, if everybody buys Priuses, you are going to have the price of fuel going down, and then everybody is going to pull their SUV out of their garage and drive around. Okay. The question is not what is the magnitude of the effect. The question is do we add that effect to the carbon score of a Prius. That is a public policy question.

Second example that is made up here distinctly for you, suppose Congress comes forward and says, we resolve to offset our carbon emissions every time we get on a plane and go back to our home district. Intuitively Members of Congress are going to say, "Okay. I will pay for my portion of the plane ride. If I am on a plane with 100 people, I am going to pay for 1⁄100 of the emissions that come out of the plane." Okay, that is a direct effect, and I think we are all okay with that being our rule.

What the indirect effects would be is if you were also asked to pay for the person that was going to sit in your seat and had to take another mode of transportation to get wherever they are going. That is the displacement effect. So should you have to pay for the other guy's or woman's carbon effect on another plane or not? That is the indirect effect.

Now, bringing this full circle with 50 seconds to go here, this is what indirect land use change is. It is not the land used to produce biofuel feedstock. It is the land needed to produce another agricultural product, say food, say in Brazil, because biofuel theoretically pushed that product to another place. So assigning a penalty to biofuels for indirect land use change, whether you like it not, is penalizing biofuels for the land expansion that occurs as a result of the cumulative impact of the agricultural sector.

And so that raises obvious questions. Also whether you like it or not, when you say the word, indirect, you are moving the carbon emissions from product A to product B. There is no way around it, and the reason is, is because the cumulative land impact of the entire agricultural sector is an accumulation of everybody's direct effects. And so you can't have a situation where people pay for direct and indirect effects because then the sum of all the parts equals more than the whole.

And I would encourage people to think about that from a cap-and-trade perspective. How do you trade someone else's carbon footprint? How are you accountable for it? Can you change it? Can you mitigate it? What type of message does a public policy send for someone overseas in that particular situation.

So I would like to close very quickly by framing this as sort of a dialogue between what is becoming two extremes. On the extreme side, is the side that says we have to throw all this stuff out. It is all completely insane. That is tempting. I have had a couple of nights where I think the exact same thing.

However, the other extreme is that we need to pretend that indirect effects are part of the carbon score and just add them on like they did in California. And that means that we are basically saying we are going to add soybean production in Brazil that might end up in food on a plate in Italy to a U.S. biofuel company's carbon score and then go make them compete with other companies. And oh, by the way, we are not going to do that for petroleum. That is the other extreme, and that is the position being espoused by a lot of environmental groups out there.

So what I would like to do, and what we need to do is two things. One, get back to comparing apples to apples. The problem with the 16 percent number with EPA, is it compares biofuels, paying for direct and indirect effects, to petroleum only paying for direct. That is not the right number if that is the case.

And the other thing is that indirect effects have a role to play. They can inform good policy. You can score fuels based on direct effects, turn around and say, I am going to look at the indirect effects for all these different fuels, so I better understand, for example, how much conventional biofuel we can use before we send ripple effects that are of concern to us through the marketplace. Inform public policy but don't add it to the carbon score.

Thank you very much.

[The prepared statement of Mr. Coleman follows:]

PREPARED STATEMENT OF R. BROOKE COLEMAN, EXECUTIVE DIRECTOR, NEW FUELS ALLIANCE, BOSTON, MA

Mr. Chairman and Members of the Subcommittee, thank you for the opportunity to submit this statement in review of the indirect land use provisions of the Federal Renewable Fuel Standard (RFS). My testimony today will focus on indirect effects.

My name is Brooke Coleman. I am the Executive Director and founder of the New Fuels Alliance, a not-for-profit national advocacy group for the production and use of non-petroleum fuels, with a particular focus on biofuels. At its core, the New Fuels Alliance is a coalition of biofuel producers, largely advanced biofuel producers, working in collaboration with communities and the private sector toward increasing the production and use of bio-based fuels.

I have been an advocate for biofuels for more than 10 years, first as the climate director for an environmental group in California called Bluewater Network and later as the director of several coalitions in support of pragmatic approaches to re-

ducing our dependence on foreign oil. I have seen the pendulum swing on biofuels several times, from the extremes of claims about biofuels completely replacing gasoline to biofuels being responsible for rainforest destruction and depriving the world's hungry of food. There is a reasonable center on many of these issues, even if we don't spend a whole lot of time discussing biofuels in that context.

With time limitations in mind, I would like to start by speaking directly to an issue that is becoming more and more controversial; that is, our new foray into what are called indirect carbon effects. It seems that we are going to have to resolve this issue as we move forward with biofuel policy, and so the subject of this hearing and the timing of it are ideal.

Where did the issue of indirect effects originate?

As you know, the amended Federal Renewable Fuel Standard passed in December 2007 requires new biofuels to be 20–60% better than gasoline to be eligible for the program. Late in the process, a clause was added to the definition of lifecycle carbon emissions, calling for the inclusion of indirect effects such as indirect land use change. This came several months before the public debate about indirect land use change even started, in February 2008, and before a substantive review of indirect effects occurred at the policy or scientific level.

Two weeks ago, the California Air Resources Board added indirect land use change penalties to the carbon score of biofuels under the recently adopted Low Carbon Fuel Standard (LCFS)—a standard being considered for adoption by 11 northeastern states and the Federal Government via Congressman Waxman's climate change (cap and trade) legislation.

Proponents of indirect land use change tend to cast their critics as somehow insensitive to rainforest degradation or swayed by the powers of the ethanol lobby. In reality, there are legitimate questions to be asked and answered about the unprecedented decision to start adding indirect carbon effects to the carbon score of any product, including but not limited to biofuels.

While the assessment and discussion of indirect effects is complicated, my statement today focuses on the basic questions.

What is an indirect carbon effect?

Proponents of including indirect effects in the carbon score of a fuel argue that these effects are a part of the fuel's carbon footprint. However, whether you are for or against indirect effects, this is not really true. Anytime you are talking about something "indirect" in the carbon world, you are talking about a market-mediated, economically or behaviorally induced, carbon effect, which is a fancy term for "ripple effects" in the marketplace occurring, in most cases, far from the point of production or use of the product.

Put another way, it is the change that could occur in the marketplace stemming from, but not as a direct result of, using a product. Consider the following two examples:

- Let's say you buy a more fuel efficient car; a Prius. The direct effect of using that car will be less fuel use and as a result less carbon emissions. That is the direct effect. The indirect effect, however, may be that you drive slightly more because it's cheaper to drive, and then turn around and use the savings to buy a flat screen TV, which emits more carbon emissions than a regular television when manufactured and used. Even more confusing, if everyone starts driving more fuel efficient cars, there will be less fuel demand and the price of fuel will drop; this will also lead to more driving. Should we attach these effects to the carbon score of a Prius?
- Let's say Congress passes a resolution committing to have its Members offset the carbon emissions from all their flights back to their districts. Presumably, this means that each Member of Congress would be charged for his or her portion of the emissions coming from each flight they take. You take the emissions from the plane and divide by the number of seats on the plane; that is your share. That is the direct effect. The indirect effect would be the carbon emissions of the person you pushed onto another plane because they could not sit where you are sitting. Should you pay for the other person's emissions or should he?

Bringing the issue back to biofuels, this is what indirect land use change is. It is not the land used to produce biofuel feedstock, it is the land needed to produce another agricultural product—say, food—because biofuel theoretically pushed that product to another place. Assigning a penalty to biofuels for indirect land use change is penalizing biofuels for the land expansion that occurs as a result of the cumulative impact of the agricultural sector.

So how do we rationalize adding an indirect carbon effect to the carbon score of a product?

This is largely a public policy question. Why should U.S. biofuels be penalized for the land clearing activities of a food or fiber manufacturer in the Amazon? Here is a key point to consider: the only way to rationalize adding an indirect effect to the carbon score of a product, such as biofuel, is to look at the world through a purely "additive lens." You have to manually—and rather arbitrarily—ascribe land clearing causation to a single product; in other words, "biofuels entering the marketplace is causing land clearing in Brazil" . . . when in fact land clearing in Brazil occurs as a result of not only agricultural demand, but also socioeconomic, political, trade, law enforcement and other variables. Biofuels is not even the sole source of agricultural demand, much less the cause of world political and socioeconomic variables.

Interestingly, this is a presumptive underpinning of the ethos of indirect effects because this is how indirect effects are modeled and enforced. Modeling indirect land use change, or any market-mediated effect, requires that the modelers freeze the world economy in a single moment in time in order to isolate the one variable being analyzed (in this case, increased biofuel demand). In other words, the model used in California to predict indirect land use change for biofuels, for example, is a static model that cannot properly ascribe "proportionate cause" to the myriad of variables that actually cause land use change.

Two weeks ago, leading investors in advanced biofuels from eight firms wrote a letter to the California Air Resources Board raising concerns about this modeling. They said:

> "Indirect land use change" is an outcome derived by adding a predetermined amount of biofuel demand to a static, preset economic model, which in turn projects the potential "price induced" expansion of the agricultural sector onto additional land. It is a useful academic exercise, but as a price model it cannot account for the profit margins that drive real world decision making. As a result, the model is likely to over estimate effects that in reality would be mitigated by market forces, or produce estimates that in many cases are simply wrong. *For example, in prior applications of the GTAP methodology, the model predicted changes in land use between 2001 and 2006 that were actually the opposite of the real-world changes observed over time.*[1]

More than 100 leading bio-scientists also submitted a letter to California, calling the science nascent and the use of it in a regulation premature. Remember, California's assessment of these penalties increased the carbon score of biofuels anywhere from 40 to 200 percent. These are game changing carbon score increases, with real commercial implications. And the economic models are often directionally wrong and controversial from a scientific perspective.

Summary of Problems & Solutions

There is no question that pristine land degradation is a problem in this and other countries. There is no question that we should be assessing the indirect effects of the energy choices we make. Biofuels could lead to more land conversion. Using electricity and natural gas in vehicles could lead to more coal combustion. Ongoing petroleum dependence could lead to all of these indirect effects, and more, given that the price of petroleum influences nearly every sector of the economy. Turning a blind eye to ripple effects is not a reasonable solution.

But there is a big difference between using these assessments to inform public policy decisions—for example, how much conventional biofuel we can use before overburdening land—and pretending that: (a) these effects are a part of the primary carbon footprint of a given fuel; or, (b) that we understand them well enough to add carbon penalties to each gallon of biofuel used. That is where a useful exercise in precaution becomes misleading and polarizing.

While considering the public policy implications of indirect effects, it is useful to consider the following "big picture" issues:

(1) When it comes to lifecycle carbon scoring, there are really only direct effects, because the indirect effect of one product is the direct effect of another. If products pay for direct effects, there are no indirect effects.

[1] In an earlier analysis of the impact of biofuels on U.S. land use patterns, researchers at Purdue using GTAP concluded the harvested area for coarse grains like corn would increase 8.3% from 2001 to 2006, U.S. harvested area for oilseeds like soybeans would decline 5.8%, and forested area would decline 1.5% during the same period. In actuality, coarse grain harvested area declined by 2%, oilseed area increased by 0.5%, and forested area increased by 0.6% from 2001 to 2006.

(2) If the goal of U.S. energy policy is *change*, how useful is it to arbitrarily assign the disruptive effects of an entire sector to only the new entrant in that sector?

(3) Consider the economic effects of this decision. A hectare of land is cleared in Brazil to produce soybeans for food. Critics of biofuels say that this land expansion occurred because biofuels is causing the world agricultural footprint to expand. So we saddle U.S. biofuel companies with a game changing carbon penalty from someone else's supply chain that is completely out of their control from a mitigation perspective.

(4) An indirect effect is, by definition, the application of someone else's direct effect to another product or fuel. Once we start doing that, we are breaking down the very principles we are espousing in cap and trade and polluter pays: that we are responsible for our own carbon footprint and can and should improve it. Do indirect effects even work in cap and trade?

The good news is there are reasonable solutions to this complicated problem. I would like to propose four (4) concrete steps to address concerns about indirect effects:

(1) Study them for all fuels; we need to try to understand the ripple effects of the energy choices we make. The outcomes can inform good policy. But the current framework—in which only biofuels are being analyzed for price-induced effects—does not work.

(2) Cast a critical eye on those that insist that indirect effects are part of the "lifecycle" carbon footprint of any product. Even if you believe that indirect effects analysis is important, as we do, this is not true. By definition, enforcing indirect effects relies on debiting Product A for the supply chain of Product B.

(3) Use the lessons of indirect effect analysis to create a better and more dynamic treatment of direct effects. For biofuels, this means incentives to use idle and marginal land, research into more sustainable energy crops, a regulatory mechanism that incents good land use behavior instead of presuming bad behavior, and limitations on certain types of alternative energy solutions. For electricity vehicles this means incentives to plug-in at night, when there is excess energy on the grid.

(4) Aggressively promote a better biofuel gallon. Going after first generation biofuels with highly questionable carbon adders is not going to expedite the production and use of the advanced biofuels that will actually make land use more sustainable. What the advanced biofuels community needs is the following:

(a) Maintain a stable and durable policy; discussion about reworking the RFS or replacing it with another program runs investment away from advanced biofuels. Investors cannot invest ahead of regulations that are constantly being changed.

(b) Create open markets. Biofuels are stuck in a market box. The best way to open markets for advanced biofuels is to mandate flex-fuel vehicles this year. These vehicles need not run on biofuel blends, but can run on biofuel blends if available. This opens up the investment horizons and demand markets for those trying to commercialize new kinds of fuels.

(c) Establish and maintain a level playing field on which to compete. We must get back to comparing "apples to apples" when it comes to valuing different fuels in a climate or energy security based regulation. Ascribing indirect effects to only one type of fuel skews the relative value of biofuels compared to petroleum.

(d) De-risk debt financing. Biofuel refineries are project financed. Advanced biofuel producers need Federal support in terms of loan guarantees and other programs that mitigate the inherent risk in making investments in highly volatile liquid fuel markets. This is a reasonable role for government, and one that will be transformative in the marketplace.

(e) Reject divisive strategies. Biofuel strategies that attempt to draw lines between good and bad biofuels are not productive, and are not helpful to advanced biofuel companies. You would not promote second-generation wind and solar by attacking the imperfections of and putting out of business first generation wind and solar companies. The same principle is true in biofuels.

Thank you for the opportunity to speak today. I would be happy to answer any questions you may have.

The CHAIRMAN. Thank you, Mr. Coleman.

Mr. Bowdish.

STATEMENT OF NICK BOWDISH, GENERAL MANAGER, PLATINUM ETHANOL, LLC, ARTHUR, IA

Mr. BOWDISH. Thank you, Chairman Holden, Ranking Member Goodlatte. My name is Nick Bowdish, General Manager at Platinum Ethanol. Platinum is a 110 MGY ethanol plant which began operations in October 2008.

Prior to October of 2008, I worked for Ron and Diane Fagen at Fagen Incorporated. Fagen, Inc. is the largest design build construction company in the fuel ethanol industry.

I appreciate the opportunity to speak to you today, and I want to touch on three things. First, in terms of the renewable biomass definition, my perspective is from a developer, from a construction company that built half the industry. There is no single factor more important than feedstock supply. I am not an expert on timber, I am not an expert on forests, but I can tell you that as an example in my testimony you have a map there that shows a geographic area and the detail, that we as developers go into, to determine whether a facility can have long-term success.

If we are truly to expand the production of ethanol from the U.S. Corn Belt to other regions of the country, we need common sense policy in this provision. I support legislation introduced by Members of this Subcommittee, including H.R. 1190, introduced by Representative Herseth Sandlin and others, to correct this definition.

Second, in regards to indirect land use change. I recognize and support that in order to conduct a thorough lifecycle analysis of greenhouse gas emissions from biofuel, direct land use changes may be considered by EPA. However, it is inherently unfair and a disservice to public policy that EPA's rule examines both direct and indirect effects of biofuels but only direct effects of petroleum.

If EPA proceeds to make extreme assumptions about the carbon intensity of biofuels, relying on an untested ideology called indirect land use change, and, remarkably, assumes there are no such indirect effects from fossil fuels, this selective enforcement will place biofuels at an unfair competitive disadvantage in the fuel market. EPA has not only missed the boat on this, they have missed the ocean-going vessel, literally.

According to the National Corn Growers Association, it takes 40 percent less energy and land today to produce a bushel of corn compared to 20 years ago. I can personally witness, on my way driving to the airport yesterday to join you today, corn being planted to the inch. I am not talking about a foot. I am talking to the inch. Precision agriculture and genetic markers are redefining the efficiency of corn.

Since 2001, U.S. ethanol producers, of which I am part of, have achieved a 22 percent drop in energy use. My second figure in the testimony I would call your attention to is Platinum Ethanol's BTU use per gallon for the month of March 2009. I would also call to your attention that EPA's recent analysis uses 30,000 BTUs, yet in my facility we achieve less than 28,000, and others in the country that are just starting are down in the 25,000 BTUs per gallon range.

I invite and encourage everyone of you and everyone of your constituents to come see Platinum Ethanol. Come understand the ethanol industry of today. Seek information and truth, not outdated statistics used by a few that get regurgitated in the media. I think it is patently indefensible that EPA is comparing the lifecycle analysis of biofuels to that of petroleum in 2005, since the carbon footprint of biofuels is only getting better, yet the carbon footprint of petroleum is only getting worse.

Indeed, if the indirect greenhouse gas emissions of biofuels are counted towards the carbon footprint, so should the indirect emissions associated with petroleum. To do otherwise is not a comparison. It is political tampering to push a minority ideology. I feel strongly that if ethanol and gasoline both had indirect effects considered, ethanol would be the clear victor.

The President's Biofuels Interagency Working Group is just the place for such peer review, and I am thankful the President has engaged other organizations to help educate EPA on this issue because they simply don't get it.

The consideration of land use effects in the lifecycle analysis should be limited to domestic direct impacts associated with growing grains until these indirect effects are better understood.

I encourage the Subcommittee, all Members, to follow the lead of Senator John Thune, and others, Representative Moran, who mentioned this earlier today, to limit EPA to only use direct effects until we fully understand this.

The third point in my closing seconds, I think it would be helpful for you to hear a perspective directly from an ethanol producer in today's marketplace. We are dealing with two major challenges; the confluence of unprecedented volatility in oil, corn, and ethanol prices and the evaporation of credit. Approximately 2 billion gallons of production capacity has been idled and more facilities, not next year, next month, are at risk of being shut down because of capital constraints.

In order to restore sustainable industry-wide profitability, ethanol needs to be allowed to price into the fuel ration just as ingredients do in a feed ration. We need the Federal Government to provide a remedy to the law that arbitrarily restricts ethanol blending in a gallon of gasoline to ten percent. I strongly encourage you to support the current petition before EPA allowing up to 15 percent ethanol in gasoline.

And if I may close with a few final comments, Mr. Chairman, ethanol's economic benefits are real. Today's ethanol industry supports almost 500,000 jobs in all sectors, provides a return on investment of 2.5 to 1 for every dollar invested, our energy security benefits are real, we are only second to Canada in terms of providing fuel to the United States of America. If we were a foreign producer—we are second. We have passed Venezuela, we have passed Saudi Arabia, we have passed Iraq.

As a nation we have invested in a Strategic Petroleum Reserve. Have Members of this Subcommittee thought about a strategic ethanol reserve? Ethanol does not degrade like gasoline and having a fuel supply readily available for our military would be wise. Many people underestimate the ability of ethanol to power our equipment, including aviation. I call to your attention Greg Poe and the

Fagen MX–2. This aircraft will perform at 19 air shows this year, including Andrews Air Force Base, at 275 miles an hour, twisting and tumbling through the air, in a spectacular display of the performance of American-made ethanol.

We can do this. This is completely in our hands to control, and ethanol is the only alternative available right now making a substantial contribution. I hope this Administration and this Congress can stay fully committed to reducing our energy dependence, and I and others in private business are ready to help.

Thank you, Mr. Chairman.

[The prepared statement of Mr. Bowdish follows:]

PREPARED STATEMENT OF NICK BOWDISH, GENERAL MANAGER, PLATINUM ETHANOL, LLC, ARTHUR, IA

Thank you Chairman Holden, Ranking Member Goodlatte, and Members of the Subcommittee. My name is Nick Bowdish and I am the General Manager of Platinum Ethanol in Arthur, IA. Platinum is a 110 Million Gallon per Year production facility that began operations in October of 2008. Prior to October 2008, I worked for Ron and Diane Fagen at Fagen, Inc., the largest design-builder of corn-based fuel ethanol plants in the United States.

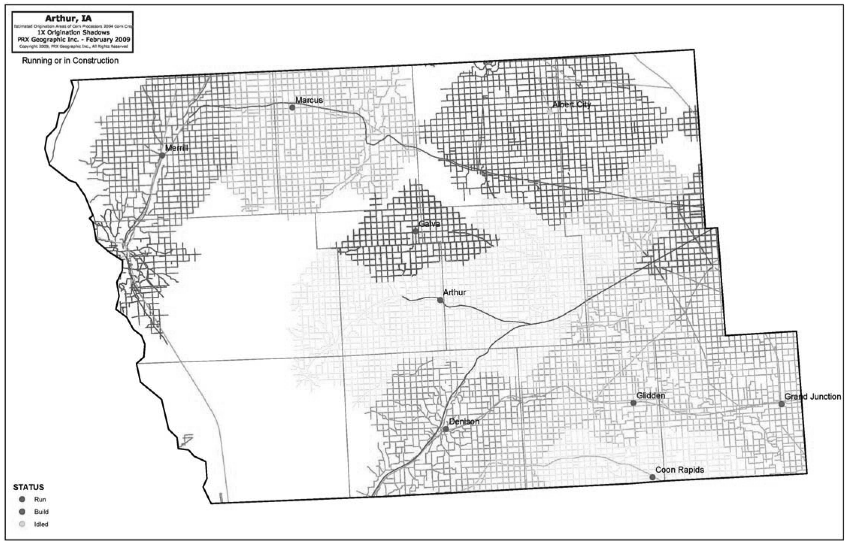
I am grateful to Chairman Peterson of the House Agriculture Committee for this opportunity to speak to you today.

I appreciate the opportunity to provide the perspective of today's evolving ethanol industry on the critical issues concerning the Renewable Fuel Standard (RFS) adopted as part of the Energy Independence and Security Act of 2007 (EISA). Today, I will focus on three primary areas; the implications of the narrowly crafted renewable biomass definition in EISA, profound concerns about the selective enforcement of so-called "indirect land use changes" against biofuels, and I would like to close by providing Members of the Subcommittee a producer's perspective on the current state of the U.S. ethanol industry and some steps policymakers might consider taking to press forward with securing America's energy supply.

Renewable Biomass Definition

First, I join the call with others today to encourage Congress and the U.S. Environmental Protection Agency (EPA) to revisit the narrow and restrictive definition of "renewable biomass" under EISA. Previous to my role at Platinum Ethanol, I was a business developer for Fagen, Inc. As my coworkers and I developed new sites for ethanol plants and advised clients on the feasibility of such projects, our primary job was to determine if the feedstock supply in the local area justified the plant site. *Figure 1.1* below is an example of the detailed mapping that takes place when siting an ethanol plant. The shadow depicts the corn draw area in order for the given facility to secure sufficient feedstock.

Figure 1.1



For long run success, an ethanol project requires access to a steady supply of feedstock, whether corn or biomass. As written in EISA, the definition of "renewable biomass" excludes significant tonnage of woody biomass and dead timber that could be harvested from our national forests and used to produce a low carbon, renewable, and cost effective biofuel.

If we are to truly expand the production of ethanol from the U.S. Corn Belt to other regions of the country, we need common sense policy for the firms and entrepreneurs who have developed the technology to efficiently convert woody biomass into advanced biofuel. Like others, I believe a workable solution to this definition controversy can be found, one which guarantees that reasonable safeguards can be established to protect our nation's most precious and sensitive national forestlands, and at the same time allow for the sensible harvest of timber and biomass. Coincidentally, doing so can help thin a significant supply of dead timber that is simply dangerous fuel for wild fires. I support legislation introduced by Members of this Subcommittee, including H.R. 1190 introduced by Representative Herseth-Sandlin and others to correct this definition.

Based on my experience in siting and helping complete ethanol projects, the current definition of "renewable biomass" is contradictory to helping ensure we can grow the supply of domestic biofuels. It is stalling greater U.S. energy security and placing an unnecessary roadblock in front of the commercialization of advanced biofuel in many regions of the country.

Lifecycle Analysis of Greenhouse Gas Emissions—Indirect Land Use Changes

The new RFS schedule provides various carve-outs for renewable fuels based on their ability to reduce lifecycle greenhouse gas (GHG) emissions:

Conventional Biofuel—is ethanol from corn starch, and conventional ethanol facilities that commence construction after the date of enactment of EISA 2007 must achieve a 20 percent reduction in lifecycle GHG emissions compared to gasoline.

Advanced Biofuel—is renewable fuel (other than from corn starch) from biomass that reduces GHG emissions by 50 percent compared to gasoline. Cellulosic ethanol and biomass-based diesel qualify as advanced biofuel under the RFS.

Cellulosic Biofuel—is renewable fuel derived from cellulose, hemicellulose, and lignin, and achieves a 60 percent reduction in GHG emissions compared to gasoline.

I am deeply concerned that the definition of lifecycle GHG emissions in EISA is being construed by EPA in a manner that unfairly penalizes domestic grain-based ethanol, based on dubious linkages made to land clearing and agricultural practices in developing countries. There is a growing effort on the part of some interests to push this "indirect land use" theory without having done any rigorous analysis or peer-review.

On March 9 of this year, President Obama issued a Directive on "Scientific Integrity" which said in part that "Political officials should not suppress or alter scientific or technological findings and conclusions." According to a study completed by Global Insight on December 1, 2008, entitled "Lifecycle Analysis of Greenhouse Gas Emissions Associated with Starch-Based Ethanol," basing policies such as the RFS or low carbon fuels standard in California on indirect land use change theory is "getting politics ahead of the science." The report determines that computer-generated lifecycle predictions about indirect land use changes require considerably more analysis. According to the report, it is virtually impossible to accurately ascribe greenhouse gas impacts to biofuels based on indirect land use change. EPA's proposed enforcement of this appears to be "getting politics ahead of science" and in direct conflict with President Obama's Directive.

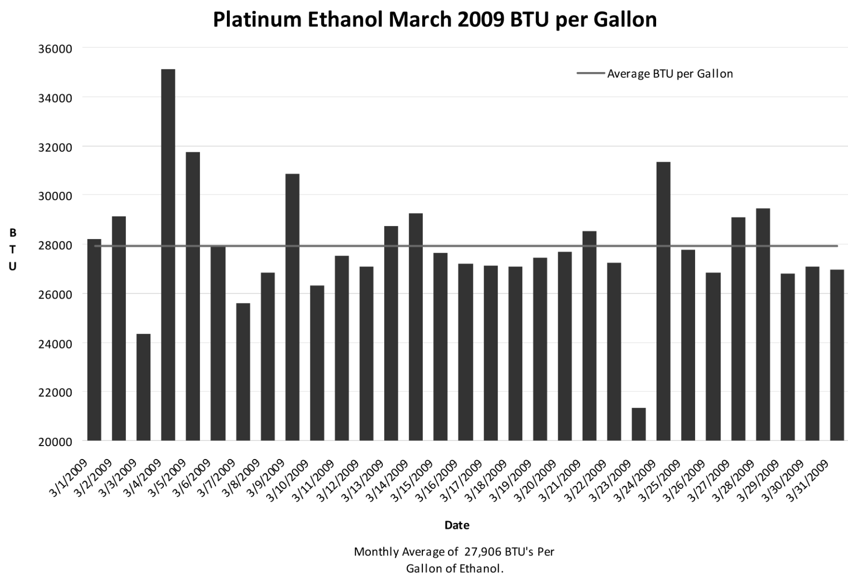
I recognize and support that in order to conduct a thorough LCA of GHG emissions from biofuel crops, *direct* land use changes may be considered by EPA. However, it is inherently unfair and a disservice to public policy that EPA's rule examines both direct and indirect effects for ethanol, but does not also calculate or estimate both direct and indirect effects for petroleum. If EPA proceeds to make extreme assumptions about the carbon intensity of biofuels, relying on an untested ideology called "indirect land use change," and remarkably assumes there are no such "indirect effects" from fossil fuels, this selective enforcement will place biofuels at an unfair competitive disadvantage in the fuels market.

According to the Global Insight report I cited earlier in my testimony, it is neither fair nor accurate to attribute all current and future land clearing to biofuels. Changes in land use have always occurred and are not new, nor are biofuels the primary driver of them. Global population growth cannot be ignored as a factor. Remarkably, lifecycle analysis is being used to actually quantify GHG emissions, and the scientific literature shows a huge variation in estimates of carbon release from land clearing in general, on the order of 50 percent plus or minus—a huge margin of error. Given this margin of error, it is unwise to rely on these models to make a major policy shift without further and more careful analysis.

Global Insight also points out that new technology is making both corn and ethanol production more efficient and more environmentally friendly. According to the National Corn Growers Association, it takes nearly 40 percent less energy and land today to produce a bushel of corn than twenty years ago. I personally witnessed corn being planted "to the inch" of where it is desired on my way to the Omaha airport. Precision agriculture and genetic markers are redefining the efficiency of corn. Furthermore, according to the U.S. Department of Energy, since 2001, U.S. ethanol producers have achieved a 22% drop in total energy use. Between 2004 and 2007, ethanol plants reduced BTU usage by between 14% and 21%.

As someone who oversees the operation of a new, state-of-the-art ethanol production facility, I can attest that the amount of energy used by plants has been cut by dramatic percentages in recent years. EPA's analysis assumes that corn ethanol plants will utilize around 30,000 BTUs of energy to manufacture 1 gallon of ethanol. Yet, in my facility and others like it around the U.S., our energy use has dropped to an average of less than 28,000 BTUs per gallon of ethanol as shown below in *Figure 2.2*, a 6 percent decrease.

Figure 2.2



I believe it is critical for policymakers and EPA to recognize that oil is becoming less efficient and more harmful to the environment, and that these lifecycle models should compare future sources of oil to future sources of biofuel on an apple-to-apple basis. With the technology coming online in corn and ethanol production, the carbon footprint is only set to improve significantly in the next 10 years; whereas feedstock sources for the petroleum industry, such as oil sands, will further degrade petroleum's carbon footprint. According to the Global Insight report, high oil prices incentivize the production of crude oil from sources such as tar sands and coal which have considerably higher GHG emissions than biofuels. Depending upon the energy source used in the mining of tar sands, well-to-pump emissions can be over 300% of conventional crude oil. I think it is patently indefensible that EPA is comparing the LCA of biofuels to that of petroleum in 2005, since the carbon footprint of oil will degrade significantly post-2005 as new oil sources like tar sands are tapped. Indeed, if the indirect GHG emissions of biofuels are counted toward the carbon footprint, so should be the indirect emissions associated with petroleum production.

Ascribing indirect effects associated with land clearing in foreign countries not only singles out the U.S. biofuels industry for uniquely unfair treatment, it establishes an unworkable precedent for regulation of other U.S. industries under future GHG control programs. The consideration of land use effects in LCA of GHGs should be limited to domestic direct impacts associated with growing grains for ethanol production. I encourage the Subcommittee to urge EPA to clarify that the calculation of lifecycle GHG emissions is limited to direct impacts.

State of the U.S. Ethanol Industry

In closing, it is beneficial for you to hear, first hand, the major challenges and opportunities facing the U.S. ethanol industry today. The same forces making it difficult for other businesses to thrive are challenging ethanol producers today. Operating an ethanol plant, like any other production facility, requires access to capital and demand for your product. However, credit markets remain frozen and the economic recession has cooled demand for many products, so we're navigating the choppy sea. Specific to ethanol, the confluence of two unwelcome factors is seriously affecting us—unprecedented volatility in oil, corn, and ethanol prices and the evaporation of credit. Approximately 2 billion gallons of production capacity has been idled and many more facilities are at risk due to capital constraints.

In order to restore sustainable industry-wide profitability, ethanol needs to be allowed to price into the fuel ration just as ingredients do in a feed ration. We need the Federal Government to provide a remedy to the regulation that arbitrarily restricts the blending of ethanol in gasoline to just ten percent. Right now, the law is biased against ethanol by limiting ethanol's use in a gallon of gasoline to just ten

percent. Without question, the single most important thing Washington can do to help is to adjust this regulation so that motorists have fuel choice at the pump. Doing so will create green-collar jobs, help reduce the cost of fuel, reduce greenhouse gas emissions, and promote prosperity in rural America. Therefore, I strongly support the petition currently pending before EPA to allow up to 15 percent ethanol in gasoline, and encourage Members of the Subcommittee to support the waiver as well.

Policies affecting ethanol provides you one of those rare opportunities to score victories on a wide array of public policy benefits, including supporting a domestic industry that creates jobs, improving energy security, and bettering the environment with calculations based on science rather than ideals.

Ethanol's economic benefits are real. Today's ethanol industry supports more than 494,000 jobs in all sectors and provides a return on investment of 2.5 to 1 for every taxpayer dollar invested, according to a report released on February 23, 2009 by Dr. John Urbanchuk, Director of LECG, LLC.

Ethanol's energy security benefits are real. According to the Clean Fuels Development Coalition, if ethanol was a foreign oil producer, only Canada would supply the U.S. with more gallons of fuel. In other words, the domestic ethanol industry supplies more fuel to the U.S. than Saudi Arabia, Venezuela, and Iraq. As a nation, we have invested in a strategic petroleum reserve. Have you considered the benefits of a strategic ethanol reserve? Ethanol does not degrade like gasoline and Members of this Committee would be wise to consider the national security benefits of having a fuel supply readily available for our military. Many people underestimate the ability of ethanol to power our equipment, including aviation. I call to your attention Greg Poe and the Fagen MX–2. This aircraft will perform at 19 Air shows this year, at 275 mph, twisting and tumbling through the air in a spectacular display of the performance ability of American made ethanol.

A prosperous America lies in the hands of a committed group of individuals recognizing that we must not rely on foreign countries for our energy needs. Ethanol is the only alternative available right now making a substantial contribution to extending our American supply of energy. The determination of this Administration and this Congress can responsibly extend the control we have of our energy supply if you will fully commit to lessening our dependence on foreign oil. I and many others in private business are ready to help.

In conclusion, I would like to once again thank Chairman Holden and Ranking Member Goodlatte for conducting this important and timely hearing. I look forward to your questions.

The CHAIRMAN. Thank you, Mr. Bowdish.

Mr. Feraci. Am I pronouncing that correctly?

Mr. FERACI. Yes, Mr. Chairman.

STATEMENT OF MANNING FERACI, VICE PRESIDENT OF FEDERAL AFFAIRS, NATIONAL BIODIESEL BOARD, WASHINGTON, D.C.

Mr. FERACI. Chairman Holden, Ranking Member Goodlatte, Members of the Subcommittee, I thank you for the opportunity to present testimony today. I am here today on behalf of the National Biodiesel Board, which is the national trade association for the U.S. biodiesel industry. Our membership produces a high-quality, renewable, low-carbon diesel replacement fuel that is readily accepted in the marketplace.

The U.S. biodiesel industry is the only game in town when it comes to commercial-scale production of biomass-based diesel as defined in the RFS2 Program. The production and use of biodiesel is consistent with an energy policy that values the displacement of petroleum diesel fuel with low carbon renewable fuel, and there are significant energy security, environmental, and economic public policy benefits associated with biodiesel use.

Yet, the industry finds itself in the midst of an economic crisis that threatens its future viability. The NBB is not seeking the creation of new Federal programs. A stable, reliable Federal policy

framework based on existing policy will allow the industry to survive the current economic crisis. Implementation of a workable, realistic RFS2 is the key component of that framework.

RFS2, for the first time, requires a renewable component in U.S. diesel fuel and provides a readily-attainable schedule for the use of biomass-based diesel that increases from 500 million gallons in 2009, to 1 billion gallons in 2012. To qualify for this program renewable fuel must reduce greenhouse gas emissions by 50 percent compared to the conventional diesel fuel it is replacing.

The science pertaining to direct effects is well established. The USDA, DOE lifecycle study was initially published in 1998, and has been continually refined and updated since that time. According to this model, biodiesel reduces greenhouse gas emissions by 78 percent. By statute EPA must consider significant indirect emissions when calculating a renewable fuels emission profile.

Unfortunately, it appears that the EPA's proposed rule that was unveiled yesterday relies on uncertain, inexact assumptions pertaining to indirect land use change in calculating biodiesel's greenhouse gas emissions profile. The result is that biodiesel produced from domestically-produced vegetables oils are disqualified from the biomass-based diesel program.

There are many factors unrelated to U.S. biodiesel production that impact land use decisions abroad. For example, in Brazil, forestry, cattle ranching, subsistence farming drive land use decisions. Yet, the EPA's proposed methodology appears to attribute this change to U.S. biodiesel production. This assumption defies common sense.

In fact, acreage in Brazil dedicated to the soybean cultivation actually decreased from 2004 through 2008, a time period during which U.S. biodiesel production increased from 25 million gallons to 690 million gallons. If biodiesel production drove Brazilian land use decisions to the degree that the EPA's proposal asserts, the opposite would be the case.

As a result of these dubious assumptions, EPA's proposed rule restricts feedstock to low carbon diesel replacement fuel to only animal fats and restaurant grease. Vegetable oils account for more than 60 percent of the feedstock that is available to meet RFS2 biomass-based diesel targets. And the RFS2 volume goals simply cannot be met if vegetable oils are disqualified from the program. Even under the so-called pathway for biodiesel that is briefly outlined in the proposed rule, there will not be enough feedstock available to meet the RFS2 volume goals for biomass-based diesel. This outcome is not consistent with either sound science or sound energy policy.

Last, U.S. agriculture has historically realized increased productivity and yields. As technology improves it is reasonable to assume that these gains in efficiencies will continue. As these efficiencies are realized, both domestically and around the globe, the potential impact of land use change due to biofuels production will be further diminished, and this must be recognized in EPA's greenhouse gas emission calculations.

Again, Chairman Holden, Ranking Member Goodlatte, I appreciate the opportunity to testify today and will be more than happy to answer any questions you may have.

[The prepared statement of Mr. Feraci follows:]

PREPARED STATEMENT OF MANNING FERACI, VICE PRESIDENT OF FEDERAL AFFAIRS, NATIONAL BIODIESEL BOARD, WASHINGTON, D.C.

Summary of Testimony:

There are significant economic, energy security and environmental public policy benefits associated with the domestic production and use of biodiesel. Though the U.S. biodiesel industry has experienced growth since 2004, biodiesel producers find themselves in the midst of a severe economic crisis that threatens the nation's ability to domestically produce low carbon, renewable diesel replacement fuel. In 2009, we anticipate production of biodiesel will be less than half of 2008 levels and utilize approximately 15% of the nation's overall production capacity.

The U.S. biodiesel industry is not seeking the creation of new programs, but is simply asking for expedient implementation of a stable, reliable policy framework that will allow the industry to weather the current economic storm and meet the readily attainable goals established for Biomass-based Diesel by the Renewable Fuel Standard (RFS2) program, as enacted in the Energy Independence and Security Act (EISA) of 2007 (P.L. 110–140). Accordingly, industry asks the Environmental Protection Agency (EPA) to ensure that the statutory 2009 volume goals for Biomass-based Diesel are enforced.

RFS2, by statute, requires EPA to consider significant indirect emissions when calculating the greenhouse gas emission (GHG) profile of biofuels. Sound science and common sense dictate that a fair, honest evaluation of international land use decisions account for substantial factors completely unrelated to biofuels production such as forestry, subsistence farming and cattle ranching. The GHG score of a biofuel should be based on sound science and not be penalized due to unrelated factors that are driving land use changes, many of which are difficult to account for in GHG emission modeling. In addition, the same standards and evaluation must be applied to petroleum diesel fuel—the fuel to which Biomass-based Diesel is being compared for purposes of determining its GHG emission profile.

As the RFS2 rulemaking process moves forward, EPA should work constructively with stakeholders to implement a workable program that can meet the RFS2 volume goals for Advanced Biofuels. The EPA should not structure the program in a manner that restricts feedstock for low-carbon diesel replacement fuel to only animal fats and restaurant grease by disqualifying vegetable oils as an eligible Advanced Biofuels feedstock. Vegetable oils account for more than sixty percent of the feedstock that is available to meet the RFS2 Biomass-based Diesel targets, and the RFS2 goal of displacing petroleum with low carbon renewable fuel simply cannot be met if vegetable oils are disqualified from the program. This outcome is not consistent with either sound science or sound energy policy.

Last, U.S. agriculture has historically realized increased productivity and yields over time. As technology improves, it is reasonable to assume that these gains in efficiencies will continue. Further, there is a powerful economic incentive for agriculture producers around the globe to adopt more efficient practices. As these efficiencies are realized in the future, the potential impact of land use change due to biofuels production will be further diminished.

* * * * *

Chairman Holden, Ranking Member Goodlatte and Members of the Subcommittee, I thank you for the opportunity to testify today on behalf of the National Biodiesel Board (NBB) about the importance of the Renewable Fuel Standard to the U.S. biodiesel industry and the potential impact Indirect Land Use Change (ILUC) assumptions could have on implementation of this worthwhile program.

About NBB: NBB is the national trade association representing the biodiesel industry as the coordinating body for research and development in the United States. It was founded in 1992 by state soybean commodity groups who were funding biodiesel research and development programs. Since that time, the NBB has developed into a comprehensive industry association which coordinates and interacts with a broad range of cooperators including industry, government and academia. NBB's membership is comprised of biodiesel producers; state, national and international feedstock and feedstock processor organizations; fuel marketers and distributors; and technology providers.

Background and Industry Overview: Biodiesel is a diesel replacement fuel made from agricultural oils, fats and waste greases that meets a specific commercial fuel definition and specification. The fuel is produced by reacting feedstock with an alcohol to remove the glycerin and meet the D6751 fuel specifications set forth by the American Society for Testing and Materials (ASTM International). Biodiesel is

one of the best-tested alternative fuels in the country and the only alternative fuel to meet all of the testing requirements of the 1990 amendments to the Clean Air Act.

Biodiesel is primarily marketed as a 5% blending component with conventional diesel fuel, but can be used in concentrations up to 20%. It is distributed utilizing the existing fuel distribution infrastructure with blending occurring both at fuel terminals and "below the rack" by fuel jobbers. Biodiesel is beginning to be distributed through the petroleum terminal system. To date, biodiesel is available in over 40 fuel distribution terminals. In the past year, two major pipeline companies have successfully tested B5 blends in pipelines, and the biodiesel industry has committed funds to continue to study the technical needs required for moving biodiesel through U.S. pipelines. Already, biodiesel is moved through pipelines in Europe and extending that capability in the U.S. would significantly increase biodiesel penetration in the U.S. diesel fuel market.

Biodiesel Public Policy Benefits: There are compelling public policy benefits associated with the enhanced production and use of biodiesel in the U.S.

Biodiesel Reduces our Dependence on Foreign Oil: Biodiesel can play a major role in expanding domestic refining capacity and reducing our reliance on foreign oil. The 690 million gallons of biodiesel produced in the U.S. in 2008 displaced 38.1 million barrels of petroleum, and increased production and use of biodiesel will further displace foreign oil. In addition, biodiesel is an extremely efficient fuel that creates 3.2 units of energy for every unit of fuel that is required to produce the fuel.

Biodiesel is Good for the Environment: Biodiesel is an environmentally safe fuel, and is the most viable transportation fuel when measuring its carbon footprint, lifecycle and energy balance. The U.S. Department of Agriculture (USDA)/Department of Energy (DoE) lifecycle study shows a 78% reduction in direct lifecycle CO_2 emissions for B100. One billion gallons of biodiesel will reduce current lifecycle greenhouse gas emissions by 16.12 billion pounds, the equivalent of removing 1.4 million passenger vehicles from U.S. roads. In 2008 alone, biodiesel's contribution to reducing greenhouse gas emissions was equal to removing 980,000 passenger vehicles from America's roadways.

Biodiesel's emissions significantly outperform petroleum-based diesel. Research conducted in the U.S. shows biodiesel emissions have decreased levels of all target polycyclic aromatic hydrocarbons (PAH) and nitrited PAH compounds, as compared to petroleum diesel exhaust. These compounds have been identified as potential cancer causing compounds.

Biodiesel is the only alternative fuel to voluntarily perform EPA Tier I and Tier II testing to quantify emission characteristics and health effects. That study found that B20 (20% biodiesel blended with 80% conventional diesel fuel) provided significant reductions in total hydrocarbons; carbon monoxide; and total particulate matter. Research also documents the fact that the ozone forming potential of the hydrocarbon emissions of pure biodiesel is nearly 50% less than that of petroleum fuel. Pure biodiesel typically does not contain sulfur and therefore reduces sulfur dioxide exhaust from diesel engines to virtually zero.

The Biodiesel Industry is Creating Green Jobs and Making a Positive Contribution to the Economy: In 2008 alone, the U.S. biodiesel industry supported 51,893 jobs in all sectors of the economy. This added $4.287 billion to the nation's Gross Domestic Product (GDP) and generated $866.2 million in tax revenue for Federal, state and local governments.

By conservative estimates, there is domestic feedstock available to support 1.77 billion gallons of annual biodiesel production in the U.S. The domestic industry has the capacity to support this level of production. The production of 1.77 billion gallons of fuel would support 78,619 jobs; add $6.660 billion to the GDP; displace 97.8 million barrels of petroleum; generate $1.345 billion in revenue for Federal, state and local governments; and reduce greenhouse gas emissions by 27.4 billion pounds—the equivalent of removing 2.38 million passenger vehicles from U.S. roads.

The Biodiesel Industry Stimulates Development of New Low-Carbon Feedstocks: The feedstock used to produce U.S. biodiesel has increasingly diversified, with waste products such as animal fat and used restaurant grease (yellow grease) making up a larger portion of the feedstock used to produce fuel. Biodiesel production is currently the most efficient way to convert lipids into low-carbon diesel replacement fuel, and as a result, industry demand for less expensive, reliable sources of fats and oils is stimulating promising public, private and nonprofit sector research on new alternative feedstocks such as algae.

Algae's potential as a source of low carbon fuel has been well documented, and a stable, growing biodiesel industry is necessary if the U.S. is to eventually benefit from the commercial scale production of algal-based biofuels. The NBB estimates

that for every 100 million gallons of biodiesel that is produced from algae, 16,455 jobs will be created and $1.461 billion will be added to the GDP.

U.S. Biodiesel Industry is Facing Severe Economic Hardship: Despite recent growth, the industry is in the midst of an economic crisis. Plants are having difficulty accessing operating capital. Volatility in commodity markets; reduced demand and inability to compete in the European marketplace are making it difficult for producers to sell fuel. Last, uncertainty relating to Federal policy that is vital to the industry's survival is sending inconsistent signals to the marketplace and undermining investor confidence.

If prolonged, this downturn will lead to a severe retraction in U.S. biodiesel production capacity. Due to current market conditions, less than ⅓ of the industry's facilities are currently producing fuel. NBB estimates that absent any change in Federal policy, U.S. biodiesel production will likely fall to 300 million gallons in 2009, which would cost the U.S. economy more than 29,000 jobs. This situation threatens the nation's ability to meet the advanced biofuels goals established in the 2007 Energy Bill.

A Reliable Policy Framework is Needed for U.S. Biodiesel Industry: The U.S. biodiesel industry is not seeking the creation of new programs. Instead, common-sense improvements and thoughtful implementation of existing initiatives will help the industry survive in this difficult economic climate. Specifically, a multi-year extension of the biodiesel tax incentive and successful implementation of a workable RFS2 are needed if the nation is to reap the future economic, environmental, and energy security benefits associated with the production and use of biodiesel. For purposes of today's testimony, I will focus on RFS2.

The Energy Independence and Security Act and the Renewable Fuel Standard: The Energy Independence and Security Act (P.L. 110–140), enacted on December 19 2007, significantly expanded and improved the RFS.

By statute, RFS2 provides for the use of 36 billion gallons of renewable fuels in the U.S. by 2022. The program establishes a use schedule for Conventional Biofuels and Advanced Biofuels. The schedule for Conventional Biofuels, which must reduce GHG emissions by 20% compared to the baseline fuel it is displacing, increases from 10.5 billion gallons in 2009 to 15 billion gallons in 2015. From 2015 through 2022, the use requirement for Conventional Biofuels remains constant at 15 billion gallons. Biofuel production facilities placed in service prior to enactment of P.L. 110–140 are exempt from 20% GHG reduction requirement that is applicable to Conventional Biofuels.

RFS2 also establishes a use schedule for Advanced Biofuels that begins at 600 million gallons in 2009 and increases to 21 billion gallons by 2022. Within the Advanced Biofuels schedule, there are specific use and GHG reduction requirements for Cellulosic Biofuels, Undifferentiated Advanced Biofuels, and Biomass-based Diesel. The statutory date of enactment for the RFS2 program is January 1, 2009.

Implementation of a Workable RFS2 Biomass-based Diesel Schedule of Vital Importance to the U.S. Biodiesel Industry: For the first time, RFS2 specifically requires a renewable component in U.S. diesel fuel as part of the program's Advanced Biofuels schedule. Specifically, RFS2 requires the use of 500 million gallons of Biomass-based Diesel in 2009; 650 million gallons in 2010; 800 million gallons in 2011; and 1 billion gallons in 2012. Between 2012 and 2022, a minimum of 1 billion gallons must be used, and the Administrator of the EPA has the authority to set the use requirement at a higher level.

To qualify as Biomass-based diesel, fuel must reduce greenhouse gas (GHG) emissions by 50% compared to conventional diesel fuel. The EPA Administrator is provided the authority to reduce the GHG emission target to 40%. By statute, the Biomass-based Diesel requirement starts in 2009, and thus, is the first component of the Advanced Biofuels schedule to be implemented. Though fuels in addition to biodiesel will in all likelihood qualify for this schedule, the U.S. biodiesel industry is the only entity producing low carbon, renewable diesel replacement fuel at commercial scale that is readily accepted in the domestic marketplace.

As is mentioned earlier in this testimony, the U.S. biodiesel industry is in the midst of an economic crisis. Plants are closing and production is well below comparable levels from last year. The EPA has the regulatory authority it needs to implement a workable program that is consistent with sound energy and environmental policy, and successful implementation of RFS2 will help create the market demand that will allow the industry to survive. A viable domestic biodiesel industry is in the nation's best interests, and expedient implementation of a workable Biomass-based Diesel program is a top industry priority. Accordingly, industry asks the EPA to take concrete steps to ensure that the 2009 volume goals established by statute for Biomass-based Diesel are enforced.

The Inexact Nature of Indirect Land Use Change (ILUC) Assumptions: As mentioned previously, renewable diesel replacement fuel must reduce GHG emissions by 50% compared to conventional diesel fuel to qualify for the Biomass-based Diesel program. The science pertaining to *direct* emissions is well established. The USDA/DoE lifecycle study was initially published in 1998, and has been continually refined and updated since this time. According to this model, biodiesel reduces GHG emissions by 78%.

By statute, RFS2 specifies that significant indirect emissions are to be considered when calculating a renewable fuel's GHG emission profile. EPA has opted to account for ILUC, in particular international land use assumptions, in its GHG calculations as part of the rulemaking process. There is neither consensus in the scientific community nor a widely accepted methodology that could be deemed credible to accurately calculate the impact of U.S. biofuel production on international land use decisions. Nevertheless, the EPA's decision to rely on a questionable GHG methodology inaccurately attributes significant deforestation in South America to the cultivation of oilseeds such as soybeans and canola produced in the U.S.

The U.S. biodiesel industry currently produces the most sustainable fuel available in the marketplace. The NBB fully supports efforts and initiatives that are designed to protect sensitive ecosystems such as the rainforests in South America and Southeast Asia.

With that said, sound science and common sense dictate that a fair, honest evaluation of international land use decisions account for substantial factors completely unrelated to biofuels production such as forestry, subsistence farming and cattle ranching. The GHG score of a biofuel should not be penalized due to unrelated factors that are driving land use changes, many of which are difficult to account for in GHG emission modeling. In addition, the same standards and evaluation must be applied to petroleum diesel fuel—the fuel to which Biomass-based Diesel is being compared for purposes of determining its GHG emission profile.

It is our understanding that the EPA's methodology places significant emphasis on land use changes in Brazil. Specifically, the EPA attributes deforestation in the Brazilian rainforest to U.S. biodiesel production, and this dubious assumption is used as the rationale to penalize the GHG emission score of U.S. biodiesel produced from vegetable oils. From 2004 through 2008, U.S. biodiesel production increased from 25 million gallons to 690 million gallons. If U.S. biodiesel production was causing significant land use change in Brazil, common sense would dictate land dedicated to Brazilian soybean production would have shown a corresponding increase.

Yet in 2004, soybean production in Brazil covered 22.917 million hectares. In 2008, soybean production accounted for 21.400 million hectares—a *decrease* of 1.5 million hectares. As U.S. biodiesel production increased by 665 million gallons, land dedicated to soybean cultivation in Brazil decreased by 1.5 million hectares—a real world outcome that casts significant doubt on EPA's preliminary assumptions and again highlights that other significant factors outside of U.S. biofuels production drive land use decisions.

Impossible to Meet Biomass-based Diesel Requirements Without Vegetable Oils as Qualifying Feedstocks: As the rulemaking proceeds and is ultimately finalized, a program structured in a manner that allows vegetable oils, including domestically-produced soybean and canola oil, to qualify as feedstock for the Biomass-based Diesel schedule is consistent with sound science and policy. Vegetable oils account for more than sixty percent of the feedstock that is available to meet the RFS2 Biomass-based Diesel targets, and the use requirements established by this component of the Advanced Biofuels schedule simply cannot be met if these feedstocks are disqualified from the program. We are hard pressed to believe this potential outcome is consistent with the will of Congress or sound environmental policy that values the displacement of petroleum diesel with low-carbon renewable fuels.

Absent vegetable oils as a qualifying feedstock, biofuel producers will be forced to rely almost entirely on animal fats and yellow grease (used restaurant grease) to meet the RFS2 Biomass-based Diesel requirements. The U.S. biodiesel industry estimates that even with the most optimistic assumptions, the most biodiesel that could be produced in a year from this pool of limited feedstock would be 410 million gallons. Though animal fats and restaurant grease are important resources for biodiesel production—and U.S. producers can make quality fuel that meets the ASTM D6751 fuel specification from this feedstock—there simply will not be enough of these feedstocks to produce the fuel needed to meet either the 500 million gallons of Biomass-based Diesel required in 2009 or the 1 billion gallons that is ultimately required in 2012. By contrast, there is ample feedstock to meet the Biomass-based Diesel schedule if vegetable oils are permitted as a feedstock.

It is also important to note other potential unintended policy impacts if the Biomass-based Diesel feedstock is limited to animal fats and restaurant grease. For example, this would add significant volatility and disruption in the markets as it pertains to the pricing of these commodities, and could compel entities not impacted by the RFS2 program that currently use these commodities in the production of other goods to seek lipids from less-sustainable sources. In addition, given winter and summer fuel blending regimes that are widely accepted and used in the marketplace, a program that limits U.S. biodiesel production to animal fats and restaurant grease would in essence make the U.S. industry seasonal in nature. Neither of these unintended outcomes is consistent with sound energy or environmental policy.

GHG Calculations Must Account for Improved Agriculture Yields and Efficiency: U.S. agriculture has historically realized increased productivity and yields over time. As technology improves, it is reasonable to assume that these gains in efficiencies will continue. Further, there is a powerful economic incentive for agriculture producers around the globe to adopt more efficient practices. As these efficiencies are realized in the future, the potential impact of land use change due to biofuels production will be further diminished.

New technology will add significantly to the U.S. raw material supply. Though the feedstock used to produce U.S. biodiesel has grown more diversified over time, soybean oil has been the most utilized biodiesel feedstock to date in the U.S. Based upon historical yield trends, domestic production of soybeans will continue to increase. However, a major research focus of companies such as Pioneer and Monsanto has been to create "virtual acres" through stepwise enhancements in yield technology and/or oil content. Monsanto plans to introduce new technology that can increase soybean yields 9 to 11 percent. Pioneer, a DuPont Company, is commercializing soybean varieties that increase yields by as much as 12 percent. After years of research investments by the life science companies, these technologies have reached commercialization and are set to have a meaningful impact on soybean yields in 2010. More than 90 percent of U.S. farmers currently utilize herbicide-resistant soybean varieties, demonstrating farmers' willingness and desire to adopt technology that can enable improved profits through increased yields or decreased costs. If this same 90 percent of U.S. soybean acres adopted the new yield technology, more than 60 million acres could see a ten percent increase in yield. This equates to more than 250 million additional bushels of soybeans (the equivalent of 380 million gallons of biodiesel) without increasing acreage in the U.S.

The same benefit can be achieved by increasing soybean oil content. Current industry genetic programs suggest ten percent oil increases are achievable within the next few years, and increasing soybean oil content by that percentage would generate approximately 120 million gallons of additional oil if adopted on 50 percent of soybean acreage. New approaches for achieving even higher oil levels in plants are being actively researched. The NBB has partnered with the Donald Danforth Plant Science Center to identify novel approaches to enhance oil production in soybeans and other oilseeds. This work centers on the hypothesis that the ability to utilize available carbon limits oil production. Therefore, the Danforth Center's work will focus on engineering carbon sinks that will pull metabolites through the oil production process in plants. This is a 3 year program that was initiated in 2008.

The soybean industry will continue to play a key role in providing feedstock for the biodiesel industry for years to come. Based upon current technology available to soybean producers, if processing capacity expands it is reasonable to project the production of at least 780 million gallons of biodiesel with existing soybean oil supplies in 2012. This estimate does not take into consideration soybean oil exports, amounting to more than 300 million gallons of soybean oil in 2008, which could be diverted into domestic biodiesel production. Nor does it take into account an estimated 1 billion bushels of soybeans that are exported and could be a source of biodiesel feedstock if the domestic crushing industry further expanded capacity.

In Conclusion: The provision in RFS2 establishing the Biomass-based Diesel Schedule is consistent with energy and environmental policy that values the displacement of petroleum diesel with low carbon renewable fuels. Expedient implementation of a workable RFS2 program is a top priority for the U.S. biodiesel industry that will allow the nation to continue reaping the economic, energy and environmental benefits associated with the increased production and use of biodiesel.

Chairman Holden, Ranking Member Goodlatte, and Members of the Subcommittee, I again thank you for having the opportunity to testify before you today, and I would be pleased to answer any questions you may have.

The CHAIRMAN. Thank you.

Mr. Pechart.

STATEMENT OF MICHAEL L. PECHART, DEPUTY SECRETARY FOR MARKETING AND ECONOMIC DEVELOPMENT AND POLICY DIRECTOR, PENNSYLVANIA DEPARTMENT OF AGRICULTURE, HARRISBURG, PA

Mr. PECHART. Chairman Holden, Ranking Member Goodlatte, and Members of the Committee, good afternoon.

As the Chairman so eloquently recognized, Pennsylvania has much to offer the biofuels effort, the environment and the renewable energy economy developing in the nation from feedstock such as wood and food waste. A recently-published report by the Hardwoods Development Council estimates sufficient woody biomass exists to allow for 6 million dry tons of woody biomass harvested annually, on a sustainable basis, with the potential of producing 6 million megawatt hours of electricity among 45 small power plants or 540 million gallons of cellulosic ethanol or 300 million, 40 pound bags of wood pellets.

Although there is a debate of how much volume that could practically produce, we know that current paper and manufactured board business in Pennsylvania uses about 1 million tons annually, and in the early 1990s, it used 3 million tons. So there is a strong emphasis and significant amount of renewable energy that could be produced from this.

The report concluded that small distributed projects such as Fuels for Schools, district heating or combined heating and power will have the most chance for sustainable feedstock supply, and therefore, success in Pennsylvania. Wood energy has the potential to be a significant part of achieving the goals of Pennsylvania's renewable portfolio standards, while also facilitating the production of advanced biofuels.

Proposed renewable biomass definition provisions in the proposed regulations for the Renewable Fuel Standard would not allow Pennsylvania to reach its full feedstock supply potential. Limiting the use of forest biomass will disadvantage some states like Pennsylvania and disincentivize achieving energy mandates, increasing costs to consumers, and creating new disparities in economic development.

To encourage the maximum development of all renewable sources of energy, the Renewable Fuel Standard should be as inclusive as possible as to feedstocks and methods rather than to arbitrarily discourage any source on its face. Wood and woody biomass is a necessary, logical, and sustainable component of a renewable energy portfolio plan. States should be in the best position to sustainably manage these decisions on a case-by-case basis as they work to achieve the portfolio standards that are most relevant to their resources and their needs. To that end Pennsylvania has already published formal guidance on harvesting woody biomass for energy in our state.

Another definitional category I would like to comment on is food waste. Food waste needs to be clearly defined and sufficiently broad to allow for an array of feedstocks such as nutshells, cocoa hulls, husks, seeds, and fruit pits. Agriculture is the number one industry in Pennsylvania, resulting in mass production of foods, including snacks, canned goods, and dairy products. The Act must

provide an expanded definition of food waste to include processing waste and cannery waste as renewable sources of biomass energy.

Pennsylvania, I would note, currently has two anaerobic digesters operating that are processing cheese waste to produce methane. Yellow, brown, and trapped grease should be provided flexibility to allow local collection and use as a renewable energy feedstock through expanded general permits within states. Renewable energy goals should support the use of yellow grease animal fat for biodiesel or methane production, or to use these materials directly as boiler fuel. Provisions should also be included for unsuitable, outdated, and altered lots of feed, grain, or animal products to include biomass energy production alternatives.

The logic that appears to be applied in the indirect lifecycle greenhouse gas accounting for land conversion such as recultivating fallow land is to assume that a vast carbon sink has now been lost and would remove any eligibility for biofuels production. Fallow land should not be subject to indirect land use lifecycle greenhouse gas calculations because it inappropriately imposes a penalty. Such acreage has provided for unintentional, temporary, and limited carbon storage. It is inappropriate that fallow land conversion automatically assume a massive soil carbon increase. Soil carbon release is most dependent upon tillage practices, and I would note in Pennsylvania in the last 2 years we have moved 50 percent of our agricultural production based on no-till, which is a tremendous accomplishment.

As structured, I don't believe the definitions allow for biofuels production that may be facilitated through the growth of warm season grasses on coal mine reclamation sites essential to both Pennsylvania and the Chesapeake Bay Region. I would note just in Pennsylvania alone we have 180,000 acres of land, abandoned mine land that could be growing energy crops right now.

This definition would need to define crops such that it is clearly broad enough to include grasses, even cool season grasses such as miscanthus, and it can't be limited to ag lands but also needs to preserve forestlands.

In closing, it should be recognized that there is not a single solution or prescription for renewable energy that fits all states equally. Some are blessed with great solar or wind energy potential, and others like Pennsylvania have an abundance of wood and waste and agricultural waste energy potential.

Moreover, there is no single type of feedstock or biofuel that is the silver bullet for our renewable energy economy. To the contrary, it is only with a mix of crops, with the right crop grown on the right acre, with the best management practices in place, and other sustainably available renewable feedstocks that we can achieve energy, security, economic, and water quality goals.

Thank you, Congressman Holden and Members of the Committee.

[The prepared statement of Mr. Pechart follows:]

PREPARED STATEMENT OF MICHAEL L. PECHART, DEPUTY SECRETARY FOR MARKETING AND ECONOMIC DEVELOPMENT AND POLICY DIRECTOR, PENNSYLVANIA DEPARTMENT OF AGRICULTURE, HARRISBURG, PA

Pennsylvania and the Chesapeake Bay Region are rich in natural resources, agricultural land and products, and renewable energy feedstocks. Because of these facts, in addition to the outstanding leadership and expertise of individuals, organizations, universities, and government agencies the region is poised to lead the nation in renewable energy production. The same geographic diversity that allows us to produce and process such a wide range of crops and commodities also dictates that our renewable energy potential come from a suite of diversified alternatives. Pennsylvania leads the nation in the growing volume of hardwood species, with 17 million acres in forestland. We have been the leading producer of hardwood lumber in the United States, with production of over 1.1 billion board feet in 2006, and Pennsylvania leads in the export of hardwood lumber. Recent U.S. Forest Service data shows that our forest growth to harvest rate is better than two to one. Our vast renewable resource puts the hardwoods industry at the forefront of manufacturing in the Commonwealth. In 2006, the industry output was $17 Billion, employing nearly 86,000 people.

Endless possibilities to create advanced biofuels are provided by the definitions of H.R. 6 of the 110th Congress, the "Energy Independence Act of 2007." However, Pennsylvania has much to offer the biofuels effort, the environment and the economy regarding feedstocks from wood and food waste, and indirect lifecycle greenhouse gas accounting that also should be taken into consideration in the current language.

Pennsylvania recognizes the importance of this resource and industry to the Pennsylvania economy. The General Assembly of Pennsylvania created the Hardwoods Development Council within the PA Department of Agriculture to promote development and expansion of the industry. A recently published report of a Council sponsored Task Force on "The Low Use Wood Resource" estimates sufficient woody biomass exists to allow for 6 million dry tons of to be harvested annually on a sustainable basis with the potential of producing 6 million megawatt hours of electricity among 45 small power plants; or 540 million gallons of cellulosic ethanol; or 300 million 40 pound bags of wood pellets. Although there is debate on how much of that volume could practicably be available for harvest, we know that current paper and manufactured board production in PA uses about 1 million tons, and in the early 1990s used 3 million tons; so there is strong evidence to show that a significant amount of renewable energy can be produced. The majority of Pennsylvania's forestland is owned privately by approximately 700,000 different people. The report concluded that small, distributed projects such as, "Fuels for Schools", district heating or combined heating and power will have the most chance for sustainable feedstock supply and therefore success in Pennsylvania. Wood energy has the potential to be a significant part of achieving the goals of Pennsylvania's Renewable Portfolio Standards while also facilitating the production of advanced biofuels.

Proposed renewable biomass definition provisions in the national Renewable Fuel Standard, taken from H.R. 6 of 2007 would not allow Pennsylvania to reach its full feedstock supply potential. Limiting use of forest biomass will disadvantage some states like Pennsylvania and disincentivize achieving energy mandates, increasing costs to consumers and creating new disparities in economic development.

To encourage the maximum development of all energy sources, legislation should be as inclusive as possible as to feedstocks and methods, rather than to arbitrarily discourage any source on its face. Wood and woody biomass is a necessary, logical and sustainable component of a renewable energy portfolio plan. States should be in the best position to sustainably manage these decisions on a case-by-case basis as they work to achieve the portfolio standards that are most relevant to their resources and needs. To that end for example, Pennsylvania has already published formal Guidance On Harvesting Woody Biomass for Energy in Pennsylvania which can be downloaded at *http://www.dcnr.state.pa.us/PA_Biomass_guidance_final.pdf.*

Federal policy should promote sustainable forest management which includes the proper and appropriate use of low value biomass material. Management of this resource improves forest health, can improve habitat quality, contributes to pest control, and reduces fire risk; as well as creating economic activity. Definitions of eligible biomass feedstocks should put working forests and forest industries on an equal basis with other renewable energy sources. Federal lands must be included into the renewable energy equation. It is illogical and counter-productive to create another disincentive to proper silvicultural management on Federal lands that are already in desperate need of treatments. Removal of biomass material can help improve for-

est health, control insects and disease, and prevent catastrophic wildfire; as well as significantly contributing to renewable energy goals and having positive impacts on rural economies. This is particularly evident on the Allegheny National Forest.

"Food waste" needs to be very clearly defined and sufficiently broad to allow for an array of feedstocks such as nut shells, cocoa hulls, husks, seeds/pits, *etc.* Agriculture is the number one industry in Pennsylvania resulting in mass production of foods from snacks, canned goods, and dairy products. The Act must provide an expanded definition of food waste to include processing waste and cannery waste as renewable sources for biomass energy. Pennsylvania currently has two anaerobic digesters operating by processing cheese whey to methane. Yellow, brown and trap grease should be provided flexibility to allow for local collection and use as a renewable energy feedstock through expanded general permits within states. Renewable energy goals should support the use of yellow grease and animal fats for biodiesel or methane production or to use these materials directly as boiler fuel. Provisions should also be included for unsuitable, out dated, and altered lots of feed, grain, or animal products to include as biomass energy production alternatives.

As structured, I don't believe the definitions allow for biofuels production that may be facilitated through the growth of warm-season grasses on coal mine reclamation sites—essential to both Pennsylvania and Chesapeake Bay Region. The definition would need to define "crops" such that it is clearly broad enough to include grasses (even cool-season grasses such as Miscanthus) and it can't be limited to agricultural lands but also needs to preserve forested land.

The broader implication for the nation is the interface of this first part of the definition and attempts to incorporate indirect lifecycle greenhouse gas standards related to biofuel development. This approach is well-intended but the limited research to date seems to assign a permanent and continual loss of soil carbon when a farmer turns over a fallow field. The current definition allows for biofuel feedstock to be produced from recultivating of fallow fields (fallow prior to 2007). This is appropriate. Those lands have most likely been fallow primarily due to the poor economics for agricultural commodities in all but the most recent years.

The logic that appears to be applied in the indirect lifecycle green house gas accounting for land conversion, such as recultivating fallow land, is to assume that a vast carbon sink has now been lost and would remove any eligibility for biofuels production. Fallow land should not be subject to indirect land use lifecycle greenhouse gas calculations because it inappropriately imposes a penalty. Such acreage has provided for unintentional, temporary and limited carbon storage. It is inappropriate that fallow land conversion automatically assumes a massive soil carbon release. Soil carbon release is mostly dependent upon which tillage practice is utilized. Drill-seeding and no-till planting significantly reduces soil carbon release than conventional tillage of fallow lands. In Pennsylvania, we have seen a dramatic shift away from conventional tillage practices in the last 2 to 3 years. These practices should be encouraged in these definitions and they should be accounted for accordingly for there increased environmental benefits instead of applying a blanket calculation for any fallow land conversion. We are sitting on at least 200 million acres of once farmed, now abandoned land in the U.S., much of it in the Northeast. A great research opportunity and motivation for sustainable agriculture exists if this land could be brought back into production in ways that also increase carbon sequestration through use of perennials. Documenting that positive Land Use Changes impact provides additional income from other farmers, or ultimately consumers, would provide incentives for farmers to implement sustainable practices.

While the indirect land use analysis under the RFS is specific to carbon, and is global in scale, we can refer to a local study demonstrating indirect land use effects on water quality. The *Biofuels for the Bay Report*, published by the Chesapeake Bay Commission in 2007, identified the potential water quality impacts to the Chesapeake Bay when high commodity prices increase corn acreage. The report found that when grown with typical levels of best management practices, the nitrogen loads from increased corn acreage could increase Bay nitrogen levels by up to 5 million pounds—a level that would eclipse annual progress in nitrogen reductions. One of the recommendations that resulted from this report was a focus on development and production of a next-generation biofuels industry—one that uses biomass such as switchgrass, forest thinnings, or fast-growing trees as feedstocks. These feedstocks do not require significant nutrient inputs and can act as riparian buffers for other agricultural land. These same feedstocks would most likely score well under an indirect land use analysis for carbon, because they have the capacity to sequester carbon and, since they are able to be grown on relatively marginal land, they do not directly compete with food and feed crops.

This is not to say that corn is a bad crop. Corn is an important source of food and feed to this country and the world. When grown using a full suite of best man-

agement practices, its environmental impact is minimal. However, our dairy, cattle, and hog growers and food processors were significantly impacted when grain prices spiked in reaction to, among other things, increasing corn ethanol production. We acknowledge that speculation, as opposed to true supply and demand, was a contributor to the price volatility, but the effect was the same.

Additionally, first-generation ethanol, such as that produced from corn, is an important first step in the evolution to cellulosic and other advanced biofuels. As we anxiously await commercial-scale technology for advanced biofuel production, first-generation ethanol will help to grow the distribution and other infrastructure needed for a mature biofuels industry. In the meantime, Pennsylvania and other states in the Chesapeake Bay region are encouraging the production of first-generation ethanol from winter cover crops such as barley. Because they are grown on the same acreage, cover crops do not compete with corn or soybeans. Cover crops also reduce excess nitrogen in the soil and reduce runoff, improving water quality.

It should be recognized that there is not a single solution or prescription for renewable energy that fits all the states. Some are blessed with great solar or wind energy potentials, and others like Pennsylvania have an abundance of wood energy potential. Moreover, there is no single type of feedstock or biofuel that is the silver bullet for renewable energy. To the contrary, it is only with a mix of crops, with the right crop grown on the right acre, with the right best management practices, and other sustainably available renewable feedstocks that we can achieve both our energy security, economic, and water quality goals.

The CHAIRMAN. Thank you.

Ms. Webster.

STATEMENT OF ANITRA B. WEBSTER, OWNER, FAMILY FOREST, LYNCHBURG, VA; ON BEHALF OF AMERICAN FOREST FOUNDATION

Ms. WEBSTER. Thank you for the opportunity to appear before you today to talk about the Renewable Fuel Standard and how it could impact family forest owners. I am here today representing the American Forest Foundation, home of the American Tree Farm System®, a network of over 91,000 family forest owners across the country who are committed to conservation.

Many of you are probably familiar with tree farmers in your own state, family forest owners who typically own small tracks of forest and manage it for wildlife, hunting, fishing, recreation, and timber production. My family forest is located near Lynchburg, Virginia, in Big Island, where I actively manage about 390 acres. I entered the tree farm system decades ago and have managed my land sustainably according to international standards since then.

Now, you probably are asking yourself why do family forest owners care about the Renewable Fuel Standard. Well, it is pretty simple. Forest biomass can and should be an important source for renewable fuels, and right now we really need new markets with the falling off of the housing industry.

Additionally, beyond my interest as a family landowner, allowing the use of forest biomass to meet our energy needs also helps reduce greenhouse gases and improves the health of our forests. If we wish to generate a large portion of our energy needs from renewables, forest biomass is a cost-effective, readily available, sustainable, and renewable source of material that can help us meet these needs.

Unfortunately, the Renewable Fuel Standard passed in Congress in 2007, essentially left out the opportunity for forest family owners and privately-held forests to supply biomass for the production of renewable fuels.

I know Congress I working on a renewable electricity standard and considering the same restrictions on the use of biomass from my lands for that electricity generation. I am here today to urge you to fix the standard and allow all sustainably produced forest biomass from both planted forests and those that naturally regenerate.

I would like to point out a few problems with the current approach to restrict forest biomass as it might be applied to my land. The first problem is a limitation to only actively-managed tree plantations. I happen to have about 20 to 30 acres stand of white pine that I planted in the late 1980s in abandoned fields, and *Photo 1* on your attachment will show that. This stand is now growing to maturity and is ready for thinning. Thinning like this will help enhance the wildlife habitat and allow the trees left behind to grow to a full height and maturity.

But under the current definition of renewable biomass it is not clear whether my planted pine stands are considered actively-managed tree plantations. If I were to talk about it myself, I don't think I would call it that since I only do minor work on the plantation, and I don't use any pesticides or herbicides or fertilizers for that matter.

Right now there is no market for the thinned trees mostly because of the timber market declines that are happening. So it is not economical to do the thinning of the forest that the forest needs right now. A renewable energy market could help me recover the cost of doing these sorts of activities, and that would, of course, improve the environment at a much lower cost.

The second problem is a limitation on the use of biomass from naturally-regenerating forests. Roughly 340 acres of my land is not planted forests but rather forestland that generates naturally, as you can see in *Photo 2* on that attachment. A number of years ago I harvested a fair bit of older trees, selling them for the lumber, but, obviously, left trees behind for seed production and shade so that the new growth could develop. This, obviously, is the way we regenerate a forest, and it had, indeed, ensured a strong, natural comeback.

While most of the trees removed in the forest will sell for lumber, not every tree is straight enough, so we either sell it for pulp or if there is no market, we have to leave it in the forest, which becomes a part of that potential forest fire. I would not be able to sell any of these trees for renewable energy because they don't qualify under the standard. The only thing I could sell are the tops, the limbs, and the brush lying around. If these restrictions are in place in an attempt to protect the environment, if you ask me as a landowner, who has worked on the land for the last 20 some years, this will not have the effect.

Instead, it has the effect of making it much more difficult to use the forest biomass as fuel stock and for renewable fuels, which could actually mean less environmental protection. The families do not have the income to stay on the land. They may be forced to sell their land to a developer or convert it to some other use, which obviously doesn't provide the environmental benefit.

Mr. Chairman, I would also like to ask you to think about this. We invented the wheel a few thousand years ago. We have in-

vented computers, but even with all those technological advances and so forth we still need viable, healthy, productive, and sustainable forests, and we also need a cash flow income.

Thank you very much, Mr. Chairman and Members of the Committee. I urge you to fix this problem and allow the nation's family forest owners to help meet our nation's energy needs.

I will be happy to answer any questions.

[The prepared statement of Ms. Webster follows:]

PREPARED STATEMENT OF ANITRA B. WEBSTER, OWNER, FAMILY FOREST, LYNCHBURG, VA; ON BEHALF OF AMERICAN FOREST FOUNDATION

Mr. Chairman, Ranking Member Goodlatte, and Members of the Subcommittee, thank you for this opportunity to appear before you today to talk about the Renewable Fuel Standard and how it could impact family forest owners in my home State of Virginia and across the country.

I'm here today representing the American Forest Foundation, home of the American Tree Farm System®, a network of over 91,000 family forest owners across the country who are committed to conservation. Many of you are probably familiar with "Tree Farmers" in your state-family forest owners who typically own small tracts of forest, and manage it for wildlife, hunting, fishing, recreation, and timber production.

My family forest is located near Lynchburg, Virginia, in Big Island, where I own and actively manage 390 acres. It started out as an old abandoned farm, but I've worked since 1985 to restore the land to a healthy forested state correcting bad forestry practices. As a participant in the American Tree Farm System®, I manage my forest sustainably, under a management plan and certified by a third-party audit to be in compliance with nine standards of sustainability. I entered the Tree Farm System decades ago and in fact, was named the outstanding Tree Farmer of the year in Virginia in 1991.

Now you're probably asking yourself: Why do family forest owners care about the Renewable Fuel Standard? Well it's pretty simple. Forest biomass can and should be an important source for renewable fuels. And right now we really need new markets, with the fall off in housing.

Unfortunately, the Renewable Fuel Standard passed by Congress in 2007 essentially left out the opportunity for family forests and other privately held forests to supply biomass for the production of renewable fuels. This is a serious concern for family forest owners, who are working hard every day to pay their taxes and maintain healthy forests.

I am here today to urge you to fix the Standard to allow *all* sustainably produced forest biomass, from both planted forests and those that naturally regenerate.

Without this change, even properties like mine, that are certified to meet international standards for sustainable forest management, could be unfairly excluded from an important emerging market, at a time when the forest products industry is at a 30 year low.

With the change, Congress can keep healthy forests as forests, preserving their capacity to store carbon and provide clean water, wildlife, recreation and scenic values to their communities.

Expanding the Standard in this manner is critically important in helping America to:

(1) Strengthen a form of renewable energy that reduces greenhouse gases.

(2) Meet our nation's renewable energy goals.

(3) Encourage sustainable forest management on millions of private forests.

(4) Create new markets for private forests.

The only forest biomass considered "renewable" and allowed under the current Standard is that from "actively managed tree plantations" that already exist or tops and limbs of trees, known as slash, and brush. By excluding biomass from naturally regenerated forests and planted forests that are not "actively managed", even if these forests are sustainably managed, family forest owners are precluded from effective participation.

Impact on Family Forest Owners

Let me give you an example on how the restrictive Standard impacts a family forest owner like me. I happen to have a 20–30 acre stand of white pine that I planted back in the late 1980's in abandoned fields (see *Photo #1* attached). This stand is now growing to maturity and is just about ripe for thinning. Normally I'd have a logger come in and remove some of the smaller trees to make way for the other trees to grow larger. Thinning like this will also help enhance wildlife habitat. I have a lot of turkey, deer, and other wildlife.

Here's the problem: under the current definition of renewable biomass, it's not clear whether my planted pine stands are considered "actively managed tree plantations." If I were to talk about it myself, I don't think I would call it that, since I only do minor work to maintain it, and I don't use any pesticides or fertilizers.

What's also unfortunate right now, if I want to do this thinning for both economic and ecological reasons, there's no market for the trees. So it's not economical to do the thinning the forest needs. A renewable energy market could help me recover cover the cost of doing these sorts of activities, so we can help improve the environment at a lower cost.

There's a related problem—in terms of qualifying as forest biomass—with the other forest on the rest of my land. The rest of my forest, roughly 340 acres, is not a planted forest, but rather forestland that naturally regenerates and essentially grows on its own (see *Photo #2*). A number of years ago, I decided to do a "shelterwood cut" where I worked to remove a lot of the older trees, selling most for lumber, but leaving trees behind for seed production and shade, so new growth can develop. This is a way to regenerate forests and ensure that my natural forest comes back strong.

While most of these trees will sell for lumber, not every tree is straight enough, so we either try to sell it for pulp or if there is no pulp market, we leave it in the forest. I would not be able to see any of these trees used for renewable energy because they don't qualify under the Standard. The only thing I could sell is the tops and the limbs and any brush lying around.

Interestingly, there is a Dominion Power facility about 45 miles from my land and that plant does use wood chips to generate electricity. I know Congress is working on a Renewable Electricity Standard and is considering the same sorts of restrictions on the use of wood for electricity. Under this scenario, the facility could not get credit for the biomass from my forests. And I am left out of the market.

This perverse result would occur with my similarly situated neighbors and colleague family forest owners across the country.

Most of the forests in Virginia are naturally-regenerating forests, meaning they aren't typically planted but come back on their own. Under the Standard, the only materials that can be utilized for fuels from this type of forest are tops and limbs of trees.

Improve the Practicality of the Standard

The current Standard only allows trees from "actively managed tree plantations" that already exist to be counted. No one really knows what that term means, and frankly, because of the incredible variation across the country in how forests grow and are managed, I think it would be incredibly difficult to figure out what that means and enforce it.

So if I plant trees in a stand that isn't actively managed, which is not well defined and could be very hard to interpret, I will only be able to sell a very small part of those planted trees for renewable fuel.

Not only is this ambiguous and confusing—requiring a landowner to guess what's in and what's out—it will be tremendously difficult to determine whether a particular tree came from an active tree plantation or perhaps was just planted in my backyard at some point. On my property I have white pine stands that are planted and white pine stands that naturally regenerated. Once trees from these stands are harvested, they all look the same. They would all go to a log-yard, where they are aggregated for sale to the highest-value market. Tracking the planted tree and the natural tree, would be an impossible and costly feat.

These kinds of restrictions are just not practical when considering the nature of the forest products supply chain and how harvesting occurs.

We understand that the intention behind the language was to protect the environment and ensure that a renewable fuels market does not unintentionally trigger unsustainable harvesting. But this is the exactly wrong way to do it. Instead, it has the effect of making it much more difficult to even use forest biomass as a feedstock for renewable fuels.

Cutting family forest owners out of markets can actually mean less environmental protection. If families do not have income to stay on the land, they may be forced

to sell their land to a developer or convert it into some other use, that doesn't provide the same level of environmental benefit.

Strengthen a Form of Renewable Energy that Reduces Greenhouse Gases

Forest biomass is plentiful in the U.S., but its potential as a renewable energy source at a national level remains largely untapped. In fact, we have fifty percent more forest biomass today than we did in 1950.

This is a critical time for our nation as we begin the difficult transition to more of a carbon-neutral economy. Healthy forests will play a central role in any national climate change strategy because they capture and store carbon emissions from all sources. U.S. forests now sequester 10% of the total U.S. carbon emissions every year, and could do even more if policies are adopted that support forest management designed to maximize greenhouse gas reducing benefits.

By redefining the Standard in a more practicable way that includes family forest owners, families will have an added incentive, and stream of revenue, that can help them stay on the land and continue managing their forest as a healthy forest.

Meet Our Nation's Renewable Energy Goals

Renewable energy standards now under consideration by Congress set forth a goal of meeting 25% or the nation's electricity demands from renewable sources of energy. But under the overly restrictive definition under consideration in these standards, only roughly 15% of the nation's available forest biomass resources could be used for electricity. The same is true for the Renewable Fuel Standard.

Unless forest biomass from all sustainably managed forests is included in the Renewable Fuel Standard, we will miss a time-sensitive window for engaging family forest owners in the nation's transition to renewable sources of energy.

Encourage Sustainable Forest Management on Millions of Private Forests

As more and more private forests are converted to non-forests uses—at the rate of 1.5 million acres every year—Congress needs to support policies that encourage sustainable forest management. Since privately owned forests make up nearly ⅔ of all forestland in the U.S., what each individual forest owner decides to do with his or her land can have a tremendous impact on the environment, wildlife, and forest-based communities.

What do we mean by allowing all sustainable forest biomass to be included in the Renewable Fuel Standard? Sustainable forest management essentially means that the forest is managed in a way that protects both the environmental and economic potential from that forest. There are a variety of tools that landowners use to help them manage sustainably. Some are as simple as having a management plan in place that specifies both stewardship and economic objectives.

Others are more complex, like forest certification, which involve a third-party audit to see if a forest is meeting specified environmental standards. Some states use mandatory or voluntary standards to ensure environmental protection.

To participate in the American Tree Farm System, for example, my property is required to be inspected by a qualified forester and then certified that it is managed pursuant to a plan that protects the air, water, wildlife habitat and the forest's capacity to continue producing fiber products in the future. It must be re-inspected periodically to make sure the stewardship objectives continue to be met.

Instead of taking the incredibly complicated and impractical approach of trying to manage forests in Federal legislation, Congress should rely on these existing tools to ensure sustainability and environmental protection.

Create New Markets for Private Forests

Including family forest owners in a revised Renewable Fuel Standard could also help them stay economically viable at a time when the forest and paper products industry has been depressed to the lowest levels in 30 years. Making a living from timber alone has become increasingly difficult. These new markets can supplement, not replace existing forest products markets.

Providing an additional income stream to struggling family forest owners, by allowing forest biomass from all sustainable sources to be included in the Standard, can help them stay on the land and maintain the forest in a healthy condition. We should not close these new and emerging renewable energy markets to those family forest owners who control the majority of forestland. Doing so severely limits the effectiveness of the Standard.

Mr. Chairman and Committee Members, if we truly wish to meet the energy goals envisioned in the Renewable Fuel Standard legislation, it is essential that a more inclusive definition of sustainable forest biomass is adopted.

We strongly believe Congress should correct the flaws in the 2007 Renewable Fuel Standard by allowing all sustainable forest biomass to be consid-

ered "renewable" under the Standard. Additionally, as Congress considers a Renewable Electricity Standard, we must ensure that ALL sustainable forest biomass can to be used in the production of renewable electricity to help meet our nation's energy goals.

Fixing the Standard will make it more practicable and accessible to millions of family forest owners like me. We urgently need this change in order to meet our nation's renewable energy goals, encourage sustainable forest management, and create new markets for family forests.

Thank you again for this opportunity to testify.

For additional information, contact:

RITA NEZNEK,
Vice President for Policy, American Forest Foundation,
[Redacted].

Photo #1: Stand of White Pine, planted in late 80's that should be thinned to remove smaller trees, allow trees left to grow larger and healthier. Smaller trees like one in right corner of photo could be used for renewable fuels markets. However, this is a planted stand, but it is not clear whether this would be considered "actively managed" and therefore count as "renewable."

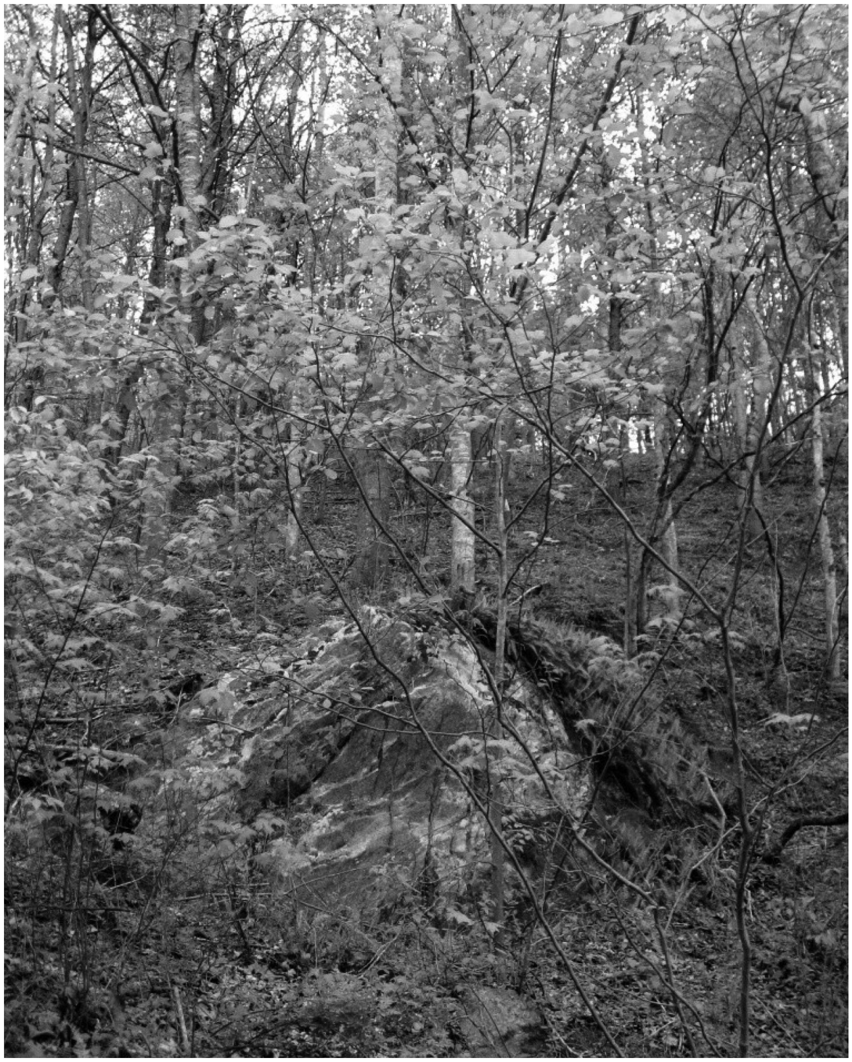


Photo #2: A mixed hardwood stand, growing naturally. Eventually, this stand will be thinned, removing some of the trees that are not growing straight or healthy, to make way for the healthy trees to grow. Under the current biomass definition, only the tops and limbs or "slash" of these thinned trees could be used

The CHAIRMAN. Thank you, Ms. Webster.

So the record indicates, we searched for a balance. Does anyone have any positive comments about EPA's proposal that was released yesterday? I know you haven't had a chance to review it.

Mr. FERACI. They are moving forward with the process. The U.S. biodiesel industry right now, we find ourselves in a somewhat tenuous situation. We have had what I call a perfect storm of events that have come together that have made things extremely difficult for biofuels producers. The rule was supposed to be finalized and the program implemented January 1, 2009. We are here in May of this year, and we are just seeing it now.

So moving the program forward and getting it implemented is a concept that is a good thing. But, obviously, the assumptions that they have made, it is a mixed blessing because then you have the indirect land use assumptions that they have made. You give with one hand, take away with the other and you disqualify vegetable oil feedstocks from being used to produce fuel, and that is just going to have to be fixed in the process.

The CHAIRMAN. Dr. Babcock, given a low level of accuracy in predicting the land use changes abroad, why do you think EPA chose to use the models that they did?

Dr. BABCOCK. In my testimony I tried to differentiate between changes in land use due to the changes in production *versus* where the land is going to come from. So if you need more cropland, where is that land going to come from? Is it going to come from increased double-cropping? Is it going to come from pasture? Is it going to come from forests?

That last link in these linked models is where the direct weakness is. I think I agree with Dr. Glauber on that, and the reason why they did what they did is because, and she referred to the Wind Rock model, that is what they had. So if they had an objective of trying to estimate land use changes, they went to where they could find someone that had some capability of doing it, and so that is why they did it.

The CHAIRMAN. Thank you. Mr. Pechart, you did a great job of explaining the problems that we face in Pennsylvania trying to participate in biofuels and definitions really hurting us. But, I wish you would elaborate, particularly for our environmental friends, the abandoned mine problem that we have in Pennsylvania, and you mentioned the Chesapeake Watershed, and we also affect the Delaware Watershed and the Allegheny Watershed because of anthracite coal being mined in the Northeast and bituminous in the Southwest. If you could just elaborate on the problem and if we were able to plant feedstocks, switchgrass on these abandoned mines, what it would mean environmentally.

Mr. PECHART. Thank you, Mr. Chairman, and that is a very good question. Some interesting statistics. In the eastern United States there are 740,000 acres of abandoned mine lands right now. It is an incredible number. And, just in Pennsylvania alone, we have 180,000 acres of abandoned mine lands. That is 2 billion tons of waste coal sitting around Pennsylvania, impacting about 4,600 miles of streams.

For Pennsylvania to clean that up it would cost us $10 billion, and that is $10 billion we obviously don't have in this economy

right now. That is $15,000 to $20,000 an acre. We have a public-private partnership right now going on and groups working to correct this problem, and I will give a good example that shows the economic impact of this.

The state spent $32 million to clean up about 960 acres of abandoned mine lands. Companies, utilities which are using fluidized bed technology and burning coal cleanly, and also restoring abandoned mine lands and planting feedstock crops on them that could be used to fuel cellulosic ethanol plants, at some point cleaned up 4,500 acres of abandoned mine lands at no cost to taxpayers. They used their own private dollars to do that.

So there is a tremendous effort underway in Pennsylvania. Feedstocks are going to be part of that. It is going to be a huge economic development tool for the communities where all of these acres of abandoned mine lands are. And the standard as presently proposed would limit the ability or the incentive for those utilities that are looking to take the next step in clean coal, which is reclaiming the land and producing next generation biofuels crops on there from doing so.

The CHAIRMAN. Thank you.

The chair recognizes the Ranking Member, Mr. Goodlatte.

Mr. GOODLATTE. Thank you, Mr. Chairman.

Ms. Webster, welcome, and I would like to ask you and Mr. Pechart a question about all of these conflicting and ambiguous definitions of what is acceptable for use as woody biomass, and whether you think that that has inhibited investment in renewable energy from wood products.

Ms. WEBSTER. I certainly think it is going to inhibit the investment. As we spoke about in my testimony, I have trees that have been planted, but according to the definition if they were not planted for woody biomass, can they be used for woody biomass? And to try and keep track of one tree from another tree as to whether or not it was planted or was not planted, when it actually hits the lumberyard, how are they going to know that this tree was or was not.

I think it is an extraordinarily complicated, unnecessarily complicated structure.

Mr. GOODLATTE. And when people are thinking about spending a significant amount of money to promote woody biomass, they are going to worry that they could get into all kinds of regulatory problems and may say, well, I will invest in something else rather than that.

Ms. WEBSTER. Precisely. Precisely.

Mr. GOODLATTE. Mr. Pechart, are you familiar with the proposed biomass definition in the Waxman-Markey Climate Change Bill?

Mr. PECHART. No, I am not, sir.

Mr. GOODLATTE. Well, I would call your attention to it, because it will even further compound the problem that we are experiencing with EPA, with the situation we have been talking about today, and with the energy bill that we passed 2 years ago that had this change made at the last minute in the definition of what qualified for biomass.

Some advocates for the current RFS biomass definition have argued that the current definition prevents over-harvesting of trees

and other feedstocks. Do you believe that it is possible the definition has the opposite effect and could potentially encourage overharvesting on the land where it is currently allowed?

That is directed to you, Mr. Pechart.

Mr. PECHART. I don't think so. As I had indicated in my testimony, at one time in Pennsylvania we had a very viable paper manufacturing industry, and we were pulling tremendous amounts of material. We have one of the largest hardwood stands in the United States in Pennsylvania. We were pulling a lot of material out of there, but when the paper mill industry started to decline, that material was just left in the woods, and it remains there today.

So I don't think right now, and to reference your earlier question, I think the segue is very good. The hardwoods industry in Pennsylvania right now is just sort of scratching their heads, and they are not sure where the future lies. They know they have a great resource that is out in their woods. We are encouraging them to look at—you need to sort of bring back that infrastructure that you once had in place that took all that stuff out of the woods and took it to the paper mills. That industry has gone away, too, but they are just sort of cautious about where this is going to go, and this proposed regulation from EPA is not helping them answer a lot of those questions right now.

Mr. GOODLATTE. So you would agree with me that the effect of discouraging harvesting woody biomass on lands where it is prohibited under these convoluted regulations would have the opposite affect of putting too much pressure——

Mr. PECHART. Yes.

Mr. GOODLATTE.—on the lands where it is allowed?

Mr. PECHART. Yes.

Mr. GOODLATTE. Very good.

Ms. Webster, what systems and protections do you have in place as a landowner to ensure that you are managing your forest so that future generations can have the same benefits from the forest as you have?

Ms. WEBSTER. Well, to begin with I have management plans. I am involved, as I said, with the tree farms systems. So there is a whole set of criteria that make me continue to be a certified tree farmer. I have the Department of Forestry in Virginia which has best management practices, so any kind of cutting and so forth are all regulated and are watched.

Third, I have, aside from the state regulations, I have a plan for the next generation, my kids. This is a family operation, so they are already on deck and come to meetings with me to be educated about forest management.

Mr. GOODLATTE. Well, thank you, and I hope you are able to instill that in your future generations of your family so they will continue to do that work and provide——

Ms. WEBSTER. Absolutely.

Mr. GOODLATTE.—jobs in our Congressional district.

Ms. WEBSTER. Absolutely.

Mr. GOODLATTE. It is very important, and we appreciate your contribution today.

Mr. Chairman, if I might ask one more question of Mr. Pechart. Some groups hail the renewable biomass restrictions in the RFS saying that these restrictions help protect forests and wildlife habitat. Do you agree with that statement?

Mr. PECHART. We don't agree with that statement in Pennsylvania. Again, a lot of our economy depends upon the hardwoods industry. We have a massive amount of state and Federal forestlands that create jobs, that put people to work. We really believe that the next generation, the next economy in Pennsylvania is going to focused around renewable energy, whether that is in agriculture or in hardwoods or in the forest products industry. And a lot of that is going to deal with biomass and getting biomass out of the woods and creating energy with it.

Mr. GOODLATTE. Well-managed forests are renewable resource for our country, and if you do that, you can have a beneficial aspect of protecting the forests. If they overgrow, that is a major contributor to problems with insect and disease——

Mr. PECHART. That is correct.

Mr. GOODLATTE.—infestation, along with forest fires. And forest fires getting out of control and being wildfires that destroy the forest rather than the natural type of a forest fire that can have a regenerative process in the forest.

So they need to be thinned, and we ought to put the thinning to work with biomass and in the process we can improve the forest and improve the wildlife habitat in my opinion.

Thank you both for your contribution. I don't mean to exclude the other four. I hope some of the other folks will have questions for them because my time has run out.

The CHAIRMAN. The chair thanks the Ranking Member. The gentleman from Iowa.

Mr. KING. Thank you, Mr. Chairman. I just want to tell you that I have breathed a sigh of relief each time I listen to each one of you give your testimony. My blood pressure has come down considerably since the first panel.

And I don't know which one of you I appreciate the most, but I appreciate all of your testimony here today. I wanted to point out to Mr. Bowdish that the plant that you hail from is not only one that we have done some work on, I personally laid a fair amount of that storm drain underneath that. I didn't just direct that it be done. I mean, actual hands on. So I know exactly where you are and how that thing is built from the cornstalks on up.

And you represent a company that is a huge part of the number one renewable fuels producing Congressional district in America when you add ethanol, biodiesel, and wind together. I have never done the math with ethanol and biodiesel, but I think that would also be true. We have been number one in biodiesel production for quite some time now. I should probably stop my commercials and get to some facts here.

First, Dr. Babcock, as I reviewed your testimony I was trying to do a calculation so that I could come to some understanding of your center's model that predicts 300,000 acres would be used per billion gallons of ethanol. And so I just do a little scratching, and it looks to me like we could probably do that in Iowa for less, fewer acres. And from this evaluation, and I went at it the other way, and I just

took a base of 500 gallons per acre that we can do, and that is pretty easily done and did the math on that, and I think I came to 150,000 acres.

Anyway, on this math how does that work out, and does it have a presumption of an average yield per acre? And then does that extrapolate across a lot of complicated factors as I understood you? Can you help me understand that model?

Dr. BABCOCK. Yes. So what happens is: say you need a billion gallons more ethanol, well, you will get more corn produced to meet that, but in getting more corn produced you are probably taking the land from some other crop somewhere else. And so there are all the cross-crop effects, and so the net effect of acreage—corn is one of the most productive crops around in terms of productivity per acre. If it is pushing out another crop that has less production per acre, you have to take that into account to get a net acreage affect.

Mr. KING. But when you calculate it, do you have a base number that makes a presumption on an annual yield? I am just thinking about the difference between Iowa yields and yields that you might get at another place that is not the Corn Belt. How does that actually extrapolate down through? Do they get to the point where on the other end of this equation, at almost the other end of the table, but I am actually thinking Brazil. And I am trying to put this equation together in my mind about we can sequester, I believe, more carbon by raising corn than you can by old-growth forests, which we should utilize. But, it seems to me that the EPA is thinking in terms of charging against corn production the burning of old-growth forests in Brazil, and at the same time we are in discussion about how we are going to convert timber waste to cellulosic ethanol.

So when you take that equation down to Brazil and say, "Okay, if we can turn it into ethanol here, we can do it there if they are going to clear the trees." Wouldn't we either make houses out of them or turn it into cellulosic ethanol? And wouldn't we put that all in our big spreadsheet, our inter-relational database so that we can do this math and really calculate out something that we can look at and have confidence that all the numbers balance?

Dr. BABCOCK. I will just briefly respond to that because there are many, many, many, many spreadsheets that are involved because you have many spreadsheets for each country involved. If you take 20 million acres of land in the United States, good corn land, divert it to fuel production, it will have ripple effects as I have heard it described throughout. You have identified many issues that need to be taken into account. What proportion of Brazil, if there is any change in Brazilian forests, what proportion of the wood is used in durable housing, for example? And I don't think we fully understand that.

Mr. KING. And I appreciate that, and we are only talking about a small part of the driving factor behind this, which is the idea of global warming itself or climate change itself. And so I would just ask this general question to the panel if anyone chooses to answer it in my seconds that remain, is there any witness on the panel that has analyzed the science that lays behind this global warming model that drives this policy we are talking about? And if so, do

you agree with their conclusion that the Earth is getting warmer because we are burning fuel into the atmosphere?

Anyone care to tackle that?

I would then, Mr. Chairman, let the record show that there was no one who volunteered to tackle that question which underlies this entire hearing, and I appreciate all the witnesses and by the way, the gentleman from Massachusetts, it has been awhile since I agreed so much with someone from Massachusetts.

I yield back.

Mr. GOODLATTE. I am from Massachusetts.

Mr. KING. Boy, I am totally embarrassed now, because I do agree with Mr. Goodlatte almost every time unless we have a regional issue that has to do with agriculture. So I appreciate it, Mr. Chairman and Ranking Member. This has been a very good hearing, and I am glad I was here to be a part of it.

The CHAIRMAN. The chair thanks the witnesses. Under the rules of the Committee the record of today's hearing will remain open for 10 calendar days to receive additional material and supplementary written responses from the witnesses to any question posed by a Member.

This hearing of the Subcommittee on Conservation, Credit, Energy, and Research is adjourned.

[Whereupon, at 2:00 p.m., the Subcommittee was adjourned.]

[Material submitted for inclusion in the record follows:]

SUBMITTED JOINT STATEMENT OF HON. JOHN H. HOEVEN III, GOVERNOR, STATE OF NORTH DAKOTA; CHAIRMAN, GOVERNORS' BIOFUELS COALITION; AND HON. CHESTER J. "CHET" CULVER, GOVERNOR, STATE OF IOWA; VICE CHAIRMAN, GOVERNORS' BIOFUELS COALITION

Mr. Chairman and Members of the Subcommittee, as Chair and Vice Chair of the Governors' Biofuels Coalition, Governor Chet Culver and I are pleased to submit this testimony on behalf of the Coalition. We appreciate the Subcommittee providing us with an opportunity to offer a state perspective on indirect land-use change and the environmental and economic benefits of ethanol, biodiesel, and other biofuels.

As governors, we have witnessed first hand the benefits that biofuels and other renewable resources provide to our states and much of the Midwest. Once economically suffering rural communities have been revived by the ability of our farms and biorefineries to deliver green jobs to our region and clean domestic fuels to all consumers—even as the nation's energy experts work toward additional oil alternatives for the future.

The decisive action taken by Congress in support of biofuels in 2005 and 2007 with the establishment and expansion of the Renewable Fuel Standard set a new benchmark for the United States. In less than 5 years, we have built a multi-billion dollar nationwide infrastructure that will soon deliver ten percent of the nation's light duty transportation fuel, and biodiesel use for heavy duty vehicles, from renewable domestic resources at a competitive price. At the same time, despite what biofuels critics say, the nation's farmers are also able to provide all the corn we need for domestic and export purposes, including the 80 percent of the corn crop that is used as animal feed.

The debate over how much corn is required for conventional ethanol production and the perceived impact this use has on international land-use change stems from misunderstandings and misinformation about modern farming and ethanol production processes. Ethanol production allows the same corn to be used for ethanol and livestock feed. The negative media of the past 2 years neglects to note that only the starch from the kernel of corn is used in ethanol refining. The protein, oils, and minerals are all captured and concentrated, and returned to farmers for use in livestock rations and emerging value added food products. Similarly, in the production of biodiesel from soybeans or other oilseeds, only the oil is utilized for the fuel, the remaining meal is a high value livestock feed that is rich in protein.

Last year, ethanol and biodiesel production returned over 23 million metric tons of livestock feed derived from the ethanol and biodiesel refining processes at a cost to livestock producers lower than the unprocessed grain they normally buy. This fact is critical in providing policy makers the information they need as they consider the impact of biofuels feedstock demand growth and the issue of indirect land-use change. The use of corn and oilseeds for fuel in no way represents a one-for-one disappearance of food from the system, and a growing chorus of scientific evidence shows that the U.S. grain based biofuels industry is not responsible for changes in international land-use.

To illustrate this point, I would like to cite the analysis of Dr. Terry Klopfenstein of the University of Nebraska. Dr. Klopfenstein's well-documented work shows that the industry standard conversion in a dry mill ethanol plant is 2.8 gallons of ethanol for every bushel of corn. In 2015, the Renewable Fuel Standard of 15 billion gallons will require 5.4 billion bushels of corn. Of this, the equivalent of 2.3 billion bushels will return to the feed market; netting a 2.8 billion bushel corn consumption for the production of ethanol. With this consideration, the total net use of corn for ethanol in 2015 leaves more corn available for food, feed and industrial uses than there was in 2002.

Such analyses make for hard-to-sell headlines, but they are the facts, and we need to set the record straight for consumers and policy makers. As a start, the Coalition recommends that the U.S. Department of Agriculture report on corn for ethanol use on an adjusted basis to reflect the use of distillers' grains as a high-value replacement for bulk corn in the animal feed category. Similarly, adjustments should be considered for biodiesel and soybean meal.

The Coalition's concerns about the complexity of indirect land-use change are shared by many in the scientific community. More than 100 scientists wrote to the State of California last year outlining the scientific and public policy problems with defining and enforcing indirect land-use in a selective (*i.e.,* biofuels only) way. These scientists pointed out that most modeling outcomes, by definition, assume little innovation. These models could not have predicted the 500 percent increase in corn yields per acre since 1940, the tripling of wheat yields since 1960, or the 700 percent increase in yield that can occur if farmers in developing countries adopt higher yield

seed varieties and more efficient farming practices. Encouraging such advances in the developing world should be a priority for foreign policy decision makers.

In addition, policy makers should consider that corn ethanol is a critical foundation in the transition to the next generation of biofuels. As research and development of feedstocks and technologies for cellulosic ethanol and other advanced biofuels continue to evolve, the potential for future land-use demands can diminish even as biofuels production grows.

There is no question that global food demand, increasing amounts of meat in the diets of citizens of developing nations, and deforestation are serious challenges for a growing world. Future fuels of all types must be incentivized carefully. At issue with indirect land-use change in the context of biofuels is a lack of data and a lack of appropriate modeling tools to assess impacts. Further, there have been no serious discussions of international treaties that should be used to cover a range of industrial and suburban development policies that have documentable impacts on forest and farm land destruction in the United States and abroad.

The governors recognize these are complex and time sensitive issues, and recently recommended to the President that an interagency task force be established on lifecycle greenhouse gas emissions and transportation fuels. This high-level task force would include the U.S. Department of Agriculture, U.S. Environmental Protection Agency, and U.S. Department of Energy, and would be charged with helping to resolve the debate over the lifecycle greenhouse gas emissions of biofuels and petroleum by requiring a thorough, objective assessment of this issue. This process should include an annual update of the lifecycle analysis of the drilling, refining and transport of petroleum products as well as the indirect emissions associated with military protection of access to world oil supplies.

The U.S. agricultural system and modern ethanol production has managed to meet demands for both ethanol and livestock feed. In doing so, many in the farm community and biofuels industry have taken serious steps to reduce fossil energy inputs, invest in more efficient production technologies, and adopt innovative tilling practices. The result of these efforts is impressive. For example, a number of scientific experts recently wrote in a letter to Secretary Vilsack that modern, highly efficient ethanol plants built since 2005 account for 75 percent of U.S. ethanol production, and that these plants require 1⁄10 of the water needed to produce a like amount of gasoline from crude oil.

In our states, we see documented decreasing fertilizer inputs per bushel of corn produced, biotech advances that allow production agriculture to feed more people for less money, and a desire by farmers and refiners to do even more. Without the advances achieved by these industries, urban life and a quality environment could not exist as we know it.

To be sure, the biofuels and agricultural industries have much to do to achieve greater levels of environmental sustainability, as do nearly all sectors of the American economy. To address this issue in a more constructive manner, the Coalition recently recommended to the President that the U.S. Department of Agriculture take the lead in bringing together biofuels industry representatives; environmentalists; state agricultural, energy, and environmental experts; and others to explore immediate policy options to achieve continuing improvement in energy water use efficiency, reduced fertilizer use, better tilling practices, improved water quality, and conservation of wildlife habitats. The governors intend this action to produce pragmatic, immediate steps that will improve the sustainability of biofuels and other agricultural products over the long term.

It is the Coalition's goal to continue to work with renewable fuel producers, farmers, environmental interests, and others to enhance biofuels productivity, efficiency, and sustainability. We look forward to working with Congress and the President to provide a pathway to a cleaner and more sustainable—economically and environmentally—transportation fuel future for our states and the nation.

Submitted Statement of William E. Flederbach, Jr., Executive Vice President, ClimeCo; on Behalf of PetroAlgae

Thank you Chairman Holden, Ranking Member Goodlatte, and Members of the Subcommittee for this opportunity to submit a statement for the record. My name is William Flederbach, Jr., Executive Vice President of ClimeCo and I am submitting this statement for the record on behalf of PetroAlgae.

PetroAlgae is a renewable fuel company commercializing the next generation technologies to grow and harvest oil and high protein feed from micro-crops. Micro-crops include algae, micro-angiosperms, cyanobacter, diatoms, and other very small aquatic organisms which grow very quickly and thus produce much more biomass

per acre per day than conventional terrestrial macro-crops can. Very high productivity per unit of land area, combined with high yields of both fuel and edible proteins, makes PetroAlgae's micro-crop-based process a renewable, carbon-neutral, food-contributing, cost-effective substitute for petroleum-based fuels. PetroAlgae uses naturally selected strains of micro-crops to produce rapid growth and high fuel yield. The process can be engineered on a massive commercial scale, creating the opportunity to produce a cost effective alternative to fossil fuels and high-protein animal feed while absorbing CO_2 from green house gas emissions (GHG). Expecting to begin commercial deployment in 2009 and opening a commercial scale pilot facility later this year, PetroAlgae is engaging with licensing prospects throughout the world. PetroAlgae offers a path to sustainable and clean energy independence through a process that is scalable globally.

PetroAlgae's process of growing and harvesting micro-crops for feedstock for petroleum products actively reduces CO_2. This can be achieved without the need to store the captured CO_2. Micro-crops are carbon neutral in that they capture more CO_2 from the atmosphere than that which is released when the biofuel is ultimately consumed.

Micro-Crop Global Benefits

Micro-crops have always been a critical component in the overall atmospheric CO_2 balance and serve as a negative feedback mechanism to the melt of icebergs. When icebergs melt, surface level albedo decreases. Albedo is found in ice and in clouds and acts to reflect shortwave radiation from the sun, thus decreasing the amount of long wave radiation emitted from the Earth (heat). However, when ocean surfaces increase, the amount of photosynthetic micro-crop also increases, acting as a negative bias to the impact of iceberg melt. The tiny photosynthetic micro-crops are an important food source in the Arctic marine ecosystem. They also absorb carbon dioxide from the atmosphere. As sea ice shrinks from warming, the micro-crops could play an important role in slowing climate change. The micro-crop process is very similar to the naturally occurring absorption process and serves to effectively absorb CO_2 from both the atmosphere and eventually from dedicated point sources of CO_2 (coal utilities and more).

CO_2 Emission in the United States

In the most recent Annual GHG Inventory report published by the United States Environmental Protection Agency (Agency, April 2009), total CO_2 emissions from fossil fuel combustion reached a staggering 5,736 million tons in 2007, up from 5,635 million tons in 2006. This category includes fossil fuel combustion in electricity generation, transportation, and industrial, residential, commercial use in the U.S. and its territories. A further breakdown of this data is discussed below.

In 2007 CO_2 emissions from fossil fuel combustion for electricity generation increased to over 2,397 million tons per year, up from 2,237 million tons in 2006. The release of CO_2 from the use of fossil fuels in industry (cement, steel, and others) also increased to over 845 million tons, up from 844 million tons in 2006. The upward trend is clear, as is the need for alternative CO_2 abatement technologies.

Current CO_2 Reduction Approaches—Electricity Generation and Industrial

In the past, the majority of CO_2 abatement technologies in the electricity and industrial fossil fuel arenas have focused on carbon capture, both pre-combustion and post-combustion.

Post Combustion CO_2 Capture

Carbon dioxide capture is most commonly based on chemical absorption, where the flue gas is brought into contact with a chemical absorbent with an ability to attach the CO_2. Typical absorbents are amines and carbonates.

The scrubber column is designed to ensure the exhaust gas and the absorbent are brought into close contact with each other. The CO_2 is then transferred from the flue gas to the absorbent, and there are two out-going flows from the scrubber column; a cleaned gas-stream with low CO_2 content and liquid-stream containing water, absorbent and CO_2.

After the absorption process, the absorbent and the CO_2 are separated in a regeneration column. When heated, the absorbents' ability to retain CO_2 is reduced, resulting in regeneration of the absorbent, which can then be re-used. The CO_2 leaves the regeneration column as a gas stream of high CO_2 purity. This gas can be transported to a CO_2 storage site or micro-crop farm. Approximately 80 to 90 percent of the CO_2 from a power plant can typically be removed by post-combustion CO_2 capture.

A major stumbling block hindering capture of CO_2 produced by fossil fuel combustion has been the extra cost and energy penalty associated with using the most com-

mon chemical scrubber absorbers. Employing the scrubbers in the power plants may reduce net power output by approximately ⅓ and raise the cost of electricity produced by 60–80%. Currently, the Electric Power Research Institute (EPRI) is evaluating alternative processes to reduce the loss of power and limit the increase in electricity costs. (EPRI, 2006)

Pre-Combustion CO_2 Capture

Additionally, CO_2 can be separated from the fossil fuel before combustion. The principle of this process is first to convert the fossil fuel into CO_2 and hydrogen gas (H_2). Then, the H_2 and the CO_2 is separated in the same way as under post-combustion, however a smaller installation can be used. This results in a hydrogen-rich gas which can be used in power plants or as fuel in vehicles. The combustion of hydrogen does not lead to any creation of CO_2.

The pre-combustion CO_2 capture is applicable to new coal power plants. There has been significant focus on the integrated coal Gasification Combined Cycle (IGCC) technology, where the power is produced from combined hydrogen combustion and from a steam turbine. Pre-combustion CO_2 capture is also applicable for natural gas power.

By pre-combustion CO_2 capture about 90 percent of the CO_2 from a power plant can be removed. As the technology requires significant modifications of the power plant, it is only viable for new power plants, not for existing plants.

Current Status of CO_2 Capture

As of today, no power plants or industrial sources with CO_2 capture have been realized. The reasons being are the significant financial risk associated with technological investments and lack of infrastructure for capture, transportation and storage. (International Energy Agency (IEA), 2007).

PetroAlgae Alternative

Although there are some additional new and novel technologies being explored such as membrane filters, adsorption and chemical looping, all of these remain very costly and full of inherent process risks.

PetroAlgae's process serves as a very viable alternative to the often controversial storage of the captured carbon from scrubbing and other technologies previously reviewed. Although micro-crop farms will absorb ambient concentrations of CO_2, micro-crop farms will likely be located adjacent to CO_2 producing facilities, like power plants, resulting in potentially significant CO_2 sequestration benefits.

Production of alternative transportation fuels from micro-crops will help reduce the amount of CO_2 in the environment without the need to store the captured CO_2. Micro-crops provide a carbon-neutral fuel because they consume more CO_2 than is ultimately released into the atmosphere when micro-crop-based fuel burns. The amount of carbon removed from the environment will depend on the number of micro-crop farms built and the efficiency with which micro-crops can be modified to convert CO_2 to fuel products.

Distinct Advantages Over Other CO_2 Capture and Storage Techniques

Much of the world's oil and gas is made up of ancient micro-crop deposits. Today, the micro-crop technology will produce "new oil" through a cost-effective, high-speed manufacturing process. This endless supply of new oil can be used for many products such as diesel, gasoline, jet fuel, plastics and solvents without the global warming effects of petroleum.

Other bio-fuel feedstock such as corn and sugarcane often destroy vital farmlands and rainforests, disrupt global food supplies and create new environmental problems. The micro-crop technology is targeted at fundamentally changing our source of oil without disrupting the environment or food supplies. Instead of drilling for old oil, PetroAlgae can now manufacture clean, new oil, anytime and anywhere, delivering a revolutionary breakthrough to the world.

In addition, the absorption of CO_2 in micro-crops is a distinct advantage over the capture and storage of CO_2 in abandoned mine sites and other geological formations around the Earth. The liability issue for carbon capture and storage (CCS) can be framed in terms of operational liability and post injection liability. Operational liability includes the environmental, health and safety risks associated with CO_2 capture, transport and injection.

There are two types of post injection liability: the *in situ* liability of harm to human health, the environment, and property, and the climate liability related to leakage of CO_2 from geological reservoirs and the effect on climate change. In general, post injection liabilities pose a unique set of challenges because of the scale of proposed CO_2 storage activities, the long timeframe over which the risks may

manifest themselves, and the uncertainties of the geophysical systems. (Mark de Figueiredo *et al.,* 2004)

Although the micro-crop process will have a small impact the operational liability associated with the capture of CO_2, it will greatly improve the risks associated with post injection liability. The captured CO_2 will be beneficially reused in the growth of the micro-crop and its end use of a biofuel, thus converting a liability into an asset.

Conclusion

PetroAlgae systems are designed to make money as fuel and food producers, so they have the potential to change CO_2 capture from a dead-weight-cost process to a profit-making process. We are not aware of any other CO_2 capture technology that has the potential to be a money-maker instead of a money-loser at large scale. The benefits of PetroAlgae's process are extensive and needs the support of the U.S. Government to accelerate the technology design and full-scale implementation.

SUBMITTED STATEMENT OF DENNIS GRIESING, VICE PRESIDENT, GOVERNMENT AFFAIRS, SOAP AND DETERGENT ASSOCIATION

The Soap and Detergent Association (SDA) is an over 100 member national trade association representing the formulators of soaps, detergents, general household cleaning products, industrial/institutional cleaners as well as the companies that supply ingredients and packaging to the formulators, including the oleochemical industry.

Oleochemicals: The Original Green Chemical Industry

The oleochemical industry is the original "green chemical" industry. For over 100 years in the United States, the industry has turned "animal fats" into fatty acids, fatty alcohols and other biobased chemicals that are widely used to manufacture soaps, detergents, personal care products, paper, plastics and tires.

The interrelationship of oleochemicals and biofuels is based on their shared "animal fats" feedstocks, *e.g.,* tallow, white grease and yellow grease and brown grease. While the United States oleochemical industry is principally based on tallow, other fats and greases are also used.

Since biodiesel and renewable diesel can also be made from "animal fats," government programs which subsidize or force a demand for animal fats-based fuels, *e.g.,* biodiesel tax credits, the alternative fuel credit and the Renewable Fuel Standard (RFS), put the oleochemical industry at an extreme economic disadvantage. This green industry should be applauded by government, but instead Federal biofuel policies have persistently threatened its continued viability as a domestic industry. If this material is lost to the industry, the logical replacement for tallow is palm oil.

The consequence of this is that all products would likely be made offshore and imported to the United States. Not only would oleochemical producers be put out of business but impacted consumer product manufacturing could be sent offshore as well. And, since palm oil production results in deforestation, the ILUC issue would simply be sent offshore as well.

Or, the oleochemical companies, in order to stay in business, could turn to petroleum-based substitutes. Either outcome would be profoundly ironic if it resulted from renewable fuels policies.

Indirect land Use Changes (ILUC) Impact on Oleochemicals

SDA is concerned that the inclusion of ILUC calculations at this point in time will disqualify plant-based renewable and biodiesel for purposes of the new Renewable Fuel Standard (RFS2). The consequence of this will be to drive producers of biomass-based diesel and biodiesel to animal fats as a feedstock with the result that the oleochemical industry will lose its critical raw material base because it will be consumed by biofuels.

The animal fats pool is insufficient to meet the RFS2 target for biodiesels in any event. So, even after it was all drawn off from the oleochemical market, the standard would still not be met.

Moreover, the supply of animal fats is inelastic; livestock production is geared to food supply, not fuel. No one is going to increase herd size for biofuels production. Animal fats are a co-product of livestock slaughter, not a demand driver. Consequently, there is no rational prospect that production will increase significantly. Annual production has been essentially flat for several years.

Animal fats-based diesels, whether biodiesel or renewable diesel, also pose challenges for cold weather use. At lower temperatures, there are so-called "cloud point" issues with such fuels which result in clogged fuel filters and lines. Reducing these

can be overcome to some degree by processing or putting special heaters and on trucks. All of this, however, adds costs. As a result, animal fats-based diesel is generally considered seasonal.

In SDA's view, disqualification of plant-based fuels under the RFS2 will effectively undermine the program. It will, *de facto*, create a non-expandable, seasonal RFS animal fats-based diesel program. The vision of the RFS2 simply cannot be realized without plant-based products leading the way into the future. Moreover, again, it stands to severely damage or eliminate the domestic oleochemical industry.

Based on the materials which SDA has reviewed, the science underpinning ILUC calculations is unsettled and evolving. If the outcome of incorporating ILUC considerations with respect to RFS2 is, as many anticipate, a disqualification of plant-based green diesels, both the RFS2 program will be threatened and the domestic oleochemical industry will see its raw material pool disappear when green diesel producers turn to animal fats, despite their significant limitations. SDA would submit that both these consequences ought to be avoided as a matter of energy policy and national interest.

Renewable Biomass Provisions

SDA's concerns with the renewable biomass provisions have principally to do with the definition of "renewable biomass" which includes "Animal waste material and animal byproducts."

Animal byproducts, *e.g.,* the tallows and greases noted above, have long, well established markets in oleochemicals as well as pet foods and other applications. While in general, all the other stipulated constituents of "renewable biomass" are either expandable crops or genuine waste products without pre-existing markets; animal-fats are traded as commodities, have a recognized economic value and are a critical raw material for an existing industry. Neither are they wastes: the price per barrel for tallow is similar to and at times higher priced than a barrel of crude oil. SDA believes that reconsideration of their inclusion ought to be undertaken. They ought not to be included in this definition.

A precedent for such consideration is found at Section 932(a)(C)(i) of the "Energy Policy Act of 2005." In defining biomass derived from "forest-related" materials the phrase ". . . or otherwise non-merchantable material" is applied. The clear implication of this is that material which otherwise has a market is excluded from the definition. SDA would respectfully urge that similar language be included in the current "renewable biomass" definition.

Summary

It is essential that the potential benefits of renewable fuels not be purchased at the cost of the continued viability of other industries. From SDA's perspective, our national energy policy with respect to renewable fuels is facing an unintended train wreck caused by a confluence of well intentioned and laudable goals. SDA believes that it is essential that we stand back and reassess the energy policy landscape.

Respectfully submitted,

DENNIS GRIESING,
Vice President, Government Affairs,
[Redacted].

SUBMITTED STATEMENT OF AMERICAN SOYBEAN ASSOCIATION

The American Soybean Association (ASA) thanks the Subcommittee for holding this hearing to examine the impact of indirect land use and renewable biomass provisions in the expanded Renewable Fuel Standard (RFS2).

Importance of Biodiesel

ASA has a great interest in the development and implementation of the RFS2, especially for biodiesel. Biodiesel is the cleanest burning biofuel currently used in commercial markets. Biodiesel is a renewable and sustainable energy source that can play a significant role in our national efforts to increase our energy security and improve our environmental footprint. Biodiesel has also provided a significant market opportunity for U.S. soybean farmers and jobs and economic development for rural communities. These facts make it difficult to understand why soy biodiesel would be excluded from the RFS2.

Biodiesel production in the United States has predominantly utilized soybean oil as a feedstock. While other feedstocks are becoming more viable, soybean oil remains the primary feedstock of choice for U.S. biodiesel production. As a result, biodiesel has provided a significant market opportunity for U.S. soybean producers by

increasing demand for soy oil. Soybeans are produced primarily for the soy meal that is used in the feed and food market. Historically, there have been surplus stocks of soy oil that have resulted in depressed prices for soybeans and restricted markets for soybean farmers.

The biodiesel industry is creating valuable green jobs and making a positive contribution to the economy. In 2008 alone, the U.S. biodiesel industry supported over 51,000 jobs, added over $4 billion to the nation's Gross Domestic Product (GDP) and generated over $866 million in tax revenue for Federal, state and local governments.

Despite the many benefits it provides, the U.S. biodiesel industry is facing severe economic hardship today. The difficulty accessing operating capital as a result of the current credit crisis, the volatility in commodity markets, reduced demand, and inability to compete in the European marketplace are making it difficult for producers to sell their fuel. In addition, uncertainty over Federal policy, such as the extension of the biodiesel tax credit and the implementation of the RFS2, is undermining investor confidence in the industry.

The National Biodiesel Board (NBB) estimates that absent any change in Federal policy, U.S. biodiesel production will likely fall to 300 million gallons in 2009, which would cost the U.S. economy more than 29,000 jobs. If prolonged, this downturn will lead to a severe retraction in U.S. biodiesel production capacity.

Renewable Fuel Standard (RFS2)

ASA believes that an expanded RFS2 that includes a specific minimum use requirement for biomass-based diesel is a necessary and beneficial program. The RFS2 is necessary to move the country toward our goals of energy independence and clean, renewable energy production. As the current market demonstrates, the production and use of biofuels is not economically viable when petroleum prices are low. Coupled with the extension of the biodiesel tax credit, the RFS2 could provide some much-needed market certainty for U.S. biodiesel production.

Under the Energy Independence and Security Act (EISA) of 2007, to be eligible for the new RFS2, biodiesel must meet a 50% greenhouse gas (GHG) reduction relative to petroleum diesel. When calculating the lifecycle GHG impact of biofuels, the statute directs EPA to consider direct and indirect emissions, including indirect land use, of all stages of the fuel and feedstock production. As a point of reference, under the existing GREET model used by the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy, biodiesel achieves a 78% GHG reduction relative to petroleum diesel. The primary area of concern and disagreement has emerged over the international indirect land use assumptions that EPA has proposed to use in conducting their updated lifecycle GHG analysis.

Indirect Land Use

Indirect Land Use Change (ILUC) refers to the GHG emissions caused by land converted to crop production globally. While we have not had time to fully assess the EPA Proposed Rule on RFS2 implementation, our initial review suggests that it is significantly flawed, and it does unnecessary harm to the competitive position of the U.S. soy biodiesel industry. EPA has included, in the proposed rule, numbers on the lifecycle greenhouse gas emissions of soy oil biodiesel that are derived from faulty assumptions, flawed analysis, and misplaced penalties.

Flaws in EPA Assumptions

We see numerous potential flaws in the approach EPA is using for indirect land use changes in its proposed rule. Further, there are numerous factors that we believe refute the possibility that significant international indirect land use change would result from the relatively small increase in U.S. biodiesel production called for under the RFS2:

1. The method used by EPA to measure indirect land use is new and untested. There is neither consensus in the scientific community nor a widely accepted methodology that could be deemed credible to accurately calculate the impact of U.S. biofuels production on international land use decisions.

2. Land use change has been going on around the world for many years, long before biodiesel was produced in the U.S. The EPA analysis uses land converted to cropland from 2001–2004 and extrapolates that into the future. Since there was very little U.S. soy biodiesel produced from 2001–2004, it is unclear how EPA justifies attributing future land conversion to soy biodiesel. Other market factors (urbanization, world population growth and dietary changes, timber and hardwood prices, *etc.*) impact and drive land use change decisions. In a recent interview Paulo Adario, director of Greenpeace's Amazon deforestation campaign said, "Biodiesel demand for soy oil is not seen as a significant driver of Amazon deforestation. Most of the soya grown in Brazil, including what is

grown on illegal plantations, is for animal and human consumption; and right now, the Brazilian government is investing in other feedstocks for the development of its biofuels program."[1] Clearly soy biodiesel is not driving land use change and any land use change that is occurring certainly cannot be solely attributed to U.S. biofuels.

3. Other market factors, including input and transportation costs, determine to what use farmers will put their land.

4. As an example, if Brazilian land use change is a key factor, then past and recent trends in Brazilian soy planted area should be a telling data point. In fact, Brazilian soy area increased most significantly in years prior to the existence of U.S. biodiesel production. In the last 5 years, when U.S. biodiesel production has increased exponentially, Brazilian soy area has remained relatively flat.

5. Yield increases by U.S. soybean farmers will play a significant role in meeting biofuel feedstock demand by producing more soybeans on the same amount of land. Historical data tell us that productivity gains and yield increases occur for U.S. agriculture. Over the 25 year period from 1981–2006, U.S. soybean farmers increased their yield from 30 bushels per acre to 43 bushels per acre. This equates to an average yield increase of ½ bushel per acre per year. This represents the minimum productivity increase that is likely to occur. With technologies currently in development, the yield increases going forward are expected to surpass those we have achieved over the past 25 years. U.S. seed technology companies are projecting that current soybean yields will double by 2030.

6. An increase of 300 million gallons of biodiesel (from 700 million to 1.0 billion gallons) under the RFS2 should not result in the substantial land use "penalty" being ascribed to U.S. soy biodiesel by EPA. From a starting point of 78% GHG reductions under the GREET model, any reasonable land use "penalty" that might be justifiably attributed to U.S. soy biodiesel should certainly not result in pushing soy biodiesel below the 50% GHG reduction threshold required under the statute.

7. Other measures are being implemented to address land use change for certain sensitive areas, such as the Amazon region in Brazil. An example is the Soy Moratorium, a pact signed by multinational soybean trading companies, Non-Governmental Organizations (such as Greenpeace and The Nature Conservancy), and the Brazilian Ministry of Environment which restricts the marketing or purchasing of soybeans from any newly deforested areas in the Amazon. The trading companies that signed onto the moratorium account for 95% of the soybeans marketed from the primary soybean growing region of Brazil.

8. We question whether the indirect emissions of diesel (the baseline against which biodiesel is being measured) are adequately factored into the baseline.

9. The statute does not require EPA to include *international* indirect emissions in their lifecycle analysis for biofuels. There appears to be a far greater degree of confidence among the scientific community in the ability to measure ILUC that may or may not occur in the United States as a result of biofuel demand. Extending the ILUC analysis globally creates far more uncertainty. Since the EISA statute only requires that EPA measure, ". . . *the aggregate quantity of greenhouse gas emissions (including direct emissions and significant indirect emissions such as significant emissions from land use changes), as determined by the Administrator,*" we do not believe that an EPA lifecycle analysis that attempts to measure *international* ILUC would be necessary or appropriate at this time.

Intent of Congress

It was not the intent of Congress for soy biodiesel to be excluded from the RFS2. If soy biodiesel is excluded, the biomass-based diesel schedule under RFS2 cannot be achieved. There are simply not enough of other biodiesel feedstocks to produce the amount of biodiesel called for in the RFS2. This is a clear indication that Congress did not intend to exclude soy biodiesel from the RFS2. The 50% GHG level that biodiesel must meet to qualify for the RFS2 is arbitrary. The GHG thresholds were established at different levels for different fuels and existing ethanol plants were exempted from the GHG threshold altogether.

[1] Nicholas Zeman, "Greenpeace: Biodiesel Not Seen as Significant Driver in Amazon Deforestation" *Biodiesel Magazine,* May 4, 2009.

Conclusion

ASA has a great interest in the development and implementation of the RFS2, especially for biodiesel. Soy biodiesel is one of the cleanest burning biofuels in commercial existence today. It is a renewable and sustainable energy source that can play a significant role in our national efforts to increase our energy security and improve our environmental footprint. Biodiesel has also provided a significant market opportunity for U.S. soybean farmers and jobs and economic development for rural communities.

The approach EPA is using for their proposed rule on RFS2 implementation appears to be significantly flawed and would do unnecessary harm to the competitive position of the U.S. soy biodiesel industry.

Again, ASA thanks the Subcommittee for holding this hearing to examine the impact of indirect land use and renewable biomass provisions in the RFS.

ATTACHMENT

American Soybean Association

Indirect Land Use & the Renewable Fuel Standard (RFS2)

Talking Points

- EPA's proposed rule inaccurately attributes significant international land use change to soy biodiesel production in the U.S.
- A lot of factors, such as urbanization, population increases, dietary changes, market economics, hardwood prices, *etc.* go into land use changes.
- U.S. biofuels do not drive international land use decisions and certainly cannot be singled out for responsibility for all land use changes.
- If soy biodiesel is excluded, the biomass-based diesel schedule under RFS2 cannot be achieved.
- It was not the intent of Congress for soy biodiesel to be excluded. They would not have set the schedule at levels that can only be met if soy biodiesel is included.
- The 50% GHG level that biodiesel must meet is arbitrary. Existing ethanol plants are exempt and do not have to meet any GHG reduction threshold.
- The statute does not require EPA to include *international indirect* emissions in their lifecycle analysis for biofuels.
- There is neither consensus in the scientific community nor a widely accepted methodology that could be deemed credible to accurately calculate the impact of U.S. biofuels production on international land use decisions.
- Under the EPA Proposed Rule, the only existing biofuel excluded from the RFS2 would be soy biodiesel, which is one of the cleanest biofuels in existence.

SUBMITTED STATEMENT OF BIOTECHNOLOGY INDUSTRY ORGANIZATION

The Biotechnology Industry Organization (BIO) is pleased to provide this written testimony on the critically important topics of the impact of indirect land use and the renewable biomass provisions in the renewable fuel standard (RFS). BIO thanks the Committee for its continuing leadership in agriculture and advanced biofuels.

BIO is the world's largest biotechnology organization, with more than 1,200 member companies worldwide. BIO represents leading technology companies in the production of conventional and advanced biofuels and other sustainable solutions to energy and climate change. BIO also represents the leaders in developing new crop technologies for food, feed, fiber, and fuel.

BIO supports efforts to reduce the carbon intensity of transportation fuels and believes that biofuels can and must contribute significantly to this important objective. Climate change is an urgent global issue, and Congress is to be commended for its leadership in addressing the contribution of transportation fuels to greenhouse gas emissions ("GHGs"). The growth of biofuel production can be done the wrong way or it can be done the right way. The advanced biofuels community supports building this industry in the most responsible and sustainable way possible.

On the issue of the renewable biomass definition in the RFS, BIO believes that the successful evolution of the biofuels industry towards next generation technologies will depend critically on the availability of sustainable sources of cellulosic biomass and other advanced feedstocks throughout the country. Any unnecessary restrictions on the eligibility of advanced feedstocks under the RFS are likely to hamper the deployment of these next generation technologies. BIO urges Congress and

the responsible agencies to ensure that all feedstocks that can be produced and harvested sustainably are made eligible for the biofuels mandates of the RFS.

On the issue of indirect land use change ("ILUC"), BIO recognizes that land use is an important component of climate and that possible ILUC impacts of biofuels production should be examined. However, current ILUC modeling is incapable of providing reliable indirect emissions estimates at this time. Modeling indirect global land use effects is a very complex undertaking. While direct impacts of production are relatively certain and traceable to the production, transportation and combustion of biofuels, indirect impacts are affected by a vast array of market and policy particulars and no model currently exists to accurately assess these factors. We do believe, however, that new and better models will be available in the near future.

There is currently no standardized modeling methodology or agreed data input for ILUC modeling. No ILUC model today comes close to capturing the interplay of economic, institutional, technological, cultural and demographic variables inherent in quantifying the indirect impact of a given fuel in an international setting. In fact, the economic equilibrium models being used by EPA in their proposed rule for the lifecycle analysis of GHG emissions from renewable fuels as required by the Energy and Independence Security Act of 2007 (EISA) were not designed for regulatory use—*i.e.,* to assign specific compliance metrics to specific fuels. Minor changes in any number of assumptions about biofuel production, agricultural economics, or land use policy can dramatically affect the outcome of current ILUC models. While EPA is making every effort to produce a capable model, the simple fact that they are having to link together several separate models that were all designed for different purposes suggests how embryonic the model development process is.

For example, in the proposed rulemaking, EPA has used the Global Trade Analysis Project (GTAP) model to test the robustness of the FASOM, FAPRI and Winrock results. GTAP is a multi-region, multi-sector, computable general equilibrium model that estimates changes in world agricultural production, which is housed in the Department of Agricultural Economics at Purdue University. The GTAP model seeks to project international land use change based on the economics of land conversion and the relative land use values of cropland, forest, and pastureland. BIO believes there are many factors ignored in the GTAP modeling of indirect land use changes. Chief among these are the many factors driving conversion of land in less developed countries. Poverty and efforts to escape poverty are a leading cause of land-use change. Uses of marginal land in less developed countries are changing rapidly due to factors other than biofuel production in the United States and other industrialized nations. Productivity of farm land in less developed countries may rise sharply, reducing the demand for land conversion attributable to lost food stocks from biofuel production in the United States. The list of relevant factors goes on and on. Set against this complexity is a simplistic conversion rate built into the GTAP model. This parameter is neither validated nor capable of validation with available world-wide macroeconomic and land use data. Thus, at its core the GTAP model is plagued by "needless uncertainty."

A paper published by the National Academy of Sciences in 2007 found that the complex factors that drive land use change globally "tend to be difficult to connect empirically to land outcomes, typically owing to the number and complexity of the linkages involved."[1] In a compendium of papers from a conference of 75 leading scientists in September 2008, under the auspices of the SCOPE workshop in Germany, the leading paper on land-use change concludes that "assessment of the GHG implications of land use and land conversion to biofuel crops is a very complex and contentious issue. A complete assessment of the GHG implications would require an accounting [of numerous international activities for which] the present assessment is limited due to the lack of data required to address all of these issues."[2] Thus, the best scientific assessment of indirect land-use change is that currently available global economic models are not robust, and that parameters and output calculations cannot be validated with available data. The accuracy of any values produced by such a modeling exercise, and thus whether the indirect land use effects rise to the "significant" level stipulated in the legislation for consideration, is therefore seriously under question.

Indirect land use assessment in relation to lifecycle GHGs has profound implications not just for biofuels, but potentially for all agricultural activity, and arguably climate policy the world over. First, by applying ILUC penalties to biofuels, effectively U.S. businesses are assuming responsibility for land use decisions—and the resulting carbon emissions—of individuals and nations around the world. This is a

[1] Turner *et al.,* 2007 [obtain report for page citation].

[2] *Proceedings of the Scientific Community on Problems of the Environment* (SCOPE), Ch. 6, p. 112–13 (2009). [insert title of article]

serious policy decision that could well set a precedent for all areas of economic activity, and would serve as potential validation of the position of China and other nations who seek to shift the responsibility for at least a portion of their domestic carbon emissions to the U.S. and other developed nations.

Second, if ILUC penalties are applied to biofuel feedstock producers, these penalties should arguably be applied to all agricultural producers and other land users. If this is the direction Congress and others seek to pursue, we needs to approach this radical shift in regulatory policy very carefully, and with the greatest possible flexibility, to minimize economic harm and other unintended consequences.

Thus, it is critical that any such regulations are approached with the utmost care, open-mindedness, and flexibility. To deliver the maximum real GHG reductions, the computation of lifecycle GHG profiles must: (1) follow consistent applied and thoroughly vetted methodology; (2) be based on contemporary and complete data; and (3) account for and encourage a range of future technology advances to ensure continued reductions in the carbon intensity of the country's fuel mix.

The role of land use in GHG sequestration and emissions is a serious climate change issue, which should be addressed in a comprehensive and consistent way in state, Federal and, indeed, international climate change policies and programs. As the representative of the biotechnology community, BIO expects to be an active supporter of and participant in programs designed to reduce GHG emissions attributable to land use and to increase permanent GHG sequestration through improved land management practices. We believe that a rigorous scientific and economic analysis of ILUC effects of biofuels production will demonstrate that first and next generation biofuels produced in the U.S. make a positive contribution to reducing the carbon intensity of transportation fuels and overall GHG emissions. It is critical that at this early juncture for state, Federal and international regulation of GHGs and carbon, regulatory agencies should develop a rigorous and consistent scientific approach to identifying and measuring GHG effects of indirect land use change attributable to a variety of activities, including the production of alternative fuels.

The critical question is whether the ILUC methodology and calculations are sufficiently rigorous and robust at this time. BIO submits the answer to this question is, emphatically: No. The peer reviewer comments from the California Air Resources Board (CARB) low carbon fuel standard review confirm that, at this time, ILUC calculations lack the requisite scientific rigor to support their incorporation into law. One peer reviewer underscored that the science and "art" of ILUC modeling and methodology is "in its infancy."[3] Another peer reviewer concluded that ILUC methodology exhibits an unacceptably large range of uncertainty, far exceeding the uncertainty associated with all of the other modeling relied upon in the Staff Report.[4] A third peer reviewer concluded that "the values used to quantify the carbon intensity due to land use change for ethanol from corn and sugarcane are not yet sufficiently developed to be scientifically confirmed; refinement and validation of those quantities is needed."[5]

BIO submitted the following recommendations to CARB at its public hearing on April 23, 2009, to postpone incorporation of ILUC modeling or calculations in final regulations:

1. The Board should direct its staff to continue soliciting input from all stakeholders and from the scientific community on appropriate ILUC modeling and reliable data sources, without any fixed commitment to GTAP or the parameters used in GTAP.

2. The Board should coordinate this further review of ILUC modeling with EPA's process for developing sounder science to support its rulemaking on the GHG emissions associated with different alternative fuels. Coordination with European regulatory processes studying ILUC should also be pursued.

3. The Board should expect this process to take as much as 2 years, after which it will again publish a staff report and proposed regulations and transmit the report for peer review. This next time, peer reviews should be completed and posted for

[3] Peer review comments of J. Reilly, *Review of Proposed Regulation to Implement the Low Carbon Fuel Standard,* April 6, 2009, ("Reilly comments") at 5 ("The indirect emissions issue . . . is a very new area where research that could establish with confidence such indirect emissions is in its infancy.").

[4] Peer review comments of L. Marr, *Scientific Review of the CARB's Proposal to Implement the Low Carbon Fuel Standard,* Mar. 31, 2009, at 2 ("The largest uncertainties in the estimation of carbon intensities are associated with the indirect effects. Relatively speaking the magnitude of direct effects are much more certain.").

[5] Peer review comments of V. Thomas, *Review of Proposed Regulation to Implement the Low Carbon Fuel Standard,* posted to website, Apr. 14, 2009 at 3.

public comment before the public comment period on the proposed regulations begins.

4. During the up-to 3 year period in which ILUC methodologies will not be finalized in California, the LCFS regulations could remain otherwise in effect, without any ILUC penalty for biofuels. This period of future scientific study and a subsequent rulemaking proceeding should be recognized for what it is—a transition period and not a permanent elimination of ILUC penalties. During this transition period, the Board could authorize the publication of best estimates of carbon intensity values for different pathways, with and without tentative ILUC values indicated by the current state of scientific modeling of ILUC.

5. The Board should establish as its legal standard for adopting ILUC methodology and calculations the development of an economically and scientifically robust, consensus model that is capable of validation by meaningful real-world data that would result in tolerable ranges of uncertainty. Until there is much greater consensus concerning the modeling and calculation of ILUC, the Board should refrain from incorporating even best estimates of ILUC impacts in final regulations.

6. If, using scientifically rigorous models or analysis, Staff determines that certain biofuel pathways will have a net ILUC benefit, *i.e.,* they will sequester more carbon than they emit through land-use change, the Board should consider early adoption of regulations that lock-in these net benefits for these "best technologies." The early recognition of these net benefits of "best technologies" should drive the evolution of the biofuels industry towards such technologies. Later, after the requisite period for scientific studies, the Board can consider adoption of final regulations that fix ILUC penalties for "lagging technologies."

7. The Board should consider adopting ILUC mitigation rules that will allow producers of technologies with significant ILUC penalties to reduce the amount of those penalties through verifiable investments in (i) activities that improve land use efficiency, (ii) research for lifecycle efficiencies, including biorefinery energy and co-product efficiencies and (iii) and other activities that secure direct carbon intensity benefits in the California or national economy.

BIO believes that CARB's adoption of these measures will allow it to implement the LCFS and to secure substantial carbon intensity savings from the use of transportation fuels in California, without imposing insufficiently justified ILUC penalties only on biofuels. BIO believes that EPA should take a similarly measured approach.

Investments in first generation biofuels are catalyzing efficiency across the entire agricultural sector. These efficiency gains have the potential to greatly lessen demand pressure on land, and, thus, to reduce GHG emissions from undesired land conversion. The proposed ILUC penalties for first generation corn-based ethanol threaten the industry with a substantial competitive disadvantage relative to all other fuels. Resulting reductions in investment in first generation technologies will, in turn, threaten recently realized agricultural efficiency gains, and will discourage investments in allied technologies—such as advanced fractionation, cold fermentation, and renewable repowering—that could further improve the direct GHG profile of biorefineries, while increasing production of food, feed and other co-products from the same acre of land.

Premature regulatory implementation of ILUC methodology and calculations will also chill investment in second generation biofuels. Even though cellulosic ethanol is indicated to have a lesser ILUC penalty than corn-based ethanol, the penalty is still substantial. Moreover, adoption of immature ILUC methodology would signal to potential investors in the fledgling industry that penalties of uncertain validity are likely to be imposed on cellulosic ethanol, and not on other alternative fuels. We understand that Congress wants to take a lead role in spurring alternative transportation fuels, and, more generally, in reducing GHG emissions across the country and the world. However, by incorporating immature ILUC methodology for biofuels the U.S. will be out of step with regulatory efforts internationally—where the European Parliament recently decided to postpone inclusion of ILUC in biofuel regulations, pending completion of an expected 2 year study of the complex methodology. BIO suggests to not lock in ILUC methodology, but to continue serious scientific studies aimed at improving modeling, securing reliable data, and resolving uncertainties. Such studies would be most usefully undertaken in conjunction with EPA's analyses of ILUC, which will also afford opportunity to share information with European and other nations studying the same issue.

ILUC methodology should also be coordinated with policies being undertaken at all governmental levels to improve agricultural practices (yields, sustainability of marginal lands, GHG sequestration from changed practices, such as no tilling, *etc.*) and to reduce pressures for deforestation and conversion of sensitive lands in at risk

countries. With land and forestry practices sensibly managed, increased biofuel production world-wide should not result in substantial net carbon emissions attributable to land use conversion in at risk countries.

In closing, the successful development of a myriad of biotechnologies and their rapid deployment throughout the economy can advance the nation's goals of both sharply reducing greenhouse gas emissions and encouraging cleaner and more sustainable energy resources. Biofuels, using the most advanced science, can significantly reduce U.S. GHG emissions compared to petroleum based gasoline and new biotechnology developments such as improved enzymes and high-yielding drought-tolerant crops are rapidly improving the GHG profile of both traditional and advanced biofuels. BIO thanks the Committee for its support of advanced biofuels, and for its consideration of these comments.

Submitted Statement of Society of American Foresters

On behalf of the Society of American Foresters (SAF), the national scientific and educational organization representing the forestry profession in the United States with over 14,000 members, please accept the following testimony for the hearing record on the Renewable Fuel Standard (RFS) held May 6, 2009.

As an organization chartered to advance the science, education, technology, and practice of forestry for the benefit of society, the SAF believes that woody biomass energy from our nation's forests is part of the solution to supplying America with reliable renewable energy. As the House is aware, it is distressing that at a time when considerable efforts are being made to address global climate change—by preventing the conversion of forests to competing uses and by mitigating the likelihood of increasingly devastating wildfires—the definition of "biomass" in a Federal RFS needlessly limits the management options available to Federal land managers, and diminishes the market incentives available to private forestland owners that allow them to resist development pressures and maintain their land as forests. We commend the House Agriculture Committee's efforts to craft a more scientifically, socially, and ecologically appropriate definition, which can help balance the nation's most pressing forest management needs and safeguard the important environmental and societal values our forestlands provide.

SAF supports strategies and policies that promote the development of economically and environmentally viable forest biomass energy production together with those that assist communities, forest owners, public forest managers, and local entrepreneurs in accomplishing urgent wildfire prevention and forest health improvement projects. This includes appropriately defining "woody biomass" in any Federal legislation.

Increased utilization of forest biomass will also help combat global climate change and improve the nation's energy security by providing an abundant, renewable fuel resource as a substitute for imported fossil fuels. On public lands in the West, many of the silvicultural treatments prescribed to reduce the risk of catastrophic wildfire and improve forest health will generate large volumes of forest biomass. Increased utilization of forest biomass can improve forest conditions in the eastern and southern states as well, where additional markets for low-quality and small-diameter trees also will enable forest managers to improve forest health. On other forests, both public and private and across the country, forest health and restoration treatments are needed to control insects and disease and to improve wildlife habitat and watersheds. This type of management can be costly, as much of the biomass removed has little to no value. An appropriately structured RFS would help to create a market for woody biomass. This, in turn, would encourage much-needed forest health or fuels reduction projects by offsetting the some of the cost of biomass removal. The current RFS, with its restrictive, one-size-fits-all definition, encourages the opposite.

Concern for the sustainability of biomass power generation has led to a prescriptive, process-based approach. The 2007 Energy Bill's RFS definition of "renewable biomass" is prescriptive and restrictive. Although this method may give some interested parties a level of comfort, it is a disservice to our nation's forests and has no basis in science. Forests are complex, diverse, and in constant flux as a result of natural and man-made disturbances. No two acres are alike and, as such, no two acres should be treated alike. Thus, such a prescriptive definition serves as a disincentive to restore forest health in many areas, because Federal requirements are too onerous and, in some cases, even contradict necessary silvicultural treatments.

Alternatively, an outcome based approach, with a broader definition of "renewable biomass", would give flexibility to manage forestland sustainably. Ideally, on private land, this would be done with the assistance of a professional forester who writes

a management plan or harvest plan that addresses soil conservation, water quality, wildlife habitat, and biodiversity. This approach would allow management decisions to be site specific and unique to the needs and goals of a particular forest. It also would serve as a powerful incentive for landowners to consult with professional foresters to promote best management principles, and to allow management efforts to adapt to changes in the landscape or as new science and management techniques become available (*i.e.,* adapting climate change or other disturbances).

In regard to public lands, the SAF believes the laws and regulations that preceded the 2007 Energy Bill, such as the National Environmental Policy Act (NEPA), National Forest Management Act (NFMA), and the Federal Land Policy and Management Act (FLPMA), more than adequately provided requirements for the sustainability of biomass removal. Past biomass definitions have excluded areas such as Wilderness, Wilderness Study Areas, and inventoried Roadless areas. These definitions, too, although politically popular, make little sense from a forestry perspective. Some of these areas, for example, are in need of habitat restoration, insects and disease containment, or fuels reduction projects, which could maintain the character of these special designations while simultaneously improving forest health. Land managers in the Forest Service and Bureau of Land Management should decide what projects are needed and where. The biomass from these projects should count toward an RFS that helps offset the cost of removal and stretch appropriated dollars toward the further enhancement of public lands.

Our forest resources are renewable. Although some biomass may be removed from public or private land, it will inevitably grow back and likely need to be removed again. There are roughly 20 billion board feet of new growth and 10 billion board feet of mortality on our national forests every year. In contrast, there are (on average) 2 billion board feet of removals. As we discuss the sustainability of biomass, which is imperative, we cannot forget that we are losing ground in our efforts to restore public forests. We also must remember that creating a viable biomass market through an RFS will help protect private forestlands from development and safeguard the environmental and economic benefits on which we all depend.

SUBMITTED STATEMENT OF NATIONAL ALLIANCE OF FOREST OWNERS

I. Introduction

The National Alliance of Forest Owners (NAFO) is pleased to submit comments to the House Committee on Agriculture regarding the "impact of the indirect land use and renewable biomass provisions in the renewable fuel standard (RFS)". NAFO is an organization of private forest owners committed to promoting Federal policies that protect the economic and environmental values of privately-owned forests at the national level. NAFO membership encompasses more than 74 million acres of private forestland in 47 states. NAFO members are well positioned to help our nation meets its renewable energy objectives, and NAFO is prepared to work with the Committee and Congress toward that end.

Private working forests are a fundamental part of the strategic natural resources infrastructure of our nation, producing renewable, recyclable and reusable wood and paper products, sustaining plants and wildlife, producing clean water and air and providing recreation experiences. Working forests also play a substantial role in helping this country achieve energy independence while reducing greenhouse gas (GHG) emissions. Forest biomass is a renewable energy feedstock that can help meet our national renewable energy goals in all regions of the country, if placed on a level playing field with other renewable energy sources.

NAFO asks this Committee to recognize biomass from private, working forests as an eligible feedstock on an even playing field with other renewable energy sources as it reviews the Federal RFS. The RFS should recognize that forest owners already work within a well established framework of laws, regulations and non-regulatory programs and actions that promote and maintain responsible forest management, and will continue to do so as they help our nation meet its renewable energy objectives.

II. Working forests will help our nation meet its objectives to increase our reliance on secure, domestic sources of renewable energy and help reduce atmospheric greenhouse gas (GHG) concentrations.

Experts have long recognized working forests as a source of real and verifiable reductions in greenhouse gases and a cost-effective source of industrial GHG offsets. The United Nations' 2007 Intergovernmental Panel on Climate Change (IPCC) highlights forest management as a primary tool to reduce GHG emissions. The IPCC states that, "In the long term, a sustainable forest management strategy aimed at

maintaining or increasing forest stocks, while producing an annual sustained yield of timber, fiber or energy from the forest, will generate the greatest mitigation benefit."[1]

However, a Federal RFS that does not appropriately include all forms of forest biomass not only limits our country's ability to produce cost-effective renewable fuels, it significantly limits the carbon benefits associated with using fuels derived from such biomass in regions of the country where forests are the dominant land use.

Appropriately including forest biomass in an RFS would take full advantage of these carbon mitigation benefits in the energy context. Likewise, a policy that discourages forest biomass utilization will forfeit these benefits.

III. Definitions of eligible biomass feedstock should put working forests on an even playing field with other renewable energy sources.

NAFO has particular concern about the definition of eligible forest biomass found in the Energy Independence and Security Act of 2007 (EISA). Definitions of qualifying renewable energy feedstocks should provide a level playing field for market access across all feedstock sources and encompass the full range of forest biomass, including trees and other plants, forest residues (*e.g.,* tops, branches, bark, *etc.*) and byproducts of manufacturing (*e.g.,* sawdust, bark, chips, dissolved wood retrieved from the papermaking process, *etc.*). Presently there are at least four different definitions of qualifying forest biomass in Federal statute.[2] This adds complexity and confusion to project developers, biomass producers and Federal program administrators who are required to determine how the various, and at times conflicting, definitions interact with one another.

As currently written, the EISA RFS definition places confusing parameters on significant acreages of private forestlands in the form of land use restrictions. These restrictions limit the ability of forest biomass to contribute to meeting the ambitious mandate to produce 36 billion gallons of renewable fuels annually by 2022.

This definition also significantly restricts the use of forest biomass from naturally growing and regenerating forests, which make up more than 90 percent of our nation's non-Federal forests. By doing so, it removes potential markets and viable economic options needed by private forest owners to support thinning for a variety of sustainable forest management practices, and who are already experiencing economic pressures from the steep declines in traditional markets such as solid wood and pulp and paper manufacturing.

The definition for qualifying forest biomass in the EISA discourages necessary and appropriate forest management activities that promote forest health and sustainability. Proper forest management focuses on moving the forest toward its desired condition. No matter the desired condition, appropriate management often includes removing material that could be used productively. By using specific definitions, such as slash, planted trees, residues, and pre-commercial thinning to limit the material that can used productively contradicts, rather than promotes, sound forest management.

Private landowners recognize that their forest's health depends on the health of neighboring forests. Limiting renewable biofuels from Federal lands limits the options of Federal land managers to manage for a healthy forest, which threaten private forests, and constricts the areas that can support a biofuels plant, especially in the West. This could mean large swaths of the country could not have adequate supply to support a plant without access to renewable biomass from Federal lands.

The current definition also creates complex chain-of-custody requirements that could cause fuel manufacturers to exclude large portions of potential feedstock supply in order to meet compliance requirements. If identifying qualifying feedstock becomes too complex or costly, project developers may forego the development of facilities that use forest biomass altogether, thereby placing the overall RFS in jeopardy.

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[1] *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds.)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, page 543.

[2] Separate definitions of eligible forest biomass can be found in Section 45(c)(3) of the Internal Revenue Code (26 U.S.C. 45(c)(3)); Section 203(b)(1) of the Energy Policy Act of 2005 (42 U.S.C. 15852(b)); Section 201(1)(I) of the Energy Independence and Security Act of 2007 (42 U.S.C. 7545(o)(1)(I)); and Section 9001(13) of the Food, Conservation, and Energy Act of 2008 (7 U.S.C. 8101(12)).

IV. NAFO is prepared to work with Congress and other stakeholders to realize the contributions of working forests in energy policy in an environmentally responsible way.

NAFO is prepared to help develop a constructive approach using forest biomass to help meet our nation's energy needs. Notwithstanding the strong record of environmental benefits private forests provide, NAFO is prepared to work with policy makers and other stakeholders to ensure that forest biomass, and all other sources of renewable energy, help meet our renewable energy objectives in an environmentally responsible way.

NAFO suggests the Committee support a Federal renewable fuel policy that promotes rather than discourages the use of forest biomass for renewable energy. Federal policy, and definitions of qualifying forest biomass in particular, should be broad and inclusive so as to encourage forest biomass utilization and foster cost-effective compliance. The current RFS definition is too restrictive, placing forest biomass at a disadvantage with respect to other feedstocks and ultimately discouraging its use.

NAFO respectfully requests that Congress consider H.R. 1190 as it reviews the Federal RFS. H.R. 1190 amends the Federal renewable biofuels standard so that it is consistent with the definition codified in the 2008 Farm Bill. This definition establishes a level playing field for forest biomass and positions forest owners to make a full contribution toward achieving the RFS objectives. NAFO supports H.R. 1190 and urges Congress to enact it.

V. Conclusion

NAFO strongly supports our nation's efforts to establish new sources of renewable energy, and thereby reduce its dependence on fossil fuels and imported energy. America's working forests can play a fundamental role in meeting these new and growing energy needs. U.S. policies should encourage investment in forests as a source of renewable energy by establishing non-restrictive definitions of forest biomass eligible for use in renewable energy programs.

The RFS should fully include forest biomass as a renewable energy source and ensure that the definition of biomass encompasses the full range of forest biomass, including: trees and other plants; forest residuals; and wood byproducts including sawdust, bark, wood chips, and dissolved wood. Such an approach will enable our country to meet its renewable fuel objectives. At the same it, it will allow working forests to make their full contribution to our nation's renewable energy portfolio while providing important additional environmental benefits, such as reduced GHG emissions, clean water, wildlife habitat quality recreation and other environmental benefits Americans need and enjoy.

For more information, please contact:

National Alliance of Forest Owners
(202) 367–1163
info@nafoalliance.org

SUPPLEMENTAL MATERIAL SUBMITTED BY HON. TIM HOLDEN, A REPRESENTATIVE IN CONGRESS FROM PENNSYLVANIA

EXHIBIT 1

Hon. LISA JACKSON,
Administrator,
Environmental Protection Agency,
Washington, D.C.

Dear Administrator Jackson:

We are writing to request an immediate extension of the comment period for proposed rulemaking pertaining to the Renewable Fuel Standard (RFS), as amended by the Energy Independence and Security Act (EISA, P.L. 110–40), to allow an additional 120 days for comment.

We believe that the current 60 day comment period does not provide sufficient time for the public to review the 549-page Notice of Proposed Rulemaking and 822-page regulatory impact analysis, nor does it allow adequate time for people to prepare their comments. Since the Environmental Protection Agency (EPA) is planning to provide details about its lifecycle greenhouse gas analysis during meetings in June, the current deadline limits the ability of people to consider and respond to the information expected to be presented at those meetings.

The future of our biofuels industry is too important to rush to judgment on such important and critical issues as what constitutes a renewable biomass feedstock and how to consider indirect land use changes. Additionally, we believe the provisions in the underlying statute must be modified in order to fully ensure that the regulations are based on sound scientific principles. If we want the biofuels industry to be successful and if we are serious about decreasing our dependence on foreign oil, the comment period must be extended while we all work to advance the goal of achieving a full range of renewable options to meet our fuel needs.

Thank you in advance for considering this request.

Sincerely,

Tim Holden

Collin C. Peterson

John Boccieri

Jim Costa

Brad Ellsworth

Stephanie Herseth-Sandlin

Larry Kissell

Blaine Luetkemeyer

Betsy Markey

Jerry Moran

Adrian Smith

Deborah Halvorson

Bob Goodlatte

Frank Lucas

Bobby Bright

Kathleen Dahlkemper

Sam Graves

Steve King

Robert Latta

Mike McIntyre

Walt Minnick

Earl Pomeroy

Glenn Thompson

EXHIBIT 2

OFFICE OF THE GOVERNOR

CHESTER J. CULVER
GOVERNOR

PATTY JUDGE
LT. GOVERNOR

April 22, 2009

Mary D. Nichols, Chairwoman
California Air Resources Board
Headquarters Building
1001 I Street
Sacramento, CA 95814

Dear Chairwoman Nichols:

I wish to share with you my concerns about the California Air Resources Board's treatment of biofuels in the proposed Low Carbon Fuel Standard (LCFS). The impact of the Board's approach will damage not only existing biofuels production, but would significantly curtail research and delivery of second and third generation advanced biofuels.

Iowa is home to the nation's leading biofuel producers, many of whom are working to transition to second-generation biofuel refining, and are working with the U.S. Department of Energy to research and demonstrate advanced biofuels from a range of feedstocks. These companies — and the thousands they employ — are producing domestic, renewable fuels that are enhancing the environment, bolstering local economies, reducing the trade deficit, and diversifying our fuel sources. I am extraordinarily proud of their accomplishments even as we work with stakeholders to achieve greater production efficiency and improved sustainability.

I am concerned about the Board's treatment of biofuels in the proposed LCFS since biofuels are treated differently from other compliance fuels and petroleum. Instead of establishing a baseline that allows various fuels to compete equitably on a carbon-based playing field, the following two issues have emerged:

- The Board has incorporated ethanol into the petroleum baseline, which means that ethanol is not only competing against other alternative fuels, but also against itself.
- The proposed LCFS enforces indirect land use effects only for biofuels, creating a potential bias in the regulation that will unfairly penalize these fuels, as well as the second and third generation fuels that may soon enter the market.

With regard to the to baseline issue, California gasoline contains 5.7 percent ethanol by volume. Yet, the Board has made 10 percent ethanol blends (E10) the baseline fuel.

As such, refiners moving from E5.7 to E10 do not receive carbon credit under the program. This baseline inclusion sets the ethanol industry up to replace itself. As outlined in the LCFS executive order (S-01-07), "[d]iversification of the sources of transportation fuel will help protect our jobs and economy from the consequences of oil price shocks." The Board's use of this baseline violates this goal.

With regard to the enforcement of indirect land use effects, it is unclear why biofuels are the only fuels under the proposed LCFS to be penalized for indirect land use effects. By requiring biofuels alone to satisfy a penalty for alleged indirect effects, the Board is creating a potential bias in the regulation and a clear disincentive to utilize biofuels of any kind.

While I support California's and the nation's efforts to better understand the indirect land use impact of various fuels, I also share the concern of over 100 scientists who wrote to Governor Schwarzenegger expressing their scientific and public policy concerns with enforcing indirect effects in a selective way. The outcome of the Board's proposed approach will not only damage existing biofuels producers, but will also significantly slow advanced biofuels investment and development.

Recognizing the extraordinary challenges of implementing an LCFS, I support expanding efforts to work with renewable fuel producers, farmers, investors, consumers, environmental leaders and others in order to find common ground on transportation fuel policies. We share a goal of reaching a future that includes flex-fuel, plug-in hybrid vehicles operating on clean power and increasingly sustainable renewable fuels. It is essential that we work together to find a common path that leads us toward this future and away from high-carbon fossil fuels.

Sincerely,

Chet Culver

Chester J. Culver
Governor of Iowa

EXHIBIT 3

March 2, 2009

Hon. ARNOLD SCHWARZENEGGER,
Governor,
Office of the Governor,
Sacramento, CA.

RE: Opposed to Selective Enforcement of Indirect Effects in CA LCFS

Dear Governor Schwarzenegger,

We are writing regarding the California Air Resources Board's (ARB) ongoing development of the Low Carbon Fuel Standard (LCFS). With the rulemaking nearing its final stage, we would like to offer comments on the critical issue of how to address the issue of indirect, market-mediated effects.

As you are aware, ARB staff continues to push a regulation that includes an indirect land use change (iLUC) penalty for biofuels. To be clear, this effect is not the direct land conversion from growing crops for fuel. It is the alleged indirect, price-induced land conversion effect that could occur in the world economy as a result of any increase in demand for agricultural production. The ability to predict this alleged effect depends on using an economic model to predict worldwide carbon effects, and the outcomes are unusually sensitive to the assumptions made by the researchers conducting the model runs. In addition, this field of science is in its nascent stage, is controversial in much of the scientific community, and is only being enforced against biofuels in the proposed LCFS.

The push to include iLUC in the carbon score for biofuel is driven at least partially by concerns about global deforestation. There is no question that global deforestation is a problem, and that indirect effects must be looked at very carefully to ensure that future fuels dramatically reduce GHG emissions without unintended consequences. The scientific community is actively seeking ways to mitigate deforestation, enhance efficient land use, feed the poor and malnourished and reduce global warming. Because of the complex and important issues involved, it is critical that we rely on science-based decision-making to properly determine and evaluate the indirect effects of all fuels, as well as any predicted changes in agricultural and forestry practices. In a general sense, it is worth noting that most primary forest deforestation is currently occurring in places like Brazil, Indonesia and Russia as a direct result of logging, cattle ranching and subsistence farming. Adding an iLUC penalty to biofuels will hold the sector accountable to decision-making far outside of its control (*i.e.,* for decisions related to the supply chains of other products), and is unlikely to have any effect on protecting forests or mitigating GHG emissions as a result of land management practices. But because indirect effects are not enforced against any other fuel in the proposed LCFS, an iLUC penalty will chill investment in both conventional and advanced biofuel production, including advanced biofuels made from dedicated energy feedstocks such as switchgrass and miscanthus, which have the potential to make the agricultural sector far less resource-intensive and could provide a significant carbon negative source of transportation fuel.

More than 20 scientists wrote to the ARB in June 2008 suggesting that more time and analysis is required to truly understand the iLUC effect of biofuels. In addition to iLUC, we know very little about the indirect effects of other fuels, and therefore cannot establish a proper relative value for indirect effects among the various compliance fuels and petroleum under the LCFS. In consideration of this and other rulemaking activities and research conducted since June 2008, we, the undersigned 111 scientists, continue to believe that the enforcement of any indirect effect, including iLUC, is highly premature at this time, based on the following two principles:

(1) The Science Is Far Too Limited and Uncertain For Regulatory Enforcement

ARB staff is proposing to enforce a penalty on all biofuels for indirect land use change as determined by a computable general equilibrium (CGE) model called GTAP. This model is set to a static world economic condition (*e.g.,* 2006), then shocked with a volume of biofuel to create the perceived land conversion result. The modeling outcome is applicable to the set of assumptions used for that particular run, but is not particularly relevant when there is a shift in policy, weather, world economic conditions or other economic, social or political variables. For example, by definition, these models assume zero innovation, which means they could not have predicted the 500% increase in corn yields since 1940, the tripling of wheat yields since 1960, or the 700% increase in yield that can occur if farmers in developing countries adopt higher yield seed varieties and more efficient farming practices. This inability to predict innovation is not limited to agriculture; similar attempts

to use economic equilibrium models in other emerging markets like telephony or computing would have been equally unsuccessful. As discussed, the model runs are unusually sensitive to the assumptions made by the modelers, which is why the iLUC modeling results published thus far differ by a factor of at least four, and under some scenarios, are actually zero for today's biofuels. Even at this late stage in the LCFS process, the GTAP model runs still do not reflect basic on-the-ground realities, such as the use of marginal and idle lands. They do not reflect recent articles about the potential for energy crops to absorb carbon at higher rates than previously thought. A partial solution to this problem is to conduct a series of model runs with different assumptions and adjustments. Unfortunately, this has not occurred at ARB (researchers have run limited sensitivity analysis within the current set of primary assumptions). We are only in the very early stages of assessing and understanding the indirect, market-mediated effects of different fuels. Indirect effects have never been enforced against any product in the world. California should not be setting a wide-reaching carbon regulation based on one set of assumptions with clear omissions relevant to the real world.

(2) Indirect Effects Are Often Misunderstood And Should Not Be Enforced Selectively

In basic terms, there is only one type of carbon impact from a commercial fuel: its direct effect. Direct carbon effects are those directly attributable to the production of the fuel, which in the case of biofuel includes the land converted to produce the biofuel feedstock. Indirect effects, on the other hand, are those that allegedly happen in the marketplace as a result of shifting behaviors. As such, penalizing a biofuel gallon for direct *and* indirect land use change is the equivalent of ascribing the carbon impact of land converted to produce biofuel feedstock as well as the land needed to produce another, allegedly displaced supply chain (*e.g.,* soy production for food). Leaving aside the issue of whether these effects can be predicted with precision or accuracy, or whether such a penalty is appropriate for the LCFS, it is clear that indirect effects should not be enforced against only one fuel pathway. Petroleum, for example, has a price-induced effect on commodities, the agricultural sector and other markets. Electric cars will increase pressure on the grid, potentially increasing the demand for marginal electricity production from coal, natural gas or residual oil. Yet, to date, ARB is proposing to enforce indirect effects against biofuel production only. This proposal creates an asymmetry or bias in a regulation designed to create a level playing field. It violates the fundamental presumption that all fuels in a performance-based standard should be judged the same way (*i.e.,* identical LCA boundaries). Enforcing different compliance metrics against different fuels is the equivalent of picking winners and losers, which is in direct conflict with the ambition of the LCFS.

Proponents of iLUC inclusion claim that all regulations are uncertain. This is true. However, the level of uncertainty implicated here far outweighs that found in other regulatory fields. For example, the European Parliament declared in December that the iLUC of biofuel "is not currently expressed in a form that is immediately usable by economic operators."[1] They decided not to incorporate iLUC penalties in their biofuel programs and initiated further analysis of the issue. It is also not enough to suggest that iLUC is a significant indirect effect, while other indirect effects are likely smaller. The magnitude of the alleged iLUC effect ranges from zero to very large, depending on the assumptions utilized. This is also likely true for other fuels, especially with regard to the marginal gallons of petroleum that are coming into the marketplace, such as heavy oil, enhanced oil recovery, and tar sands. Either way, even small effects are significant under the LCFS. Just a few g/MJ separate corn ethanol from petroleum in the proposed regulation, and advanced biofuel is very close to CNG and hydrogen under certain scenarios. We agree with the sentiment expressed by many experts that while indirect effects are important to understand, enforcing them prematurely and selectively on only certain fuels in a performance-based standard could have major negative consequences, even for GHG mitigation. Put another way, no level of certainty justifies asymmetrical enforcement of indirect effects.

Given the limited time, a reasonable solution to the challenges discussed above is to submit an LCFS regulation based on direct carbon effects (including direct land use impacts) and support a rigorous 24 month analysis of the indirect, market-mediated effects of petroleum and the entire spectrum of alternative fuels, regardless of source. The analysis could be conducted in collaboration with other institutions and governments implementing carbon-based fuel standards, and should include a consideration of the best way to prevent carbon effects outside the primary system

[1] *http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+TA+P6-TA-20080613+0+DOC+XML+V0//EN&language=EN#BKMD-27.*

boundary, including promoting sound land use practice with more direct policy solutions. This approach is consistent with the principle that all fuels should be judged through the same lens in a performance-based standard, as well as the approach taken by the European Parliament. It is worth noting that an LCFS policy based on direct effects already favors non-land intensive, advanced biofuel production over conventional biofuel production.

The LCFS provides an incredible opportunity to reduce the carbon intensity of transportation fuel and promote a more sustainable transportation fuel marketplace. We commend your leadership and the ARB staff for their ability to process a challenging set of scientific data resources into a workable regulation. However, it is critical that the LCFS stay on course with regard to its primary mission of establishing a level, carbon-based playing field for all fuels.

We are writing this letter as researchers in the field of biomass to bioenergy conversion, but the signatories do not represent the official views of the home institutions, universities, companies, the Department of Energy, the United States Department of Agriculture, or any of the National Laboratories. We look forward to working with ARB to ensure that the regulation reflects the best science available, and takes a policy approach that is balanced across all fuel pathways.

Sincerely,

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cc:

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LINDA ADAMS, *Secretary*, Cal-EPA;

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MIKE SCHEIBLE, *Deputy Director,* Air Resources Board;

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EXHIBIT 4

Truman National Security Project

March 24, 2009

To:
Hon. ARNOLD SCHWARZENEGGER,
Governor,
Office of the Governor,
Sacramento, CA

From:
Truman National Security Project
1420 K St NW Suite 250,
Washington, D.C.
www.trumanproject.org
202–216–9723

RE: National Security Concerns Regarding Selective Enforcement of Indirect Effects in CA LCFS

Dear Governor Schwarzenegger,

We are writing in regard to the California Air Resources Board's (ARB) continuing development of the Low Carbon Fuel Standard (LCFS). As the ARB approaches a final set of rules and regulations, we would like to comment on the deep connection between our reliance on carbon based fuels and our national security. We applaud California's leadership for being on the cutting edge of promoting cleaner fuel use, which we see as a critical component of bolstering American security. We are concerned, however, that the indirect land use change (iLUC) penalty for biofuels will have an adverse effect on our ability to develop alternative fuels. This in turn will prolong the United States' reliance on fossil fuels and deepen the damage caused by both our reliance on oil and by climate change.

While the push to include iLUC in the LCFS is well-intentioned, we believe it is misplaced. The science of indirect effects is far from precise, and the model on which the iLUC effect is based is highly variable depending on the assumptions of the individuals conducting the research. Put simply, the jury is out on the science of iLUC. Equally important is the fact that no other fuels are penalized for their indirect effects. Singling out one fuel source—in this case biofuels—puts that source at a comparative disadvantage, thereby undercutting new investment and the development of new technologies. Fossil fuels create indirect effects and negative externalities as well, but neither they nor any other fuel source face punitive measures as a result. Until the science of indirect effects is strong enough to create a standard by which all fuel sources can be judged, it would be unwise to single out any single fuel source *vis-à-vis* others. This is especially true in the case of fossil fuels, which would have an unfair advantage under the regulation if their indirect effect is assumed to be zero.

This is not simply a scientific or environmental matter. It is a matter of national security, which is threatened by our reliance on oil and the effects of climate change. That is why we, as former members of the United States Armed Forces and intelligence services are writing to you on this important subject. Biofuels play a critical role in breaking our dependence on oil and mitigating the impact of climate

change. The links between national security, fossil fuels, and climate change are many and they are severe.

- ***Our reliance on fossil fuels puts petrodollars in the hands of dictators and terrorists.*** Based on 2007 production estimates, a $5 increase in the price of crude oil will add $5 billion annually to the coffers of Venezuela, $7.5 billion to Iran, and $18 billion to Russia. This money allows these countries to act against the best interests of the United States. In 2008, U.S. counter-terrorism officials declared that Saudi Arabia, the world's top oil producer, remains the world's leading source of money for Al Qaeda and other extremist networks.
- ***Oil Kills Democracy.*** It's a simple fact that democracies rarely, if ever, go to war with one another. Unfortunately, oil kills democracy. There are twenty-three countries in the world whose oil and gas products constitute more than 60% of their total exports. None of these countries are democracies. Creating a world of more democratic states in which leaders cannot keep their populations at bay with petrodollars requires a world in which fewer fossil fuels are consumed.
- ***Protecting the world's oil infrastructure costs U.S. taxpayers billions.*** The United States is responsible for patrolling the world's sea lanes and ensuring safe passage for seaborne commerce, much of which is oil products. The U.S. Navy is budgeting $28.1 billion for operations alone in 2009. A significant portion of this outlay is to make sure oil flows are not interrupted.
- ***The Cost of Oil Places Undue Stress on the U.S. Military.*** Every time the price of oil increases by $10 per barrel, the Department of Defense is forced to spend another $1.3 billion on fuel—that's the equivalent of the Marine Corps' entire annual procurement budget. Fuel efficiency also has life and death consequences: seventy percent of battlefield tonnage is attributed to transporting fuel. Attacks on fuel convoys in both Iraq and Afghanistan have become a major cause of U.S. casualties. A more fuel-efficient military would save the U.S. billions of dollars and untold lives.
- ***Climate Change Places Undue Stress on the U.S. Military.*** One the most drastic effects of climate change is an increase in the intensity and frequency of tropical storms. Hurricane Katrina proved how devastating this can be not just for our civilian population, but also for our armed services. Military units were needed to respond to the storm, and the cost of repairing the damage to the Pascagoula Naval Station in Mississippi reached several billion dollars. These are resources that could have been better spent on improving intelligence, hunting down terrorists, or sending critical equipment to our troops in Iraq and Afghanistan.
- ***Climate Change Creates Political Instability and Acts as a Catalyst for Failed States and Terrorism.*** Climate change causes drought, the disappearance of drinking water, and a rise in sea levels. Billions of people live near coastal plains that could easily end up underwater. This would cause the mass-migration of millions of people and create ungoverned spaces where terrorists can flourish, just as they did in Afghanistan in the 1990s and just as they currently do in Somalia. Competition over resources, which increases with drought and dwindling water supplies, can also lead to violence. The most tragic evidence of this is the conflict in Darfur, where competition between herders and farmers for land sparked a genocidal conflict that has claimed the lives of 400,000 people.

Having served in uniform ourselves, there is nothing we take more seriously than the safety and well-being of our country. We are calling on the State of California to lend us a hand in keeping America safe by enacting a fuel regulation that is unbiased and does not enforce indirect carbon effects against only one type of fuel. There is no silver bullet to the energy and security challenges we face, but biofuels have a crucial role to play. We hope California will continue to be a national leader in energy issues and allow biofuels to play that role.

Sincerely,

ROBERT "BUD" MCFARLANE,
National Security Advisor to President Ronald Reagan,
Lieutenant Colonel, U.S. Marine Corps, 1959–1979;

WILLIAM C. HOLMBERG,
Chairman of the Biomass Coordinating Committee,
American Council on Renewable Energy,
Lieutenant Colonel, U.S. Marine Corps (Retired), 1951–1970;

DAVID R. ADAMS,

Corporal, U.S. Marine Corps & ARNG, 1978–1988;
WILLIAM BANTA,
Major, U.S. Marine Corps, 1951–1961;
MERTON J. BATCHELDER, JR.,
Captain, U.S. Marine Corps, 1951–1959;
RYE BARCOTT,
Captain, U.S. Marine Corps, 2001–2006;
JOHN L. BERMAN,
Captain, U.S. Air Force, 1951–1955;
JOSEPH E. BLES,
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HERBERT W. BRUCH,
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VIVIAN T. CHEN,
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PAUL CLARKE,
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CHARLES G. COOPER,
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ROBERT DIAMOND,
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Captain, U.S. Marine Corps, 2001–2007;
CHRISTOPHER FINAN,
Captain, U.S. Air Force, 2000–2007;
JOEL N. GORDUS,
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WILLIAM E. HUTCHISON,
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ERICA JEFFRIES,
Captain, U.S. Army, 1998–2003;
TED KAEHKER,
Commander, U.S. Navy (Retired), 1984–2006;
LELAND S. KOLLMORGEN,
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GERALD E. KUECKER,
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PETER LOHMAN,
Captain, U.S. Army, 2001–2005;
WILLIAM R. MALONEY,
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WILLIAM T. MARIN,
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MELISSA EPSTEIN-MILLS,
Captain, U.S. Marine Corps, 2002–2006;
JAMES MORIN,
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Captain, U.S. Navy (Retired), 1954–1984;
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Captain, U.S. Army, 2000–2008;
DOUGLAS RAYMOND,
Captain, U.S. Army, 1995–2000;
BROOKE F. READ, JR.,
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ALEX ROSSMILLER,
Intelligence Officer, Defense Intelligence Agency, 2004–2006;
FREDERICK M. RUTHLING,
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ERIK SAAR,
Sergeant, U.S. Army, 1998–2004;
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JOHN S. STORM,
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Specialist 4, U.S. Army, 1969–1970;
ORRIE D. SWAYZIE,
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MAURA SULLIVAN,
Captain, U.S. Marine Corps, 2001–2006;

GEORGE R. THOMAS,
Lieutenant (JG), U.S. Navy, 1959–1962;

GEORGE M. VAN SANT,
Colonel, U.S. Marine Corps (Retired), 1945–1977;

KAYLA WILLIAMS,
Captain, U.S. Army, 2000–2005;

THOMAS R. ZAJAC,
Corporal, U.S. Army, 1950–1954;

EXHIBIT 5

New Fuels Alliance

October 23, 2008

MARY D. NICHOLS, *Chairman,*
California Air Resources Board,
Headquarters Building,
Sacramento, CA.

Dear Chairman Nichols,

We, the undersigned 30 companies and individuals, are writing to provide comment on the prospect of including indirect land use change (ILUC) in the California Low Carbon Fuel Standard (LCFS), and in general, to discuss the public policy implications of enforcing indirect effects of any kind in the regulation. This letter is submitted in response to comments submitted to the Air Resources Board (ARB) on the issue of ILUC over the past several months, including at the most recent public workshop held on October 16th.

First and foremost, we recognize that promoting the production and use of biofuels could help achieve domestic and global sustainable development goals, but that there are challenges associated with growing the biofuels industry in an environmentally responsible way. While the growth of crop-based biofuels should not be allowed to exacerbate sensitive land degradation here or abroad, there is nonetheless an opportunity to promote positive land use development in the context of both conventional and advanced crop-based biofuels. As such, it is important that the LCFS be careful in its regulatory approach if it is to foster sustainable fuel production.

The argument in favor of including ILUC in the LCFS is based on the belief that biofuels have significant indirect land use impacts, and ignoring them is the wrong public policy decision. The argument against including ILUC in the LCFS is based on the belief that the field of ILUC—and perhaps indirect impact modeling in general—is too uncertain to regulate at this time.

The public policy decision to extend the scope of the LCFS from direct to indirect, market-mediated effects is a monumental one. This is true for land use change, or any other indirect effect. Direct impacts are relatively certain, verifiable and attributable to specific types of fuels. This is true because these effects are directly related to and traceable to the production, transportation and combustion of those fuels, including upstream land use change attributable to fuel production, such as the conversion of pasture to corn or other biofuel feedstock.

Indirect impacts, on the other hand, are market- and policy-mediated. They are, in essence, the ripple effects of any given market decision in the global economy. Indirect impacts have not been enforced by any regulatory agency against any product in the world. Indirect impacts, whether applied to biofuels or any other fuel, occur as a consequence of a myriad of nested, policy and socioeconomic variables. An article published in *BioScience Magazine* captures the complexity of indirect effects, as they relate to deforestation: "[a]t the underlying level, tropical deforestation is . . . best explained by multiple factors and drivers acting synergistically rather than by single-factor causation, with more than one-third of the cases being driven by the full interplay of *economic, institutional, technological, cultural and demographic variables.*"[1] This review of land change science goes on to conclude that it has proven difficult to achieve a theory of coupled land use changes that lead to useful, predictable outcomes for this highly complex process. Similar approaches have led to strikingly different outcomes depending on location, scale and other complex factors, making prediction uncertain.

[1] Helmut J. Geist & Eric F. Lambin, *Proximate Causes and Underlying Driving Forces of Tropical Deforestation,* BIOSCIENCE MAGAZINE, Volume 52, No. 2 (Feb. 2002).

It may be possible to model these impacts over time, so we should not abandon the idea of developing the science. But it is also true that no model today comes close to capturing the interplay of economic, institutional, technological, cultural and demographic variables inherent with quantifying the indirect impact of any fuel. In fact, the economic equilibrium models being offered as the mechanisms to quantify (and perhaps enforce) ILUC in the LCFS were not designed for regulatory use—*i.e.,* to assign specific compliance metrics to specific fuels. They were designed to analyze the impacts of policies in more general terms. Using a model to publish a paper is very different than using a model to assign specific values that could fundamentally change the business landscape for alternative energy companies. As indicated in a 2008 GTAP paper on biofuels, referenced by the ARB LCFS website under GTAP peer review: "researchers have begun to use a CGE (computable general equilibrium) framework [to assess biofuels], however, with several caveats such as lack of incorporating policy issues, absence of linkages to other energy markets, and land use changes, *etc.* Our study makes an attempt to address these issues. However, the studies on CGE modeling are few, largely due to the *infancy of the industry and limitations on the availability of data* [emphasis added]." [2]

We are aware that proponents of including ILUC in the regulation argue that a preliminary quantification of ILUC is better than ignoring the impact all together; that "zero" is not the right number for ILUC for biofuels. While it is likely true that zero is not the right number for the indirect effects of any product in the real world, enforcing indirect effects in a piecemeal way could have very serious consequences for the LCFS. For example, zero is also not the right number for the indirect impact of producing a gallon of petroleum, using more electricity from coal and natural gas, producing advanced batteries and hybrid vehicles, or commercializing fuel cell technology. Yet, to date, ARB has not devoted any significant LCFS rulemaking resources to investigating the indirect effects of other fuels. If ARB is to enforce indirect, market-mediated effects, they must be enforced against all fuel pathways. The argument that zero is not the right number does not justify enforcing a different wrong number, or penalizing one fuel for one category of indirect effects while giving another fuel pathway a free pass.

Proponents of ILUC inclusion insist that they know enough about ILUC to enforce it in a fuel regulation. For example, the June 26 UC letter defending ILUC inclusion states that ILUC is more certain than claimed because the analysis conducted to date utilizes peer-reviewed models like FAPRI and GTAP. However, the fact that these models are peer-reviewed should not be inferred to mean that they have been peer-reviewed to be used for the purpose of enforcing indirect effects against specific fuels in a carbon-based fuel regulation. CGE models like GTAP provide estimates of land use change in distant locations, but at the price of severe limits in accuracy and at the expense of a realistic inclusion of complex causes of land use change. It seems that the desire for the utility of CGE models has overwhelmed the need for accuracy in estimating ILUC effects. The outcome could be poor public policy in the early stages of an unprecedented yet incredibly important transition in our liquid transportation fuel economy.

The June 26 UC letter also does not acknowledge the depth of uncertainty of predicting market-mediated effects of any kind, or the status of current research into this vast scientific space. For example:

- The current ILUC analysis for biofuels is very limited in scope. The public discussion has thus far been limited to the reductive effect of corn ethanol demand on world agricultural markets, and the possible conversion of relatively pristine lands that could occur from agricultural expansion. In addition, ARB has commented that non-corn energy crops (*e.g.,* for cellulosic ethanol) will have a similar land use ripple effect if, in fact, land is used. But the analysis has not investigated the possible counter-balancing effect (*i.e.,* benefits) of increased biofuel production, whether related to more sustainable agricultural land use and crop shifting, decreased urbanization, or the market-mediated effects of additional fuel supplies. Simply by increasing the profitability of agriculture, both domestically and overseas, biofuel production can have many positive effects on farmers and farming systems. In Californian, profitability helps farmers resist the pressures to transfer irreplaceable cropland to urban development, among other benefits. Given that land use change comes as a result of the interplay of so many variables, the exclusive focus on the reductive land use effect is of great concern.
- The modeling scenarios publicized to date have severe data and technical shortcomings. While it is true that the GTAP model is peer-reviewed, it is also well

[2] See *https://www.gtap.agecon.purdue.edu/resources/download/4034.pdf,* p. 3.

recognized that any model is only as good as the inputs used. For example, the UC letter states that they are using the "state-of-the-art" GTAP model to perform ILUC analysis for corn ethanol. The GTAP results were largely similar to those released by another researcher using the FAPRI model. But the UC letter fails to mention that they used the same land use conversion emissions data—a single set of data from the 1990s—for both exercises, without any apparent additional analysis or verification. So it should not be surprising that the results are largely the same. Other land use emissions studies have shown a tenfold difference in land conversion emissions depending on what assumptions are used. In another example, the GTAP model does not include inputs for idle or CRP lands. This is a concern for two obvious reasons: (1) idle lands will be the first to be converted under any reasonable land conversion scenario; and, (2) any model that does not include idle and CRP land will produce exaggerated forest effects because the major points of domestic agricultural land use expansion are disabled. Lands in developing countries without clear rents (economic values in a marketplace) cannot be analyzed in GTAP. This includes much one-time cropland that is not accounted for or included in the GTAP estimates of effects. The preliminary ILUC numbers reviewed to date have been described as robust by several researchers involved, but an analysis that does not include the major points of domestic and international agricultural land expansion is not robust. It is important to note that the amount of U.S. agricultural land acreage dedicated to all crops, and coarse grains in particular, has generally declined during the last several decades while agricultural output has increased. It is also important to note that U.S. corn acreage has decreased in 2008. Historically in North America, advances in crop production technology correlate to the stabilization of forest use and a steady increase in forested acreage over the last century. Biofuel production, if carefully developed, could lead to a similar process in many third world settings, and the opposite effect of that feared. These considerations put into serious doubt the fundamental assumption that increased demand for crop-based products necessarily increases acreage planted.

- None of the available models being utilized for ILUC analysis are capable of taking into account the "interplay of economic, institutional, technological, cultural and demographic variables" inherent with land use change. For example, the GTAP figures presented by ARB staff on June 30 were neither sensitive to U.S. Federal biofuels policy, which contains land use provisions designed to discourage certain types of land conversion, nor the energy or land use policies in those countries where the land conversion allegedly takes place in the scenarios modeled. This means that the ILUC scenarios do not (and cannot) take into account variables that would fundamentally change the outcome of the given modeling exercise, even directionally. Among the many variables driving deforestation and other forms of land use change are domestic and international policy, infrastructure development (including roads for oil and timber extraction), soil quality, topography, droughts, floods, wars, domestic cost of labor/land/fuel or timber, population and migration, urbanization and poverty. A recent paper published by the National Academy of Sciences (NAS) notes that, ". . . no facet of land change research has been more contested than that of cause. Empirical linkages between proposed causal variables and land change have been documented, but these commonly involve the more proximate factors to the land-outcome end of complex explanatory connections, such as immigrant, subsistence farmers and deforestation or locally configured common property resource regimes and land degradation. The distal factors that shape the proximate ones, such as urban poverty or national policies, tend to be difficult to connect empirically to land outcomes, typically owing to the number and complexity of the linkages involved. Attention to proximate causes elevates the potential to commit errors of omission . . . ."[3] In trying to ascribe specific, numerical (CO_2 e g/MJ) land use impacts to specific types of biofuels, ARB and UCB staff are in essence attempting to disentangle nested variables when it is the cumulative effect of these factors that cause the net outcome of land use change. This may be useful for policy analysis, but is far more dangerous as a methodology for assigning specific indirect land use change values to specific fuels within in a small fraction (CA ethanol) of one sector (motor fuels) of the global economy.
- The noticeable lack of indirect effects analysis for other fuels, particularly oil, is of serious concern. ARB staff has mentioned the possibility of an ILUC analysis for petroleum, but land use is only a part of the overall indirect carbon ef-

[3] B.L. Turner II, Eric F. Lambin, Anette Reenberg, *The emergence of land change science for global environmental change and sustainability,* PNAS vol. 104, no. 52 (Dec. 26, 2007).

fect of oil. The indirect effects of unmitigated petroleum consumption, in a world economy largely dictated by petroleum and energy indicators, are vast. For example, noted agricultural economist (and architect of the GTAP model) Wally Tyner recently concluded that 75% of the run-up in *corn prices* is due to increased oil prices. Advocates for ILUC inclusion argue that higher corn prices cause crop shifting toward corn and away from soybeans, which drives up the price of soybeans and attracts Brazilian (rainforest) acres to soybean production. However, the UC researchers appear more inclined to ascribe the carbon effects of this theoretical causal chain to biofuels rather than to oil. It remains unclear, in a space characterized by many layers of interrelated effects, whether ascribing this effect solely to biofuels is correct. If the rising price of agricultural commodities is a concern—as the catalyst for additional planting—it is now clear that oil prices have a profound effect on agricultural commodity markets. There are also market- and policy-mediated effects for electrification from coal and natural gas, hydrogen production from coal and natural gas, and hybrid production.

- The June 26 UC letter posits the argument that underestimating ILUC for biofuels is probably worse than overestimating ILUC since underestimating ILUC would create incentives for the overproduction of crop-based biofuel. The obvious implication is that without ILUC penalties for biofuels, we may face a runaway, unfairly advantaged crop-based biofuels industry with potentially serious land use impacts. This position seems out of touch with the realities of the U.S. transportation fuels industry. Roughly 86% of the Federal subsidies handed out to energy companies between 2005 and 2009 will go to fossil fuel companies. A recent report out of Purdue University (by an author of the GTAP model) concluded that the price of oil is primarily responsible for the increased price of grains, including corn. The increasing price of agricultural commodities has put enormous strain on the conventional biofuels industry, suspending production at dozens of plants. The initial LCFS Policy Analysis published in August 2007 recognized that the new, low-carbon transportation fuels needed in California are at a disadvantage because they "compete on a very uneven playing field: the size, organization and regulation of these industries are radically different." It is difficult to see how enforcing even conservative indirect effects against biofuels, especially while not enforcing any indirect impacts against other fuels (as is the current LCFS trajectory), would unfairly incent crop-based biofuels. More likely, it will perpetuate the *status quo,* and continue California on a path toward (increasingly less sustainable) oil dependence. It is also instructive to point out, as the LCFS Policy Analysis did in August 2007, the duality of California's climate policy: to encourage investment and improvement in current and near-term technologies, while also stimulating innovation and the development of new technologies. To this end, it is imperative that the LCFS value and devalue all fuels equitably, so as not to exacerbate an already uneven playing field for alternative fuels.
- The fundamental assumption of the current ILUC argument—that using an acre of land in the U.S. for fuel will require almost an acre of crop development somewhere else—produces questionable results when applied to "good" public policy initiatives. For example, under the same assumption it is possible that setting aside land for the Conservation Reserve Program (CRP) creates more carbon emissions, because it takes agricultural acreage out of domestic food and feed production, which results in agricultural cultivation of grasslands and deforestation abroad. It is possible that other land protection policies, including national parks and wilderness areas, also fail the "zero sum" land use assumption because they take timber and agricultural land out of traditional production. By the "zero sum" standard, any land conservation policy in California or the United States exports pollution (or creates ILUC) elsewhere.
- Enforcing indirect impacts using the methodology envisioned by ARB may produce questionable market behaviors. ARB has discussed having a "non zero" land use change attribution (*i.e.,* penalty) in the LCFS for certain broad categories of fuels (*e.g.,* corn ethanol, biodiesel, cellulosic ethanol, *etc.*). However, it is generally accepted that different regions have different tolerances for increased agricultural production, as well as different indicators for agricultural products based on weather, supply/demand, annual plantings, *etc.* Yet, agricultural expansion in a region that can tolerate it pays the same ILUC price under the LCFS as expansion in regions that cannot tolerate intensification. And both farmers, irrespective of the efficiency or sustainability of their crop, pay for theoretical environmental damages abroad that they have no control over. The public policy proposal to penalize products for decisions and trends far outside of

their sector and control is a major one, may not produce the desired behavioral effect, and should endure a substantial public review process.

- We are not sure that ARB is applying the principle of indirect effects enforcement in a balanced and consistent way. For example, ARB staff has made clear their inclination to debit all crop-based ethanol for ILUC, irrespective of the type or location of the land used for production. However, on the subject of tar sand petroleum use by oil companies, ARB staff has implied only that oil companies will be debited *if they use tar sands in California.* Put another way, the penalty for biofuels is automatic while the penalty for oil can be avoided by redistributing its product. This creates obvious compliance inequities, but also questionable climate accounting in the marketplace. Oil companies will simply use lighter crude in California to escape penalty under the LCFS. But this decision will short supply of light crude elsewhere and increase the demand for tar sands and other resource intensive crude with obvious climate impacts. Requiring oil companies to account for tar sands use abroad is the definition of a market-mediated effect. Yet ARB seems more inclined to enforce market-mediated effects against ethanol, for land use change, than indirect effects against oil companies for heavy crude and tar sands.

To be clear, the renewable fuels industry supports the ongoing effort to better understand the indirect effects of the energy choices we make. But the enforcement of indirect effects of any kind, given the complexity and relative infancy of the field, must be done carefully and in a balanced way. Some members of the UC scientific community want to include ILUC in the LCFS. But this is not a consensus position. In addition to the 27 signatories of the June 24 letter to ARB, Dr. Michael Wang of Argonne National Laboratory, one of the foremost experts in lifecycle carbon assessment (LCA) field and author of the GREET model being used as the framework for the LCFS, recently stated, "indirect land use changes are much more difficult to model than direct land use changes. To do so adequately, researchers must use general equilibrium models that take into account the supply and demand of agricultural commodities, land use patterns, and land availability (all at the global scale), among many other factors. Efforts have only recently begun to address both direct and indirect land use changes . . . [w]hile scientific assessment of land use change issues is urgently needed in order to design policies that prevent unintended consequences from biofuel production, conclusions regarding the GHG emissions effects of biofuels based on speculative, limited land use change modeling may misguide biofuel policy development."[4] The signatories of the June 24 letter expressed similar concerns.

The UC letter signatories dismiss the rationale that ILUC be left out of the LCFS at this time based, in essence, on the assertion that ILUC exists. As stated, all fuels and products have indirect carbon impacts. Yet, zero may in fact be the right number for "indirect effects" for all fuel pathways in the first version of the LCFS from a public policy perspective if: (1) ARB and UC cannot enforce scientifically defensible numbers because of the lack of verifiable or reliable data or an incomplete understanding of the full spectrum of indirect effects across all fuel pathways; and/or, (2) there are serious unanswered public policy questions about the merits of enforcing indirect effects in a performance-based carbon regulation; and, (3) there is no accounting for the foregone public benefits of domestic and international biofuel development, or for the export of pollution to other locations on a strict LCFS policy with high penalties for domestically produced biofuels. To this latter point, it is worth noting in any discussion about market-mediated, indirect effects the potential to destabilize the advanced biofuels sector with overly aggressive or inequitable compliance metrics against conventional biofuels. It is well understood that conventional biofuels are a cornerstone for the development of advanced biofuels, which includes infrastructural, political, market acceptance and investment risk considerations. Enforcing additional compliance metrics against conventional biofuels will not accelerate the commercialization of advanced biofuels.

Notwithstanding the challenges ahead, our industry is eager to be an early actor under the regulation and looks forward to the ongoing formulation of the LCFS rule. We strongly agree with the UC researchers that the challenge that comes with ushering in new technical, economic, social and environmental areas of inquiry and action is of balancing further study with implementation. But we do not agree that throwing uncertain numbers at selected fuels under the LCFS will create a positive outcome for either the environment or the LCFS policy itself.

[4] See *http://www.transportation.anl.gov/pdfs/letter__to__science__anldoe__03__14__08.pdf.*

We would be happy to address questions or concerns you may have, and appreciate your leadership on this important endeavor.

Sincerely,

BROOKE COLEMAN,
Executive Director,
New Fuels Alliance;

VINOD KHOSLA,
Khosla Ventures;

CARLOS RIVA,
Chief Executive Officer,
Verenium Corporation;

NEIL KOEHLER,
Chief Executive Officer,
Pacific Ethanol;

COLIN SOUTH,
President,
Mascoma Corporation;

NECY SUMAIT,
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RAHUL IYER,
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RICHARD W. HAMILTON,
President & CEO,
Ceres, Inc.;

RICHARD GILLIS,
President & Chief Executive Officer,
Energy Alternative Solutions, Inc.

cc:
Governor ARNOLD SCHWARZENEGGER,

DAVID CRANE, *Special Advisor for Jobs & Economic Growth,* Office of Governor Schwarzenegger,

LINDA ADAMS, *Secretary,* Cal-EPA,

A.G. KAWAMURA, *Secretary,* California Department of Food & Agriculture,

MIKE SCHEIBLE, *Deputy Director,* Air Resources Board,

KAREN DOUGLAS, *Commissioner,* California Energy Commission.

EXHIBIT 6

April 15, 2009

MARY D. NICHOLS,
Chairwoman,
California Air Resources Board,
Headquarters Building,
1001 "I" Street,
Sacramento, CA.

Dear Chairwoman Nichols,

We, the undersigned advanced and cellulosic biofuel companies, are writing to provide our collective comments on the Proposed Regulation to Implement the Low Carbon Fuels Standard (LCFS).

First, we commend the state of California for its exemplary vision and leadership in developing energy policies that aspire to reduce greenhouse gas emissions, decrease our reliance on fossil fuels, and stimulate the economy. The Initial Statement of Reasons (ISOR) says the LCFS is designed to ". . . create a lasting market for clean transportation technology, and stimulate the production and use of alternative low-carbon fuels in California." We agree that these policy goals are both admirable and absolutely critical to the future of our nation. However, we are greatly concerned that because the draft regulation creates an unlevel playing field for both first- and second-generation biofuels, these goals ultimately will not be reached.

Because the LCFS is structured as a performance-based regulation, fair determination of a fuel's lifecycle carbon intensity is critically important. Lifecycle anal-

ysis serves as the foundation of any performance-based, technology neutral regulation. As such, it is essential that ***all*** regulated fuels are evaluated using the same analytical boundaries. Unfortunately, the Air Resources Board's (ARB) analysis uses asymmetrical boundaries to assess the carbon intensity of various fuels. Specifically, biofuels from any feedstock grown on land are penalized for a highly uncertain and unproven market-mediated effect known as indirect land use change, while petroleum and other fuel types are assumed not to cause any indirect carbon effects or market-mediated impacts. One important indirect petroleum effect that must be acknowledged is the long-term impact of not immediately beginning to diversify away from fossil fuels. Failure to transition away from fossil fuels will result in increased demand for conventional oil, which depletes those sources faster today and accelerates the need for higher greenhouse gas fossil hydrocarbons (*e.g.,* tar sands and oil shale) tomorrow.

Supporters of enforcing indirect land use effects against biofuel often suggest that this policy decision is necessary to help encourage advanced biofuel production. In fact, in a November 2008 news article, ARB member Dan Sperling stated, "I really think these biofuels producers should appreciate that this is going to help them, especially those that use cellulosic or biomass feedstocks."[1] We have a distinctly different point of view. We are concerned that the inclusion of indirect effects penalties for biofuels, and other inequalities in the LCFS, will erode investor confidence and market certainty for both first *and* second-generation biofuels. Contrary to the belief held by some, producers of next generation biofuels such as cellulosic ethanol *are* not supportive of selectively including indirect effects in the LCFS. The successful development, commercialization, and sustained production of second-generation biofuels is largely contingent upon continued market opportunities for the first generation of biofuels. Securing financing for second-generation biofuels projects in today's economy is challenging enough; but the negative signal sent to potential investors by the enforcement of selective and questionable penalties against biofuels may be insurmountable.

Artificially limiting the use of first generation biofuels may inadvertently close the door to future renewable fuels. Over the past 30 years, the first-generation ethanol industry has established robust transportation and storage infrastructure; cultivated an investment base and created financial networks; advocated policies that create market certainty; and, more generally, raised the nation's collective experience level related to introducing renewable fuels into a market dominated by fossil fuels. It is also critical to understand that some conventional biofuel companies are also some of the largest investors in cellulosic ethanol. We view the transition to second-generation biofuels as being evolutionary rather than revolutionary.

Many of us were signatories of an October 2008 letter to ARB Chairwoman Mary Nichols from second-generation biofuels companies, researchers, and organizations. The letter clearly stated, ". . .we do not agree that throwing uncertain numbers at selected fuels under the LCFS will create a positive outcome for either the environment or the LCFS policy itself."[2] The letter further suggests, ". . . no model today comes close to capturing the interplay of economic, institutional, technological, cultural and demographic variables inherent with quantifying the indirect impact of any fuel." Our position on these issues has not changed.

ARB's use of vastly different boundaries for different fuels is clearly demonstrated by the cursory assessment of the direct land impacts of crude oil operations. ARB examined the direct land impacts of *only* California oil fields, while ARB's boundaries for biofuels analysis are *global* in scope and include indirect carbon effects. ARB's analytical boundary for oil's direct land impacts might be justifiable if California produced all of the oil it consumes. However, more than 60% of the oil consumed in California is imported from outside of the state. Further, there is no evidence that ARB conducted a comprehensive analysis of the indirect, market-mediated impacts of oil imported or produced in the state. Preliminary analysis presented by Life Cycle Associates to ARB in January indicated several potential sources of indirect and direct GHG emissions associated with oil production that have been overlooked in ARB's analysis and most other traditional lifecycle analyses. Examples of these emissions include methane from flaring, methane from tailing ponds, and emissions associated with some refinery byproducts. The report said that other fuels could—and should—be run through economic models and other analytics to test for indirect effects. This has not been done.

[1] Lamb, Celia. "Biofuels makers object to state's proposed standards for cleaner fuel." *Sacramento Business Journal.* November 7, 2008.

[2] Letter to Chairwoman Mary Nichols. *http://www.arb.ca.gov/lists/lcfs-lifecycle-ws/46-arb__luc__final.pdf.*

Next-generation biofuels producers agree with the 111 scientists and academics from California and other states who recently submitted a letter to Governor Arnold Schwarzenegger, stating, "Leaving aside the issue of whether these [indirect] effects can be predicted with precision or accuracy, or whether such a penalty is appropriate for the LCFS, it is clear that indirect effects should not be enforced against only one fuel pathway." The letter's signatories, including members of National Academies of Sciences and Engineering, further stated that the proposal ". . . creates an asymmetry or bias in a regulation designed to create a level playing field. It violates the fundamental presumption that all fuels in a performance-based standard should be judged the same way." [3]

We think it is important to recognize that due to the highly uncertain nature of indirect land use change modeling and the lack of consensus on methodology, European institutions recently decided to postpone inclusion of indirect land use change as a factor in determining the carbon intensity of biofuels in the European Union (EU) Renewable Energy and Fuels Quality Directive.[4] Rather, the EU institutions directed the initiation of a 2 year study aimed at gaining a better understanding of the land impacts of biofuels and methods for minimizing land effects. We believe ARB should consider a similar 2 year study period and coordinate fully with EU officials and U.S. Environmental Protection Agency to develop a methodology for analyzing indirect effects that is uniform, validated, and scientifically sound.

We are also greatly concerned by the ISOR's premature presentation of insufficient and questionable analysis on the land use change impacts of cellulosic feedstocks. In the ISOR, cellulosic crop-based biofuels are assumed to induce indirect land use change emissions of 18 g CO_2-eq./MJ. There is very little research and virtually no modeling to support this initial conclusion. In fact, ARB's indirect land use change assessment for cellulosic biofuels relies almost entirely on a few pages of information from an unpublished, un-reviewed paper by Purdue University researchers. The Purdue authors themselves characterize the analysis as a "very rough picture" of the potential land impacts of cellulosic feedstocks. While ARB characterizes the cellulosic indirect land use change value as preliminary in nature, publishing the result at all will establish a view of cellulosic biofuels that may be significantly disconnected from reality. We also question ARB's selection and use of specific assumptions. For example, ARB assumes average cellulosic feedstock ethanol yields will be 250 gallons/acre. Published literature and data from field trials suggest commercial-scale ethanol yields will be much higher.

In closing, we strongly encourage the ARB to continue to refine and improve its lifecycle modeling framework. We also believe the methodology and ARB's results must be further peer-reviewed by a multi-disciplinary group of disinterested economists, climate change scientists, soil scientists, plant biologists, and other experts. This has not yet been done. We strongly recommend the delay of inclusion of indirect effects in the LCFS regulation until more appropriate analytical tools are developed and rigorous peer review is conducted. Additionally, if ARB is truly committed to fairly enforcing market-mediated effects on a level playing field, the Board should immediately initiate a comprehensive research effort that examines the indirect effects of all fuels.

We sincerely appreciate the opportunity to provide comment and look forward to continuing to work with ARB to develop a workable policy that achieves the state's ambitious, but attainable, carbon reduction goals.

Sincerely,

Abengoa Bioenergy,
BioEnergy International, LLC,
BlueFire Ethanol Fuels, Inc.,
California Ethanol & Power, LLC,
Ceres, Inc.,
Coskata,
Iogen Corporation,
Novozymes,
Pacific Ethanol,
Qteros, Inc.,
Verenium,
ZeaChem Inc..

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[3] Letter to Gov. Arnold Schwarzenegger. *http://www.arb.ca.gov/lists/lcfs-lifecycle-ws/74-phd_lcfs_final_feb_2009.pdf.*

[4] See *http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+TA+P6-TA-2008-0613+0+DOC+XML+V0//EN&language=EN#BKMD-27.*

EXHIBIT 7

April 21, 2009

MARY D. NICHOLS, *Chairman,*
California Air Resources Board,
Headquarters Building,
1001 "I" Street,
Sacramento, CA.

RE: Investor Concerns About Enforcement of Indirect Effects in the CA LCFS

Dear Chairman Nichols,

As members of the California clean energy investment community, we appreciate the opportunity to comment on the proposed California Low Carbon Fuel Standard (LCFS), and specifically, to discuss the critical issue of how to address concerns about indirect effects under the regulation.

As a general matter, we commend your leadership and that of the Schwarzenegger Administration in acting to reduce the carbon intensity of California transportation fuels. Most importantly, we support your focus on a performance driven regulation that provides important predictability for clean fuel investors, and attempts to avoid picking winners and losers. As leading investors in advanced biofuels and other transportation solutions, we are sensitive to the need to promote the lowest carbon and most sustainable solutions. In reviewing the LCFS proposal dated March 5, 2009 we noted that the Air Resources Board (ARB) plans to score the different compliance fuels based on their direct "cradle to grave" carbon effects. It also appears that ARB plans to enforce an additional carbon penalty on biofuels for "indirect land use change (iLUC)" based on newly evolved economic modeling. We the undersigned, have significant concerns about the current use of iLUC and its selective application to biofuels.

As investors in a range of low carbon fuel technologies, we want to ensure that fuel options are treated equally and scored with the same level of accuracy, including the petroleum fuel baseline. This is important so that we can invest with a clear understanding of the performance of a particular fuel option under an LCFS. Indirect effects of all kinds, not just land use change, may have significant impacts on the footprint of each fuel option and its viability under an LCFS. Our primary concern is that if indirect effects are included in the regulation that they be studied with equal scope and effort across all fuels before they are applied to any fuels. The current approach, which selectively adds iLUC to biofuels, reduces the carbon benefits of both advanced and conventional biofuels, but leaves significant uncertainty about how the other alternatives will be treated under the regulation and whether the number assigned to biofuels will hold up under further review. This will likely have a significant chilling effect on the development of lower carbon fuels, including advanced biofuels.

At a basic level, we also have increasing concerns about the validity of current indirect effects modeling—specifically for "land use change", which is the only effect currently modeled for the LCFS. According to a wide range of scientific experts in the field, many of whom expressed their concerns about the selective enforcement of indirect effects in a letter dated March 2, the underpinnings of the current iLUC methodology are problematic and may be proved faulty under closer scrutiny.

First, we are concerned that the model itself—called GTAP—is not yet peer-reviewed for its new application as a predictive carbon model, and that GTAP has a documented history of being imprecise. "Indirect land use change" is an outcome derived by adding a predetermined amount of biofuel demand to a static, preset economic model, which in turn projects the potential "price induced" expansion of the agricultural sector onto additional land. It is a useful academic exercise, but as a price model it cannot account for the profit margins that drive real world decision making. As a result, the model is likely to over estimate effects that in reality would be mitigated by market forces, or produce estimates that in many cases are simply wrong. *For example, in prior applications of the GTAP methodology, the model predicted changes in land use between 2001 and 2006 that were actually the opposite of the real-world changes observed over time.*[1] Unfortunately, ARB is currently rely-

[1] In an earlier analysis of the impact of biofuels on U.S. land use patterns, researchers at Purdue using GTAP concluded the harvested area for coarse grains like corn would increase 8.3% from 2001 to 2006, U.S. harvested area for oilseeds like soybeans would decline 5.8%, and forested area would decline 1.5% during the same period. In actuality, coarse grain harvested area

Continued

ing on this overly simplified modeling methodology to assign indirect land use change penalties that will have very real commercial implications. It is our belief that the modeling methodology needs to be improved and further validated to a point where the level of uncertainty is more akin to other regulatory standards. For example, ARB's on-road emissions model (EMFAC) has been validated by real world carbon monoxide data based on ambient air monitors in tunnels. Conversely, there has been little attempt to validate the inputs or outputs used for the GTAP analysis. There are indications that some of their assumptions may be wrong. For example, GTAP assumes that the productivity of new land being converted is 40% less than existing land. However, this assumption does not square will actual yield and productivity data coming out of Brazil.

Second, we are concerned that the bulk of the modeling to date has been focused on a single fuel option—biofuel. This modeling exercise is being used to increase the carbon score of cellulosic ethanol by ~80 percent, and conventional biofuels by ~40–200% depending on the type of feedstock. It appears that the oil baseline, along with all other alternatives including natural gas, hydrogen, and electrification are assumed to have no indirect effects, even though each fuel certainly has "price induced" carbon effects. For instance, if more natural gas is used for transportation then not only will its price rise, but it must be replaced in the electricity portfolio—some percentage of which is likely to be coal. We believe that any estimates of indirect effects need to be evenly applied across fuel options. Each fuel will have a different set of indirect carbon effects. In some cases those indirect effects will consist primarily of a single impact such as land use change, while in others it will be the sum of many small effects, but the science must be applied with equal diligence across all compliance and baseline options.

Some groups have suggested that the current iLUC modeling would help advanced biofuels. This claim is not accurate. Selective indirect effects enforcement against biofuels makes all biofuels, including advanced biofuels, less competitive against the baseline and other alternatives. As investors we are also concerned because selective enforcement adds risk and uncertainty to the advanced biofuels sector by: (a) destabilizing the conventional biofuel sector, which continues to build the infrastructure and support the technological development that is necessary to allow advanced biofuels to reach commercialization; (b) institutionalizing a regulatory bias against all biofuels and sending mixed regulatory signals to the market, which amplifies market risk and will chill investment in advanced biofuels; (c) artificially limiting the type of feedstock available to advanced biofuel producers, which limits the scalability of emerging advanced biofuel companies. It is not enough to suggest that advanced biofuel companies are helped by the LCFS as long as their carbon scores are lower than that of petroleum. Their advantage is artificially diminished by selective application of indirect effects. Furthermore, investments are based on a much more diverse set of metrics inclusive of regulatory bias, politics, market barriers, science, infrastructure and other risk. In general, asymmetrical application of indirect effect penalties exacerbates investment risk in all biofuels.

We are also aware of the argument that an LCFS without indirect land use change ignores a very real effect of biofuels. However, we feel strongly that zero is not the right number for oil or any other alternative either. Indirect effects come as a consequence of a myriad of worldwide economic, political and social variables, and should not be prematurely and selectively applied to a single option in a performance regulation. An LCFS without indirect effects (*i.e.,* based on direct effects) captures the full well-to-wheels carbon emissions of producing and using various fuels, including the land converted for production of biofuel feedstock. Delaying the assignment of indirect effects will not lead to massive investment in higher carbon conventional biofuels, as some have feared. Investor time horizons are long enough that the risk of future penalties for iLUC will be taken into account.

Our primary concern as investors is that the LCFS provides a fair and enduring set of standards that regulate all fuels on a level playing field. Selective enforcement of indirect effects creates an asymmetry that will have unintended consequences, and creates exactly the kind of regulation that makes investors wary. We believe that an LCFS using direct effects in conjunction with an economy wide carbon regulation such as AB32 has the capacity to address indirect effects as direct effects through clear management of unregulated imports. However, we support several additional strategies to address concerns about indirect effects: (1) a multi-disciplinary assessment of the indirect, market-mediated carbon effects of all fuels; (2) ongoing improvement of the treatment of direct land use under the GREET model; (3) the design and implementation of a regulatory process by which all fuel producers, in-

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declined by 2%, oilseed area increased by 0.5%, and forested area increased by 0.6% from 2001 to 2006.

cluding fossil fuel companies, customize the carbon impacts of their fuels, including land intensity. The apparent alternative—using biofuels as a pathway to stretch the traditional carbon assessment boundaries into indirect effects—will be counterproductive for the economic and environmental interests of State of California and will undermine investments in viable near-term solutions to petroleum dependence and climate change.

We appreciate the opportunity to comment on this important regulation and look forward to providing any additional information you might need.

Sincerely,

[alphabetical listing]

ANDREW FRIENDLY,
Principal, Advanced Technology Ventures;

ERIK STRASER,
Partner, Mohr Davidow Ventures;

JASON MATLOF,
Partner, Battery Ventures;

JOSH GREEN,
Partner, Mohr Davidow Ventures;

KELSEY B. LYNN,
Principal, Firelake Capital Management LLC;

MARTIN L. LAGOD,
Managing Director, Firelake Capital Management LLC;

MAURICE GUNDERSON,
Senior Partner, CMEA Capital;

PAUL HOLLAND,
General Partner, Foundation Capital;

STEVE GOLBY,
Partner, Venrock;

WILL COLEMAN,
Partner, Mohr Davidow Ventures.

EXHIBIT 8

Environmental and Energy Study Institute

March 16, 2009

MARY D. NICHOLS, *Chairwoman,*
California Air Resources Board,
Headquarters Building,
1001 "I" Street,
Sacramento, CA.

Chairwoman Nichols:

Reducing greenhouse gas emissions from transportation fuels is an important and urgent challenge for both California and our nation. It is one of the many hurdles that our nation will need to overcome if we are to address the climate crisis effectively and quickly. We at the Environmental and Energy Study Institute commend the staff of the California Air Resources Board for its thoughtful effort and leadership to establish a low carbon fuel standard—for the State of California and as a model for the nation.

However, we are writing to express our concern that the excellent work the staff has done to assess the direct lifecycle carbon emissions of various fuels, based upon scientifically sound and generally accepted methodologies, is significantly undermined by the inclusion of indirect carbon emissions from land use changes attributed to biofuels production, about which there is very little consensus in the scientific community. Scientists are only just beginning to explore the indirect relationships (if any) between biofuels production in the U.S. and land use changes around the world. To base such a critical policy decision upon such an uncertain and unsettled body of knowledge inserts a significant, unfounded bias against a class of fuels which may offer, in the final analysis, great promise in meeting our nation's pressing climate and energy challenges.

Traditional lifecycle assessments include only what have come to be known as 'direct emissions'. Direct emissions include the carbon contents of the fuel itself, as well as the greenhouse gases released during each stage of production (from "well

to wheels"). Direct emissions are measurable, attributable, and described in well-tested models (such as the GREET model).

"Indirect emissions", on the other hand, are those emissions that are **assumed** to occur somewhere in the world as a result of general market forces exerted by the production of a particular kind of fuel—in this case, the greenhouse gas emissions thought to be released from tropical deforestation and other land use changes as an indirect, market-driven result of farmland in the U.S. being diverted away from food or feed crops to growing biofuel crops. **Unlike direct emissions, indirect emissions cannot be observed, measured *in situ* or attributed to particular production chains.**

The CARB staff is calculating these indirect emissions using a general equilibrium model to estimate aggregate emissions from land use change at the global level due to the impact of U.S. biofuel production on global markets. General equilibrium models simulate changes and trends in commodity production by assuming a closed system that seeks economic 'equilibrium' as determined by regional constraints of supply and demand. These models, however, are especially sensitive to the assumptions underlying the inputs and processes included in the model. In particular, assumptions regarding the supply of agricultural land, the availability of marginal lands, farmer behavior, agricultural production practices, economic value and use of biofuel co-products, and competing uses for land and natural resources, substantially affect model results. Determining the 'right' assumptions and assigning values can be a highly subjective process over which scientists, policymakers, and stakeholders frequently disagree.

Confounding the problem further is the difficulty of determining additionality. Even if one assumes that biofuel production is the proximate cause of a certain amount of deforestation, one cannot assume that those forests would have otherwise remained intact in the absence of biofuel production. There are many causes of deforestation and land use change—timber demand, livestock grazing, mining, urban sprawl, global food and feed demand, and subsistence activities. People continually seek to realize the highest value from the land. If biofuels are removed as a market driving factor, other factors will likely fill the void. **In sum, using these models to calculate indirect emissions remains a highly subjective and speculative process, dependent on a number of *a priori* assumptions that bias the outcome.**

There is another, more fundamental issue with including indirect emissions in the LCFS assessment: this concerns the precedent of holding an industry in the U.S. responsible for activities (real or supposed) undertaken by people across distant borders in other sovereign nations. If this standard is to be applied to biofuels, in fairness, should it not also be applied to the assessment of fossil fuels, hydrogen, and electricity? On a broader level, is this a new standard to which other industries and public policy decisions should be held? The analysis of indirect effects could be applied to regulate against a host of other economic and social activities. All large scale activities that use scarce resources, affect markets, or influence economic or social behavior are likely to have some distant, indirect effects.

Global deforestation, conversion of native grasslands and shrublands, and ecosystem degradation are very real problems, with impacts on biodiversity, water security, and the welfare of indigenous peoples. These land use changes have been accelerating for decades, driven by many factors—**long before the U.S. biofuel industry came on the scene.** The resulting greenhouse gas emissions are huge, amounting to over 18% of total global emissions. The international community must work together with urgency and speed—through international negotiations, treaties, and financial and technical assistance—to prevent further loss of forests and ecosystems across the globe.

Including indirect emissions from land use change in the LCFS, however, is not likely to promote the stable climate and healthy ecosystems that we all seek. Instead, **it will only reduce the political legitimacy of the LCFS as a fair and objective tool for comparing fuel options and unfairly penalize an industry that offers great promise for addressing the nation's climate and energy challenges.** If the LCFS is to be an objective, technology-neutral assessment tool, it must treat all fuels equitably, using consistent, generally accepted, scientific criteria and methods. Otherwise, it will merely serve to reinforce the predispositions of the modelers.

Sincerely,

Carol Werner

CAROL WERNER,
Executive Director, Environmental and Energy Study Institute.

cc:

Hon. ARNOLD SCHWARZENEGGER, *Governor* of California,

DAVID CRANE, *Special Advisor for Jobs and Economic Growth,* Office of Governor Schwarzenegger,

LINDA ADAMS, *Secretary,* California Department of Food & Agriculture,

MIKE SCHEIBLE, *Deputy Director,* Air Resources Board,

KAREN DOUGLAS, *Chairwoman,* California Energy Commission.

EXHIBIT 9

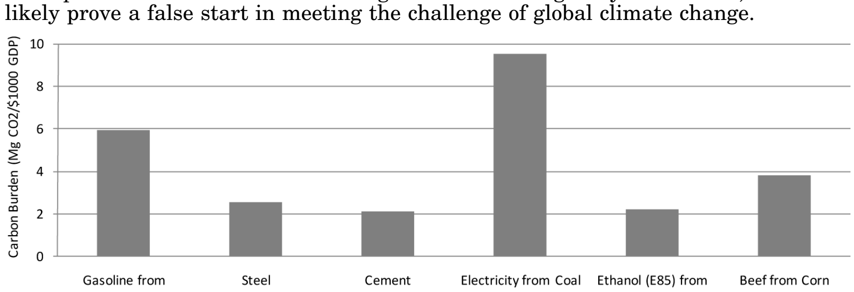
Iowa State University of Science and Technology

April 6, 2009
MARY D. NICHOLS, *Chairwoman,*
c/o Clerk of the Board,
Air Resources Board,
Headquarters Building,
1001 I Street,
Sacramento, CA.

Dear Ms. Nichols:

California's proposed Low-Carbon Fuel Standard (LCFS) is one of the nation's first attempts to implement greenhouse gas (GHG) policy. We hope the policy that emerges is not merely a first attempt at regulation but ultimately proves to be an effective mechanism for GHG reduction because it will set precedent for the nation and possibly the rest of the world. We are concerned that as currently proposed the LCFS will be ineffective in reducing greenhouse gas emissions as well as inadvertently slowing the deployment of technologies that can reduce our reliance on petroleum and other fossil fuels.

Fundamentally, the LCFS fails to address the fact that all economic activity generates GHG emissions. Under the proposed rules, only transportation fuels are held accountable for the burdens of carbon that are discharged into the atmosphere. Although no national inventory has been completed on the carbon burdens of the various goods and services generated by our economy, they are not difficult to estimate on the basis of megagrams (metric tons) of carbon dioxide equivalence per $1000 of gross domestic product (Mg CO_2/$1,000 GDP). For example, steel, concrete, and corn ethanol all produce about 2 tons of carbon dioxide per $1,000 GDP. Beef from corn-fed cattle is 4 tons, gasoline from petroleum is 6 tons, and electricity from coal is almost 10 tons. Clearly, products and services other than transportation fuels place significant carbon burdens on the atmosphere, which the LCFS does not address. Although some would argue that it is a start, we must not let it be a false start, slowing the ultimate goal of actually reducing the amount of greenhouse gases in the atmosphere. Recent proposals to include indirect land use change (ILUC) considerations in the calculation of lifecycle GHG emissions for transportation fuels is an attempt to correct for the shortcomings of LCFS as originally formulated, but it will likely prove a false start in meeting the challenge of global climate change.



All economic activity generates greenhouse gas emissions. The Low-Carbon Fuel Standard does not effectively address the ultimate sources of carbon being discharged into the atmosphere. Source: Brown and Gifford (Iowa State University).

As described last year by Searchinger *et al.*[1] and Fargione *et al.*,[2] one possible outcome of a LCFS that excludes other kinds of economic activities in the calculation of GHG emissions is a net increase in GHG emissions. They developed scenarios for corn ethanol production that assumed the resulting corn deficit in world markets would be filled by farmers converting rainforests and grasslands to agricultural lands. Depending upon the assumptions employed for this land conversion, the net carbon dioxide emissions potentially could overwhelm the emissions saved by using biofuels in place of gasoline. Both groups of researchers argue that this deficit, although not directly the result of biofuels agriculture, should be made the responsibility of ethanol producers. To many, this so-called indirect land use change argument seems eminently reasonable in the face of environmental policy that only holds certain sectors of the economy responsible for GHG emissions.

On the other hand, one has to question the wisdom of adopting a policy that so grossly distorts responsibility for net GHG emissions that it is unlikely to be effective in reducing them. The problem with using ILUC to assign responsibility for net GHG emissions is of two kinds. First, field research demonstrates that GHG emissions associated with land-use change are driven by many cultural, technological, biophysical, political, economic, and demographic forces rather than by a single crop market.[3] Accordingly, it is virtually impossible for the biofuels industry to affect the course of land use change outside the value-chain of its own feedstock suppliers. This is made abundantly clear in comparing the 20 million acres of cropland that has been devoted to ethanol production in the U.S. over the last decade to the 500 million acres of Brazilian rainforest that disappeared over a similar period of time.[4] The inclusion of ILUC in calculating the LCFS will have virtually no influence on the course of land use change in the developing world or the associated GHG emissions. On the other hand, the nascent biofuels industry, if saddled with the GHG emissions generated by other sectors of the world's economy, will not be able to compete in energy markets.

Second, a GHG policy that makes exceptions for some sectors of the economy and shifts the associated carbon burdens to other sectors is likely to encourage further growth in GHG emissions. As the Searchinger and Fargione studies revealed, burdening biofuels agriculture while exempting food agriculture could have the effect of encouraging unsustainable land stewardship in the developing world with the perverse outcome of increasing net GHG emissions around the world. All economic activity should be directly responsible for the GHG emissions emanating from them if this situation is to be avoided.

We encourage the California Air Resources Board (CARB) to consider more effective mechanisms than ILUC for controlling GHG emissions including application of a low carbon standard to all goods and services in our economy, both domestically produced and imported. In this way we can reduce GHG emissions while encouraging development of biofuels technologies, which have so much potential to reduce dependence on imported petroleum and help mitigate global climate change.

Sincerely,

ROBERT C. BROWN,
Director, Bioeconomy Institute,
Anson Marston Distinguished Professor in Engineering,
Gary and Donna Hover Chair in Mechanical Engineering,

HANS VAN LEEUWEN, DENG, BCEE, PE,
Professor of Environmental and Biological Engineering;

RICHARD M. CRUSE,
Professor and Director Iowa Water Center;

JOHN F. MCCLELLAND,
Senior Physicist and Molecular Analytics Group Leader,
IPRT/Ames Laboratory—USDOE;

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[1] Searchinger, T., Heimlich, R., Houghton, R. A., Dong, F., Elobeid, A., Fabiosa, J., Tokgoz, S., Hayes, D., and Yu, T.-H. (2008) *Use of U.S. Croplands for Biofuels Increases Greenhouse Gases Through Emissions from Land-Use Change,* SCIENCE 319 (5867) pp. 1238–1240; originally published in SCIENCE EXPRESS, 7 February, DOI: 10.1126/science.1151861.

[2] Fargione, J., Hill, J., Tilman, D., Polasky, S., Hawthorne, P. (2008) *Land Clearing and the Biofuel Carbon Debt,* SCIENCE 319 (5867) pp. 1235–1238; originally published in SCIENCE EXPRESS, 7 February, DOI: 10.1126/science.1152747.

[3] Kline, K.L. and Dale, V.H. (2008) *Biofuels: Effects on land and fire;* Letter to the editor, SCIENCE 321, 199.

[4] Glantz, M.H., Brook, A.T., Parisi, P. (1997) *Rates and Processes of Amazon Deforestation,* National Center for Atmospheric Research, available on the Web: *http://www.ccb.ucar.edu/rates/rateschart.html* (accessed April 2, 2009).

THEODORE J. HEINDEL,
Professor and Associate Chair for Academic Affairs,
Department of Mechanical Engineering;
GLENN NORTON,
Center for Sustainable Environmental Technologies,
Iowa State University;
CARL J. BERN PH.D., PE,
University Professor,
Agricultural and Biosystems Engineering Department;
ALICIA CARRIQUIRY,
Professor of Statistics;
ROBERT J. ANGELICI,
Distinguished Professor Emeritus, Chemistry;
MARK A. EDELMAN,
Professor of Economics and Public Policy;
STEPHEN H. HOWELL,
Director, Plant Sciences Institute,
Professor of Genetics, Development and Cell Biology;
DON HOFSTRAND,
Co-Director, Agricultural Marketing Resource Center;
STUART BIRRELL,
Kinze Manufacturing Professor,
Associate Professor, Department of Agricultural and Biosystems Engineering;
JOHN G. VERKADE,
Professor of Chemistry and University Professor;
KENNETH J. MOORE,
Professor of Agronomy;
DAVID GREWELL, PH.D.,
Assistant Professor,
Agricultural and Biosystems Engineering;
JILL EUKEN,
Deputy Director,
Bioeconomy Institute;
JOHN A. MIRANOWSKI,
Professor of Economics,
Director, Institute of Science and Society.

EXHIBIT 10

April 20, 2009

MARY D. NICHOLS, *Chairman,*
California Air Resources Board,
Headquarters Building,
1001 "I" Street,
Sacramento, CA.

RE: Call for Third Party Analysis of Indirect Land Use Change and Indirect Effects in Support of the CA LCFS

Dear Chairwoman Nichols,

We are writing regarding the California Air Resources Board pending rulings next week on the Low Carbon Fuel Standard (LCFS), in particular the premature and selective inclusion of indirect effects as a metric by which biofuels alone will be judged. We believe immediate action is necessary to avoid weakening an otherwise critical carbon-based fuel policy.

The issue of how to deal with indirect effects has slowed down the rulemaking already, and is increasingly controversial from a scientific perspective. We are concerned that unresolved issues related to indirect effects enforcement are needlessly eroding support for an otherwise critical fuel policy. We are therefore requesting that CARB immediately enact an LCFS based on direct carbon effects while establishing an expeditious process to assess and account for indirect effects across all fuel pathways, including petroleum.

In a letter dated March 2, 111 scientists outlined their concerns about the selective and premature enforcement of indirect effects in the proposed LCFS. We have not received a response to the letter from ARB, and have not observed any

discernable shift in the approach taken by staff. As discussed, while there is general consensus around the need for an LCFS, and the decision to enforce direct "cradle to grave" carbon effects against all fuels, the inclusion of indirect land use change and indirect effects for biofuels alone are felt to be premature and erroneous based on the following two major factors:

A. The science around indirect effects is not mature and/or robust enough to be included in something as significant as the LCFS. In addition, the GTAP model used to determine indirect effects has not been validated with any significant amount of field data and/or compared with other available models that are not commodity-based.

B. Indirect effects should not be selectively leveraged against any fuel type, including biofuels. All fuels have direct and indirect effects that should be considered as part of the LCFS. The notion that the GTAP model has been used and that fossil fuels have no significant indirect effects is unacceptable without validation and acceptance within the peer-reviewed literature. This result produced by the GTAP model reinforces the need for a thorough and robust comparative study of different models and different methodologies of all fuel types that must be completed before they are added as a component under the LCFS.

Although this letter has sparked significant national interest and highlighted the lack of any consensus around indirect effects, thus reinforcing the conclusion that further study is absolutely essential before inclusion within the LCFS, our concerns have not been addressed by CARB and no data has emerged to suggest that CARB's numbers for indirect land use change are well grounded. We are therefore requesting that CARB Board take the following actions:

A. Submit an LCFS regulation based on direct carbon effects, including direct land use impacts.

B. Commission the National Academy of Sciences to conduct an 18 month study on indirect effects of all transportation fuel candidates to develop and validate a robust science-based tool that can be used within the LCFS. CARB staff should continue to lead a corollary effort during this time.

The LCFS provides an incredible opportunity to reduce the carbon intensity of transportation fuel and promote a more sustainable transportation fuel marketplace. We commend your leadership and the CARB staff for their efforts in developing a workable LCFS regulation. However, it is critical that the LCFS stay on course with regard to its primary mission of establishing a level, carbon-based playing field for all fuels.

We are writing this letter as researchers in the field of biomass to bioenergy conversion, but the signatories do not represent the official views of the home institutions, universities, companies, the Department of Energy, the United States Department of Agriculture, or any of the National Laboratories. We look forward to working with ARB to ensure that the regulation reflects the best science available, and takes a policy approach that is balanced across all fuel pathways.

Sincerely,

BLAKE A. SIMMONS, PH.D.,
Vice-President, Deconstruction Division,
Joint BioEnergy Institute,
Manager, Biomass Science and Conversion Technology,
Sandia National Laboratories;

HARVEY W. BLANCH, PH.D.,
Chief Science and Technology Officer,
Joint BioEnergy Institute,
Lawrence Berkeley National Laboratory,
Member, National Academy of Engineering,
Merck Professor of Chemical Engineering,
University of California, Berkeley;

BRUCE E. DALE, PH.D.,
Distinguished University Professor,
Dept. of Chemical Engineering & Materials Science,
Michigan State University.

cc:

Hon. ARNOLD SCHWARZENEGGER, *Governor* of California,

DAVID CRANE, *Special Advisor for Jobs & Economic Growth,* Office of Governor Schwarzenegger,

LINDA ADAMS, *Secretary,* Cal-EPA,
A.G. KAWAMURA, *Secretary,* California Department of Food & Agriculture,
MIKE SCHEIBLE, *Deputy Director,* Air Resources Board,
KAREN DOUGLAS, *Commissioner,* California Energy Commission.

EXHIBIT 11

Comment Log Display

Below Is The Comment You Selected To Display.

Comment 51 For Low Carbon Fuel Standard (LCFS09)—45 Day.

First Name: CHRIS
Last Name: HAGERBAUMER
E-mail Address: *chrish@oeconline.org*
Affiliation: Oregon Environmental Council

Subject: comments on LCFS proposed regulation
Comment:

The Oregon Environmental Council (OEC) greatly appreciates CARB's hard work developing regulations to establish a Low-Carbon Fuel Standard. The LCFS is an innovative and important approach to tackling global warming, and we are strongly supportive of it.

Lest you wonder why an out-of-state organization is interested in CARB regulations, you should know that the Oregon Department of Environmental Quality will hopefully be given the authority by the Oregon Legislature this session to undertake rulemaking to establish a LCFS in Oregon.

For many years, OEC has worked to support the development and application of a variety of technologies and strategies to reduce greenhouse gas emissions from the transportation sector, including the production of regional, sustainably produced, low-carbon biofuels.

OEC is advocating for a LCFS in Oregon that will harmonize with California's, and we want to make sure that LCFS implementation is accurate and fair.

The beauty of a LCFS is that it is performance-based, allowing affected companies to meet the standard through a variety of means and avoiding premature conclusions about the "right" technology. Encouraging development of the right technologies hinges upon an even playing field. We are worried that CARB is creating an uneven playing field by choosing to account for the potential indirect carbon effects of biofuels, while not accounting for the potential indirect carbon effects of other fuels.

Indeed, other fuels have indirect carbon effects: for example, the use of natural gas as a vehicle fuel means less natural gas will be available for stationary energy needs, potentially leading to the development of more coal-fired power plants. Likewise, the use of electricity for our transportation needs may increase demand on electricity and push us to dirtier fuels like coal.

Likewise, oil companies are turning to the most polluting, most carbon-intensive means of producing oil—they are disturbing vast tracts of land and harming ecosystems while extracting oil from tar sands. What is the indirect effect of relying on a resource that has peaked? What is the indirect effect of increasing petroleum prices on food prices and the resulting increase of food prices on land use change?

In your draft regulation, you indicate that you believe other fuels do not have indirect carbon effects. In order for us to be comfortable with that statement, we need to see your analysis. The potential indirect carbon impacts of fuels besides biofuels need to be modeled by CARB, as well.

We believe it is prudent to follow the example of the EU and the recommendations of the 111 scientists who wrote to you on this subject who have called for an initial LCFS based on direct emissions while we take the time necessary to thoroughly assess indirect effects for all fuels.

An even playing field is crucial to responsible implementation of a LCFS.

Thank you very much for your consideration.

Attachment:
Original File Name:
Date and Time Comment Was Submitted: 2009–04–08 16:19:42

EXHIBIT 12

Sustainable Conservation 15 YEARS 1993-2008

March 18, 2009

Mary Nichols, Chair
California Air Resources Board
California Environmental Protection Agency Building
P.O. Box 2815
Sacramento, CA 95812

Dear Chairperson Nichols,

I am writing regarding the development of the Low Carbon Fuel Standard (LCFS). Sustainable Conservation is supportive of this important, groundbreaking regulation as envisioned by Governor Schwarzenegger. When announced by the Governor, one of the benefits of the proposed regulation was to increase five-fold the amount of renewable fuels used and produced in California. We believe this is an important, if challenging, goal.

California agriculture can and should play a key role in not only providing a sustainable food supply to the United States and indeed the world, but also meeting a portion of our transportation fuel needs. That is an effort we are actively engaged in with partners at the California Department of Food and Agriculture, UC Davis and others. Specifically, we have several projects on the ground to demonstrate the potential of sustainably produced biofuels in California with minimal water use and without a significant, or possibly any, food-for-fuel trade-off.

We recently obtained a copy of a letter signed by over 100 scientific experts from universities and national labs across the country, including members of the National Academy of Sciences. They make a compelling case against an indirect land use penalty based on current information. We are also sympathetic to the case made by some other organizations concerned about the environmental impacts of current production systems. As such, we recognize that there is a lack of scientific consensus and understanding in regard to the "indirect" effects of biofuels production, and that the model currently in use has not been validated against real world data and is therefore imperfect.

Whatever regulations are adopted, California, under the California Air Resources Board's leadership, should initiate and lead an effort to work with national and international experts to 1) more fully understand the complicated links between agriculturally derived fuels in the United States and deforestation in other parts of the world; and 2) assess the best ways to mitigate deforestation and other habitat destruction across the world (as a result of biofuels production). Some research by respected labs and universities shows that biofuels production on degraded agricultural land can provide opportunities for

positive land use change in emerging economies if it is done right and the proper incentives are given; this may also be true for California.

We also believe that a prudent approach for the LCFS is to promulgate a robust regulation based on direct carbon effects, including direct land conversion for feedstock production in California. In addition, promulgating an LCFS with selectively enforced "indirect" effects is warranted if there is sufficient scientific basis for it. We are concerned that may not be the case currently and this could lead to at least two unintended consequences: 1) the potential for increased CO_2 as refiners will be compelled to reduce biofuels use and increase petroleum use in the near term; and 2) the premature inclusion of an emission factor for market driven effects before there is better understanding of the science across all fuel pathways will stifle innovation that will be necessary to meet the goal of a five-fold increase in renewable fuels use in California.

We know you are faced with a difficult decision and that the issues are complex and controversial. We are happy to provide any additional perspective that may be useful.

Sincerely,

Ashley Boren

Ashley Boren
Executive Director

cc: Governor Arnold Schwarzenegger
Linda Adams, Secretary, California Environmental Protection Agency
Mike Chrisman, Secretary, California Natural Resources Agency
A.G. Kawamura, Secretary, California Department of Food and Agriculture
Karen Douglas, Commissioner, California Energy Commission
James Boyd, Commissioner, California Energy Commission
Low Carbon Fuel Standard public docket

EXHIBIT 13

CALSTART

April 15, 2009

MARY NICHOLS, *Chair,*
California Air Resources Board,
Headquarters Building,
1001 I Street,
Sacramento, CA.

RE: Comments on Proposed Low Carbon Fuel Standard Regulation

Dear Chairman Nichols,

CALSTART strongly supports the adoption of a Low Carbon Fuel Standard (LCFS) as a discrete early action measure in California's fight against climate change. Though it is somewhat more complicated, the general concept of the LCFS is similar to the Alternative Fuels Portfolio Standard recommended by CALSTART and the California Secure Transportation Energy Partnership (CalSTEP) in its January 2007 Action Plan. We applaud the Air Resources Board (ARB) for their work to date in developing this important, first-of-its-kind policy to reduce greenhouse gas emissions from transportation fuels. Since 2002 and the adoption of the Pavley program, the ARB has been working to reduce tailpipe emissions. An equal or greater amount of technology forcing regulation should now be applied to the fuel sector. The successful and timely implementation of California's LCFS is a necessary component of the broader fight against climate change. The schedule has already been delayed and, given what we now know about rising greenhouse gas concentrations in the atmosphere, further delay would not be prudent.

ARB staff has done a commendable job on the initial analysis and regulatory design, particularly with regard to the detailed calculations of direct emissions associated with the various fuel pathways. We offer the following comments and recommendations to strengthen the LCFS and improve its ability to both reduce emissions in California and serve as a model for a national program. We are providing comments on the following critical issues:

- **Implementation and emissions timeline:** recent warnings from scientific experts make clear the fact that we cannot afford to delay emissions reductions. We urge ARB to move forward with LCFS implementation without delay and to consider how best to encourage near term emissions reductions under the LCFS.
- **Indirect emissions:** the science in this area is new and evolving, and the current regulation only examines one type of indirect effects—land use changes, primarily from biofuel production. Ideally, we would like to see the inclusion of all indirect emissions from all fuels, once the science has evolved and there is greater consensus about the secondary impacts of all fuels. This was the approach chosen by the European Commission.
- **Process for proposing new or modified pathways:** ARB should provide a thoughtful yet efficient and affordable method for stakeholders to propose new or modified inputs for both direct and indirect emissions. Such a process would improve the accuracy of the carbon intensity values while providing an incentive for regulated parties to reduce the direct and indirect emissions associated with their specific fuel pathways. This is particularly important if ARB moves forward with a regulation that includes indirect land use change emissions as currently outlined in the proposed regulation.
- **Models, inputs, and assumptions:** the LCFS is heavily dependent on complex models with many inputs and assumptions. While indirect land use change is the most controversial area, there are additional factors that have not been thoroughly verified. We recommend that ARB continue working to refine and improve upon the underlying pathway analysis at the heart of the LCFS through an ongoing public process. The goal should be to make sure the latest, best science is employed and to validate the models and results as data become available.

CALSTART believes that a successful LCFS based on sound and scientifically defensible analysis can serve as a model for a similar policy at the national level. It is therefore very important that we "get this right" in California.

Encourage Early Reductions and Avoid Delays

Recent research suggests that policymakers should strive to encourage increased near term emissions reductions. It now appears that the Intergovernmental Panel

on Climate Change may have underestimated the impacts of climate change.[1] Furthermore, there is increasing evidence that suggests that the climate change effects of greenhouse gas emissions will be largely irreversible[2] and potentially abrupt. In light of these warnings from the scientific community, there is a clear need to accelerate emissions reductions through intelligent policy choices and timely implementation of climate regulations and programs such as the LCFS.

The LCFS and Complementary Policies Should Encourage Early Reductions

As currently written, the LCFS has a backloaded compliance schedule and a relatively modest end goal. We understand the various constraints that led to this result, but believe that it highlights the need for complementary policies to drive early reductions.

Furthermore, though CALSTART has not done extensive analysis on the subject of accounting for emissions over time, we agree with ARB staff on the need to continue evaluating the Fuel Warming Potential (FWP) method. This method shows promise because it has a scientific basis and takes into account the fact that emissions today are more damaging than emissions tomorrow. However, we understand and agree with ARB's decision to use the simple Annualized method in the early years, as indirect land use emissions debate has not been settled and the FWP method has not yet been adequately peer reviewed. After ARB validates the models and addresses the ongoing concerns over indirect emissions, we would recommend further consideration of the FWP method for time accounting.

The LCFS Should be Implemented without Delay

We commend ARB staff for the large volume of work they have completed to date on fuel pathway analysis and regulatory design. The LCFS is a complex and labor-intensive policy and ARB has done an admirable job of avoiding major delays. As we continue to move through the implementation process, it is important to keep up the momentum, to the extent that the analysis is sufficiently rigorous for regulatory purposes. As mentioned above, we believe the direct emissions analysis is relatively sound and can form the basis of a regulatory program in the early years. Whether or not ARB decides to include indirect emissions at the outset of the program, we stress the need to move forward with some version of the LCFS on schedule. If ARB elects to delay the inclusion of indirect effects to allow for additional study and validation of model findings, we believe the study should move forward quickly and the indirect effects should be incorporated as soon as possible.

Study and Account for Indirect Emissions from All Fuels in a Consistent Manner

The issue of indirect emissions in general and emissions from indirect land use change in particular has probably been the most controversial aspect of this process to date. The science in this area is new and evolving, but it is clear that indirect emissions deserve further consideration and should not be ignored. CALSTART commends ARB staff for attempting to address this difficult issue in assigning carbon intensity values to fuels for the LCFS. In the words of MIT Professor John Reilly, one of the peer reviewers for the LCFS, "this is a very new area where research that could establish with confidence such indirect emissions is in its infancy. Ideally one would like to have had the scientific community investigate these issues and to have published competing estimates, resolving among them better or worse approaches and identifying uncertainties."[3] Given the timeframe and the available data, ARB has had to move forward without this luxury. While the work done around indirect effects for the LCFS has clearly advanced the science in this area, there is more to be done.

The Science Regarding Indirect Emissions is Still Uncertain

The scientific arguments on both sides of this issue are well-known and we will not rehash them here. It is important to note, however, that there is a general lack of consensus and that the resistance to staff's approach on this issue is coming from the scientific community as well as from many elements of the biofuels industry.[4]

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[1] "Projections of Climate Change go from Bad to Worse." *Science*, March 20, 2009. *http://rael.berkeley.edu/files/IARU-Coverage-Science-March24-2009.pdf.*

[2] "New Study Shows Climate Change Largely Irreversible." NOAA press release, January 26, 2009. *http://www.noaanews.noaa.gov/stories2009/20090126_climate.html.*

[3] "Review of Proposed Regulation to Implement the Low Carbon Fuel Standard." Peer review of John Reilly, Senior Lecturer, Sloan School of Management, MIT. *http://www.arb.ca.gov/fuels/lcfs/peerreview/041409lcfs_reilly.pdf.*

[4] For example, 111 Ph.D. researchers recently wrote a letter to Governor Schwarzenegger stating their opposition to selective enforcement of indirect effects in the LCFS, and noting that "the

Continued

Even some of those who strongly support the inclusion of indirect land use emissions from biofuels production admit that there may still be some uncertainty over the magnitude of the effect.

ARB Staff's Initial Statement of Reasons (ISOR) indicates that the staff is confident about the direction of the effect. However, the ISOR underlines the uncertainty surrounding the actual quantitative estimates of indirect land use change emissions, stating that "the tools for estimating land use change are few and relatively new"[5] and that "although one may argue that there is no scientific consensus as to the precise magnitude of land use change emissions and that the methodologies to estimate these emissions are still being developed, scientists generally agree that the impact is real and significant."[6] CALSTART is not disputing the claim that these effects are real. However, we are concerned that the actual methods, models, and resulting effect magnitudes may not yet be sufficient for regulatory purposes. We are particularly concerned with the ability of the GTAP model to accurately predict the effect of domestic biofuel production on foreign land management practices and international agribusiness investment decisions.

ALL Indirect Emissions Should be Included once the Numbers are Better Understood and Independently Evaluated

The LCFS should create a level playing field that allows fuels to compete with each other on the basis of lifecycle emissions. As proposed, however, the LCFS includes indirect land use change emissions from biofuels but does not include any other indirect effects. The ISOR notes that "staff has identified no other significant effects that result in large GHG emissions that would substantially affect the LCFS framework for reducing the carbon intensity of transportation fuels."[7] However, given the small differences in relative carbon intensities between the various fuels and the uncertainty as to the magnitude of indirect land use change emissions, CALSTART is concerned that the inclusion of indirect effects on a selective basis could undermine the integrity of the LCFS. If ARB staff has reason to believe that indirect emissions from other fuels such as conventional gasoline and diesel are negligible or nonexistent, we would encourage staff to make this analysis publicly available.

CALSTART believes that the LCFS should ultimately include all emissions (direct and indirect) from all fuels, particularly if sound analytics can be adopted for accurately estimating the secondary impacts. We are concerned that selective enforcement of indirect effects may create the appearance of a bias that could potentially hurt the chances of broader adoption of the California model. We believe that the lack of readily available models and estimates for indirect emissions from other fuels is an argument for additional study, within a strictly time limited period, rather than an argument for assuming a value of zero. We commend ARB staff for stating that they "will continue to work with interested parties to identify and measure [other indirect] effects,"[8] and believe that a thorough and rigorous independent analysis is the best way to address these issues. Whether or not indirect effects are included at the outset of the regulation, we recommend moving forward with a comprehensive and independent analysis of indirect effects as soon as possible.

CALSTART has not done extensive analysis of the direct and indirect emissions from conventional fuels and we do not have hard data to present. However, if ARB is going to look beyond direct emissions and make assumptions about how economic activity in the USA will drive economic behavior in other countries, there are a number of greenhouse gas impacts associated with the carbon intensive incumbent fuels that deserve attention. Below are some examples:

- *Oil exploration:* it is our understanding that direct emissions from oil exploration are not included in the carbon intensity calculations for petroleum-based fuels.
- *Military protection of oil supplies:* many economists have attempted to quantify the costs of protecting oil supplies in the Persian Gulf. One estimate from researchers at UC Davis' Institute for Transportation Studies put the annual economic costs of military operations tied to defense of oil supplies at $26.7–$73.3 billion, with $5.8–$25.4 billion of this tied directly to the cost of defending the

science is far too limited and uncertain for regulatory enforcement." *http://www.arb.ca.gov/lists/lcfs-generalws/28-phd__lcfs__mar09.pdf.*

[5] LCFS ISOR, X–5.

[6] LCFS ISOR, IV–48.

[7] LCFS ISOR, ES–29.

[8] LCFS ISOR, ES–29.

use of motor oil by U.S. vehicles.[9] The emissions from these large scale military operations would be difficult to quantify, but that does not mean they should be ignored.[10] Even more controversial and difficult, but no less real, are the carbon emissions associated with global conflict over energy. Clearly there was a carbon impact when the Iraqi Army blew up the wells in Kuwait during the first Gulf War and fires raged for weeks thereafter. When such conflicts occur, will the emissions be factored into the respective inventories and models?

- Indirect, "spill-over" emissions from petroleum: changes in the price of oil are likely to have far-reaching impacts on a variety of markets and actors worldwide. Emissions resulting from this would be difficult to quantify because of the degree to which oil touches all aspects of our economy, but this does not mean these effects are not real.

These are just a few examples of the types of effects that we think should be examined. There certainly may be others.

Additional Work is Needed to Get this Right

CALSTART recommends that ARB commission a rigorous and comprehensive study of indirect emissions from all petroleum-based and alternative fuels through an independent and well respected body such as the National Academy of Sciences. To avoid the pitfall of paralysis by analysis, we recommend that such a committee be given a defined period of 12–24 months to report back. The Energy Independence and Security Act of 2007 highlighted the need for additional work in this field as it relates to biofuels, and indirect emissions from other fuels are even more uncertain.[11] If the study could be completed quickly, ARB could implement the LCFS in two phases, beginning with direct effects only and including the indirect effects after the completion of the study. While we think this phased approach has merits, we understand that this delay could be problematic and that ARB is likely to move forward with a regulation that includes indirect land use change. Even if this is the case, we believe it is important to proceed immediately with an independent review of indirect effects for all fuels, with the goal of updating and refining the carbon intensity values as the science evolves. Regardless of the approach taken, we don't recommend the ARB delay any further in implementing the program. It is time to move forward.

We are aware of the fact that some may view our position and recommendations on indirect emissions as a delay tactic designed to support the ethanol industry in the early years of the LCFS. CALSTART is a fuel- and technology-neutral organization with no particular interest in supporting the ethanol industry at the expense of the environment or other alternative fuels. Rather, we believe this study would improve the analysis underlying the LCFS, address legitimate stakeholder concerns, and increase the chances of a broader adoption of the California model.

Create a Thorough and Efficient Process for Proposing New or Modified Pathways

CALSTART commends ARB staff for including in the regulation processes for modifying model inputs to reflect specific processes (Method 2A) and for creating new fuel pathways (Method 2B). CALSTART believes it is imperative that these processes apply to indirect emissions as well as direct emissions. The language in the ISOR refers only to new or modified inputs for direct emissions, but ARB staff mentioned in the March 27th LCFS workshop that they saw the need to "provide a path forward" on the indirect emissions side as well. Staff indicated that they would create a process for stakeholders to get credit (in the form of a reduced carbon intensity value) for demonstrated reductions in indirect emissions, perhaps through an expanded Method 2B.

Such a process is vitally important to the success of the LCFS, especially in light of the fact that ARB is likely to move forward with a regulation that includes con-

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[9] "U.S. Military Expenditures to Protect the Use of Persian-Gulf Oil for Motor Vehicles." Mark Delucchi and James Murphy, April 1996, revised March 2008. *http://www.its.ucdavis.edu/publications/2004/UCD-ITS-RR-96-03(15)__rev3.pdf.*

[10] Former U.C. Berkeley Professor Alex Farrell, who was deeply involved in the lifecycle calculations underlying the LCFS, agreed in a private conversation with John Boesel in February 2008 that "such emissions probably should be included" in the LCFS.

[11] EISA 2007 directs the Secretaries of Agriculture and Energy to carry out a Biomass Research and Development Initiative focused on, among other things, "the improvement and development of analytical tools to facilitate the analysis of lifecycle energy and greenhouse gas emissions, including emissions related to direct and indirect land use changes, attributable to all potential biofuel feedstocks and production processes." EISA, Title II, Subtitle B, Sec. 232(b)(3). *http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=110__cong__bills&docid=f:h6enr.txt.pdf.*

troversial estimates of emissions from indirect land use change. This process would both improve the accuracy of the carbon intensity values and provide an incentive for regulated parties to reduce the direct and indirect emissions associated with their specific fuel pathways. From a practical standpoint, the process will be much more effective if it is quick, efficient, and transparent. If ARB is able to incorporate such a process in to the regulation, this should help to address some of the concerns of biofuel producers and should also improve the overall public perception of the regulation.

Continually Work to Improve and Validate Models, Inputs, and Assumptions through a Transparent Public Process

The LCFS is dependent on complex models with many inputs and assumptions. Given the nature of the regulation and the available data and models, the LCFS represents a departure from past ARB regulations. Other ARB models and programs had some scientific uncertainty, but this program stands out due to the modeling constraints and assumptions, the scarcity of data for some of the key inputs, and the relative lack of real world validation of model results.

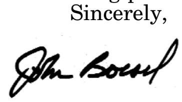
The most obvious area of potential disagreement is indirect land use change. The LCFS relies on relatively new science and models that are intended to predict the outcomes of international economics and human behavior. Given the lack of consensus and the changes in ARB's indirect emissions estimates over the past several months, we expect to see ongoing work in this area. For example, Professor Valerie Thomas noted in her official peer review of the LCFS, "that observed data have not been used to validate the GTAP model findings is a significant weakness. The changes in corn production resulting from the Federal renewable fuel standard, and the change in Brazilian sugar production resulting from increased ethanol production should be measurable, and should be measured to validate the model assumptions. The ARB model should be adjusted to reflect data." [12]

While ARB's estimates of emissions associated with indirect land use change have generated the most debate, CALSTART notes that there are other areas of uncertainty that deserve additional attention. One factor that can easily tip the balance between various fuels is the Energy Economy Ratio (EER). Like indirect land use, this area has generated disagreement and a wide range of estimates. ARB staff admits that "the data are relatively limited" for establishing EER values for advanced and emerging vehicle technologies.[13] Professor Linsey Marr outlines many important issues related to EER calculations and assumptions in her peer review of the LCFS.[14] The co-product credit is another factor that deserves additional scrutiny.

Given the degree to which the success of the LCFS relies on accurate models and inputs, we urge ARB to put into place a thorough and rigorous process for refining and improving the underlying analysis. This process should be transparent and open to public participation. Ongoing dialogue and stakeholder input should help to improve the underlying analysis as well as the public perception of the LCFS program.

CALSTART thanks the ARB for the opportunity to provide input throughout this rulemaking process.

Sincerely,



JOHN BOESEL, *President and CEO*

EXHIBIT 14

University of California, Davis

College of Agricultural and Environmental Sciences,

Agriculutral Experiment Station

Cooperative Extension

April 22, 2009

[12] "Review of Proposed Regulation to Implement the Low Carbon Fuel Standard." Peer review of Valerie Thomas, Associate Professor, School of Industrial and Systems Engineering, Georgia Institute of Technology. *http://www.arb.ca.gov/fuels/lcfs/peerreview/041409lcfs__thomas.pdf.*

[13] LCFS ISOR, ES–18.

[14] "Scientific Review of the California Air Resources Board's Proposal to Implement the Low Carbon Fuel Standard." Linsey Marr, Professor of Civil and Environmental Engineering, Virginia Tech *http://www.arb.ca.gov/fuels/lcfs/peerreview/041409lcfs__marr.pdf.*

MARY D. NICHOLS,
Chairperson, California Air Resources Board,
Headquarters Building,
1001 I Street,
Sacramento, CA.

Dear Chairperson Nichols:

The California Air Resources Board (CARB) is poised to adopt a Low Carbon fuel Standard (LCFS) at its up-coming meeting on April 23, 2009. Through the LCFS, CARB seeks to lower the carbon intensity of transportation fuels by 10% by 2020 by blending alternative fuels derived from biomass with petroleum-based fuels. I fully support this objective. As you realize, this seemingly modest objective masks a difficult, complex task, never before attempted by any state or national government. While difficulty is not an excuse for inaction, complexity requires prudence in choosing what to do in difficult situations. If the CARB adopts the LCFS, including the currently proposed method of calculating GHG values derived from indirect Land Use Changes (iLUC), it will make a serious regulatory mistake. The current iLUC policy is a regulatory bias that cannot be justified. It will inhibit the development of valuable alternative fuel sources, handicap the development of green energy businesses in California, and increase the costs of alternative fuels. In my view, it is based on some important misunderstandings about the nature of modern farming systems and about how biofuel businesses could best develop and evolve over time. It significantly overestimates the reliability and usefulness of the modeling method chosen to predict green house gas (GHG) costs associated with agricultural biofuels, particularly those associated with land use change in remote locations.

If CARB adopts the LCFS as proposed, as a remedy it should also at a minimum agree to support a rigorous search for alternative methods of estimating ILUC, provide for frequent external review and assessment of these methods, and create a process for estimation of ILUC GHG costs based on a comparison of approaches. Land change science, the direct evaluation of land change processes and effects where they actually occur, offers an alternative to the method of indirect inference now used as the sole means to assess indirect sources. The use of comparative methods is a more justifiable basis for assigning something as complex and hard to define as an indirect GHG value. While it will be difficult, difficulty is not an excuse for inaction. The European community, faced with same uncertainty, has prudently opted for the development of additional assessment methods. This would be wise for California as well. The LCFS will have implications beyond affecting the carbon intensity of transportation fuels. Since the consequences will be large and many will be unpredictable, and since there is serious scientific agreement about the best means to go about regulation, the CARB should do whatever is possible to achieve the most rational standard possible.

There are several issues that I wish to address and have staff consider. These are based on comments that I made at the CARB board meeting on March 26, 2009, at the invitation of the CARB staff.

1. Crop based biofuels do not always compete directly with food uses. It is not a question of food (or feed) vs fuels, but a question of how to create more sustainable agro-ecosystems (more diverse, more profitable). In many cases, crops grown for biomass may facilitate that process, not only in California also in many locations in the developing world were human need is great.

2. The distinction between first generation biofuels and second generation biofuels referred to in the regulation and justifying documents is partially arbitrary and misleading. If the entire crop plant were used (corn, sugarbeets), then energy yields could be similar to or even greater compared to so-called 2nd generation crops like switchgrass. An integrated bio-refinery may change the production of energy to a by-product or waste management process rather than the primary activity from the use of purpose grown crops. In many cases, the use of some high quality crop resources may facilitate the use of a larger amount of low quality ones. These developments will need time to evolve from current crop-based models. This evolution should be encouraged by regulation, not stifled prematurely.

3. California should encourage indigenous biofuel production to do its share to reduce GHG without exporting all the consequences of doing so to other locations. This is partly a matter of ethics, but the state will also have the best estimates of GHG effects for local systems.

4. The key to a successful transition to a low carbon future will be entrepreneurial innovation. The state should err on the side of encouraging such innova-

tion. The effects of regulation on the energy sector are so fundamental, far-reaching and complex, that prudence and time are needed to achieve the greatest net environmental and social benefits possible.

5. The decision to impose an iLUC handicap on agricultural biofuels was premature and occurred without sufficient understanding of the nature of agricultural systems. This decision violates the principle of a performance standard by excluding potentially viable biofuel sources and methods. iLUC should be estimated using several methods, with a preference for direct estimation. Reliance on a single method is unwise because no model is currently able to deal with this complex issue adequately. Additional time is needed to create comparative iLUC approaches. In the interim, CARB should rely only on the best direct GHG estimates.

6. California, the United States, and European Union should agree on the use of several policy approaches to avoid undesirable LUC changes, including direct intervention to protect high value ecological areas in developing parts of the world, while allowing for the fulfillment of needed human development. This important goal cannot be achieved in a single regulation like the LCFS and may be inhibited by it. The difficulty of this effort should not inhibit attempting it.

Before concluding, I wish to comment in greater detail on the use of models to infer a market-induced effect on land use change in Latin America and elsewhere—the idea that if we cut down rainforests to replace crops used for biofuels, more harm to the atmosphere is done than good. This concern is the basis for the bias against agricultural biofuels built into the proposed LCFS. There is considerable disagreement among scientists about how best to quantify and account for the indirect affects of land use practices. Staff at the CARB, and some scientists testifying to the CARB, have asserted that the best science available has been adopted by CARB to set its standard. Actually, it would be more accurate to say that the most convenient science available has been adopted. CARB has decided to use a computable global equilibrium model called GTAP for this purpose. GTAP is widely and justly admired, and is a significant intellectual achievement. It predicts the effects of changes in the supply of agricultural commodities on market prices and sales around the world, among other outputs. It accounts for global market adjustments in multiple economic sectors. For the purposes for which it was created, it is very useful. CARB, however, is using it to infer changes in land use in remote regions, especially primary forest clearing in the tropics. Doing so allows the agency to create a green house gas cost associated with this clearing and assign that cost to a biofuel produced in Iowa, for example. Ironically, the cost of indirect land use change for crop based biofuels is itself estimated indirectly. Importantly, land use change is not discovered by using the model. Rather, land use change is assumed to occur in the model, so choosing this model necessarily results in a land use change prediction. This is a troubling way to implement an important policy like the LCFS because it gives the appearance of and in fact creates an automatic bias against one class of biofuels, contrary to the principle of a truly performance-based standard.

Alternatively, newly developing land change science points instead to many other factors that have been in place for decades or longer, and which are far more influential locally. GTAP was not created to estimate ILUC in remote locations where markets and property rights do not function and where the loss of existing vegetation will not have significant consequences. So what might be justly deemed the best science for one purpose, is inadequate, inappropriate and far from best when used inappropriately for another. An indirect estimate of indirect land use change may result from the operation of an elegant model, but it fails the test of predicting actual behavior in real landscapes.

This disagreement may seem merely like an argument among modelers. Why is it important enough to cause a delay the adoption or modification of a part of the LCFS? The reason is that the consequences of these new policies affecting the regulation of carbon are large. The LCFS, and other carbon regulations like AB 32 now in force in California are not simply carbon regulations. They will affect all aspects of our lives and make many things that we have come to value more costly and more difficult. They will have profound long-term economic and social consequences which cannot be accurately predicted. With such radical changes in store, we should not be in a rush. A prudent approach to policy would be incremental, characterized by an appropriate sense of humility. In times of great change and uncertainty like the present, it is more reasonable to be suspicious about the reliance on a single model for creating policy. Where serious scientific disagreement exists, as it does here, more time should be taken. Before institutionalizing bias against agricultural biofuels, additional ways of estimating indirect land use changes associated with ag-

ricultural biofuels and associated carbon accounting should be developed and compared. It is possible that the estimates of the carbon costs of biofuels using differing methods may prove to be even greater than the one proposed by CARB currently. But the state will have a level of certainty and justification more appropriate to the level of consequences stemming form the regulation.

Prudence suggests that when creativity and innovation will be needed to overcome unprecedented challenges like eliminating the use of oil, the regulatory process should err on the side of encouraging innovation. This is exactly the opposite of what will occur if the LCFS is adopted as currently proposed. In the end, policy makers have to decide, as the CARB staff and those that support its decisions have had to decide. But at a fundamental level these decisions are not based on science, but on the preferences of scientists and regulators for certain ways of regulating. The sciences involved cannot be used to analyze or justify their own presuppositions or the proper limits for their use in policy making. An algorithm cannot tell us which values are most important.

I have spent my lifetime working on food production on several different scales, using several different approaches, from organic gardening to family-scale dairying to commercial crop production in California, with some international agricultural experience to add leaven. The concerns raised here are not mine alone, however, but are shared by many agricultural scientists, engineers, international development specialists and biologists interested in the best ways forward to a future with reduced dependence on petroleum. These have been expressed in letters and comments to CARB, so far without noticeable effect. I do not work for a petroleum company or the biofuels industry. But I do care about a prosperous future for the people of California and a sustainable environment. My own biases are towards developing more crop alternatives for farmers in California with the hope of improving the agro-ecological performance of farms and their profitability. The right agricultural biofuels may do both in the appropriate locations, supported by prudent policies. Trying to determine how to achieve these goals and the effort needed to do so should not be forestalled by hasty policy making. The European community, faced with same uncertainty, has opted for the additional development of assessment methods. This would be wise for California as well.

While I am critical of some aspects of the proposed LCFS regulation, I appreciate the extraordinary efforts and good faith of CARB staff as they worked to create a uniquely challenging regulation. I have enjoyed working with them both professionally and personally.

Sincerely,

STEPHEN R. KAFFKA,
Department of Plant Sciences,
University of California, Davis, and
Director of the California Biomass Collaborative.
srkaffka@ucdavis.edu
530–752–8108

EXHIBIT 15

University of California

Agriculture & Natural Resources

Cooperative Extension • Sutter/Yuba Counties

April 21, 2009

MARY D. NICHOLS, *Chairwoman,*
c/o Clerk of the Board
Air Resources Board,
1001 I Street,
Sacramento, CA.

Dear Ms. Nichols,

I have been asked to review the animal nutrition discussion in the appended report to the Proposed Regulation to Implement the Low Carbon Fuel Standard (Vol. II) by the California EPA Air Resource Board. I have a Masters degree in Animal Nutrition from UC Davis Animal Science Department. I also have been employed by the University of California Cooperative Extension since 1982 working with the California livestock industry conducting applied research and educational programs. This experience gives me extensive practical knowledge of livestock diet formulation and management.

In the strict nature of the University, my comments are unbiased toward the outcome of the findings. My only desire is to make sure that the best science is used in the estimation or modeling that directs public policy decisions.

The document was difficult to review, due to poor referencing and a lack logical page numbering to the over 300 pages of information. The reader is given a reference to Appendix C with no direct page number to find the start of that section. Much time is loss searching the document to find the appropriate information to make a coherent comment. Of the references given for Appendix C that were animal nutrition related, fifty-eight percent had an incomplete citation to allow the reviewer to find and review the document. Both of these document deficits could indicate that staff had a limited amount of time to properly develop the document.

Animal nutrition expertise is greatly lacking in the discussion on pages C–51 to C–54. The performance of an animal can greatly differ based on the optimization of the ration of feeds provided and the animal's nutritional requirements. There is a great amount of University information on DDGS available. Most nutritionists use the National Research Council publications on Nutrient Requirements of Beef Cattle, Dairy, and Swine as the guide for nutritional composition of feeds. Single stomached animals (swine and rats) have very different digestive capabilities from ruminate animals (cattle and sheep). In most cattle operations, DDGS serves as a protein source and competes with soybean meal, canola meal, and cottonseed for diet utilization. The amount of use in diets will be determined by price. Like all by-product feeds, there is a limit to the amount that can be included in the diet.

On page C–52 it is stated that the nutrient concentrations in DDGS vary considerably. This is normal for by-product feeds and all livestock nutritionist and managers can address that in ration formulation. In almond hulls, the nutritional composition will depend on the fan adjustment that sorts hulls from shell and twigs that have much lower digestibility. Nutritional testing and ration construction using variable products is a normal operation in the industry. This also is applicable to the browning reaction concern stated. The feed is tested in a laboratory and the price and amount in the ration are adjusted to economically meet the performance needs of the animal. The document presents feeding as a static process, when it is very dynamic with varying animal nutritional needs and ability to adjust the diet to optimize the animal performance based on research and applied feed knowledge.

On page C–53 it is stated that "less protein in DDGS is available to the animal". Ruminate protein utilization is divided into two areas; rumen and bypass. The combination of both these provides the total protein utilization. The quote addresses the rumen protein utilization, but does not recognize the importance of bypass protein. This is an important aspect that needs to be acknowledged.

The concerns about lysine, sulfur and phosphorus in DDGS diets raised in the document again indicate the lack of animal nutrition knowledge represented in this section of the document. Ration formulation is again a process of analyzing of the feed's composition and optimizing the ration of different feed sources and supplements to meet animal requirements for different performance (growth, lactation and pregnancy). All of these concerns can be addressed in the ration formulation.

Transportation and handling of DDGS has occurred in California. I have observed large and small operations using the product and all have adapted systems to utilize the product without problems. Feed utilization is based on price for energy and protein content. If livestock producers find a lower priced product, they quickly invest in proper storage and feeding infrastructure. With 1.6 million dairy cows in California, at the right price and location of plants in the dairy production areas, transportation and utilization of WDGS would not be a problem.

On page C–54 the document demonstrates a lack of knowledge of the livestock feeding industry and the educational institutions that work with them. Producers are keenly aware of how to feed the product and both the California State Universities (Fresno, Chico and Cal Poly) and University of California have active applied research and education programs for growers on any issues if it should arise in using DDGS.

It is not made clear what "traditional feeds" are in the document in the first paragraph on page C–52 or how the LCFS model of DDGS utilization is developed. I have reviewed publication by Wang *et al.* (2008), and find it provides sound animal nutrition data to the analysis. It is a superior review and analysis of the DDDS utilization to the discussion in this document. This is an area that the staff clearly needs to educate themselves on to be able to competently make any conclusions that direct important policies of the State of California.

I disagree with the staff recommendations on DDGS. Livestock producers will use all the DDGS if it is produced and priced correctly. In California, it could displace canola meal in most rations, which is being shipped in from Canada for approxi-

mately $70/ton for transportation. This would greatly reduce the carbon footprint if the DDGS was produced in California.

I suggest that it would be prudent for the deliberation of this policy be extended. I invite the staff to engage the UC Davis Animal Science Department in the discussion of the correct method to use to evaluate DDGS ration utilization.

Sincerely,

GLENN NADER,
UC Livestock and Natural Resources Advisor.

EXHIBIT 16

Comment Log Display

Below Is The Comment You Selected To Display.

Comment 209 For Low Carbon Fuel Standard (LCFS09)—45 Day.

First Name: VIRGINIA
Last Name: DALE
E-mail Address: *vdale212@comcast.net*
Affiliation:

Subject: Great uncertainty surrounds Indirect Land-Use Change (ILUC) estimates; therefore ILUC fact
Comment:

April 22, 2009

California Air Resources Board
Headquarters Building
Sacramento, CA 95812

REF: Great uncertainty surrounds Indirect Land-Use Change (ILUC) estimates; therefore ILUC factors should be excluded until better data and documentation are available and scientifically peer-reviewed

Dear Board Members:

I am writing to recommend that CARB reconsider the proposal to include indirect carbon emissions from land-use change (or Indirect Land-Use Change—ILUC—factors) in the Low Carbon Fuel Standard (LCFS) rule. A delay in adopting the ILUC component of the proposal for GHG emission calculation is warranted because current ILUC emission factors are theoretical estimates rather than science-based calculations.

The ILUC implications of the LCFS are largely based on a global equilibrium model that is not capable of assessing impacts on indirect land use. Instead, natural resource extraction activities may very well be among the most significant factors contributing to the accelerated loss of natural habitat in the remaining forest zones of our planet. Based on my field work in the Brazilian Amazon, Panama, Guatemala and personal research in south and southeast Asia as well of review of numerous scientific studies, it seems that land-use change in developing countries is a combination of cultural, environmental, social, economic, political, and technological factors. Global market conditions often have a quite limited influence. In contrast to the model predictions, numerous studies suggest that improved prices and expanded market options for products, as expected under biofuel policies, reduce pressures for deforestation and provide tools and incentives to promote more sustainable land use.

The ILUC estimates carry significant uncertainty because they are based on: (a) a model that was never validated or calibrated for the purpose of estimating land-use change; (b) input data for land use with degrees of uncertainty much larger in magnitude than the changes modeled, casting considerable doubt on the validity of results; (c) one set of modeling results when the same model produced wide-ranging results for indirect land-use change in response to minor adjustments in assumptions and inputs (and there is ongoing debate surrounding the accuracy and validity of many of those assumptions, factors and inputs) as documented in the papers published on the GTAP website and for CARB in the past 24 months; and (d) a hypothesis for indirect land-use change that does not meet the "rules of reason" tests established in U.S. courts for indirect environmental impacts, exposing the LCFS rule to potentially serious implementation obstacles that could be avoided if the ILUC component were postponed until better data and analytical tools are developed.

Examination of the land use and economic models show that there is not currently any accepted approach for calculating indirect land-use change impacts from U.S. biofuel production and policy. GTAP has not been calibrated or validated for making

land-use change estimates. The GTAP modeling assumptions used to estimate ILUC do not come close to reflecting the conditions and forces that prevail in the areas where impacts are estimated to occur. Baseline land-cover and land-use data and other underlying assumptions for the modeling carry huge uncertainties, yet these uncertain inputs determine the results. The sensitivity of results is illustrated in part by the wide range of ILUC results reported among the GTAP reports issued on this topic in 2008 and 2009.

Several U.S. Court decisions have considered if and when indirect environmental impacts need to be incorporated under proposed government projects. The decisions can be assembled under "rules of reason" that help determine when indirect impacts should be incorporated. The basic question is, "Are the impacts (indirect land use change effects, in this case) reasonably certain to occur as a result of proposed action, or is the estimate (of ILUC) based on speculation?" There is a lack of consensus on this issue in the scientific community. But, several considerations from past court cases may help answer the "rule of reason" question:

(a) Are estimated ILUC impacts speculative within the context of all the other events, circumstances and contingencies that exist to enable the effect (*e.g.,* deforestation)?

(b) Is the impact (loss of natural habitat/deforestation) inevitable, independent of the proposed action and the theorized indirect impacts?

(c) Does the "precautionary principle" clearly favor one proposed action over another? (*e.g.,* What are the impacts on land-use change and deforestation if less biofuels are accepted under LCFS due to the assumed ILUC factors?)

(d) Is the estimated impact increasingly tenuous as inquiry extends outward from the core project area?

(e) If there is a "reasonably foreseeable" indirect impact, does it occur in a remote locale that is not under direct U.S. control?

(f) What is the "legally relevant cause" of the impact? (Is the ILUC impact isolated from the proposed action?)

Thus it cannot be concluded that the estimated indirect impacts are caused by the proposed action. In the case of the California LCFS, rather than include ILUC factors at this time as proposed, we recommend that a more prudent approach would be to identify these as possible indirect impacts and recommend mitigations to limit the likelihood of negative effects. Such mitigations could include adherence to sustainable production standards that are developed and monitored by third parties.

I applaud your pioneering efforts to establish a LCFS and support your initiatives to reduce emissions and improve welfare for present and future citizens. However the market-mediated land-use impacts hypothesized by GTAP and similar economic models are not merely inaccurate; they may indeed be estimating impacts that are opposite to what could be expected in the real world, particularly when biofuel production is backed by incentives for sustainable production, environmental legislation and enforcement. Much more work is needed to better understand the interactions among these factors, going beyond theories, to calibrate and validate models that reflect how behavior is impacted, and to better quantify the degree and direction of impacts from biofuels.

Sincerely,

VIRGINIA H. DALE, PH.D.,
212 Whippoorwill Drive,
Oak Ridge TN, 37830.

Attachment:
Original File Name:
Date and Time Comment Was Submitted: 2009–04–22 11:37:55

EXHIBIT 17

Comment Log Display

Below Is The Comment You Selected To Display.

Comment 128 For Low Carbon Fuel Standard (LCFS09)—45 Day.

First Name: GAL
Last Name: LUFT
E-mail Address: *luft@iags.org*
Affiliation:

Subject: comments on LCFS/land use

Comment:

One can argue the land use surcharge back and forth on a philosophic level and on the accuracy of the model. However, there are several fundamental problems with the way land use surcharge is applied. Generally speaking land use intensity is highly cyclical. It corresponds mainly a combination of demand and price for agriculture products. The report clearly stated the case for land use intensity increase with increased demand for bio-fuels. However, as seen recently, the price of agriculture commodities are only partially dependent on bio-fuel demand. In Q4 of 2008 we saw record production of ethanol but nonetheless corn and ethanol prices fell by 70%. This means that corn prices are more sensitive to oil prices than to demand from the biofuels industry. Put those two together, and the result is that as oil prices go up, commodity prices go up, corn prices go up and land use intensity goes up with it. Then we go through a period of oversupply with corresponding price reduction and land use intensity reduction. So to the extent that bio fuels offset the demand for oil and put a downward pressure on gasoline price, it moderates the increase in land use intensity.

The second error I see in the analysis is in the accounting of GHG emissions from the conversion of cattle pasture to agriculture (corn) land. Most cattle pasture in the U.S. is grass land. The cattle eats the grass and converts it to methane which is 23 times more potent then CO_2. As corn becomes more expensive, feed become more expensive so meat production becomes less economical. It is logical that meat growers will then lease their land to corn growers. As I see the reality of corn expansion, brand new barren land is the last resort. The growers will first grow more corn on the land they already cultivate, then they will use land that was cultivated in the past but is now idle (because it was not profitable to cultivate). Then they would use cattle pasture that is more productive than barren land. As I said, the calculation of land use change from cattle pasture to corn is incorrect because it does not take into account the root system (corn has a much more robust root system which capture more CO_2 than grass root system. Corn harvesting does not involve removing the roots from the ground.) and it only focuses on CO_2 which misses the potent GH effect of methane gas. Add to this the GHG emission of meat processing, packaging, freezing and transportation and you will get huge savings in GHG emissions when converting cattle pasture to biofuels crop.

The third error is ignoring the fact that the same market forces that increase the demand for corn ethanol and with it increase in land use intensity, will eventually find a cheaper alternative that will reduce the demand for corn ethanol and with it reduce the land use intensity: As land become more valuable and corn more expensive, corn ethanol will become more expensive too. This will further increase the effort to invest and produce ethanol from other sources such as cellulosic ethanol and ethanol from algae/seaweed. These new and cheaper sources will undermine the demand for corn ethanol which will reduce the demand for land eventually causing the land to revert back to its original use. This demand destruction is surly within the scope of the timeframe that the land use change surcharge applies to.

Attachment:
Original File Name:
Date and Time Comment Was Submitted: 2009–04–19 11:24:50

EXHIBIT 18

BIOMASS COORDINATING COUNCIL

RENEW THE EARTH

RECEIVED
MAR 2 3 2009
OFFICE OF THE CHAIRMAN
AIR RESOURCES BOARD

March 19th, 2009

Mary Nichols
Chairman
California Air Resources Board
1001 I Street
P.O. Box 2815
Sacramento, CA
95812

Dear Mary,

How well I remember your splendid work at the US Environmental Protection Agency.

There are a host of excellent reasons why indirect land uses calculations should not be included in determining the full fuel cycle carbon footprint of biofuels in California. Rather than repeat the already well articulated rationales, I would like to approach the matter from a different perspective – the value of the agriculture and forestry sectors to the California, the US and the world's economy today and in the years ahead.

As California and the United States struggle with current challenges, Americans can be assured of the commitment, hard work, creativity and sacrifices of farmers, ranchers and foresters. This has been true throughout our history. In most cases, being close to the land, they will correctly respond to reality if not encumbered by special interests of those overly protective of the status quo food and fuel industries.

In these troubling times, it is critical to recognize the irreplaceable value of "new-wealth industries." These are industries based on natural resources – mining (oil, gas, coal, metals and minerals); agriculture; aquaculture; silvaculture (forestry); all renewable technologies (based directly or indirectly on the sun) – biomass (biofuels, biopower and biothermal energy), solar, wind, geothermal, hydro and water power, and renewable hydrogen; recycling and reuse; and, human creativity. These natural resources have built this great nation. Some are being depleted and their loss threatens the national, energy and economic security of the United States. They must be replaced by others that are renewable and made sustainable by good stewardship and steadily improving land management.

New wealth industries are vital to the reconstruction of America during these trying times, given their economic multipliers (generally more than three, whereas service industries are limited to one or a little more). They create new basic industries and quality jobs; they have ready markets

-- many are "shovel ready", they encourage "positive, nation- and community-oriented" consumption and, contribute to national, energy, homeland, economic, and environmental security while reversing greenhouse gas build-up.

In our haste to recover economically, we are using stimulus dollars in supporting important service industries, police, fire fighter, teachers, public servants, marketers of goods and services to stimulate consumption, etc. versus generating new wealth industries. As valuable as these service professions are, they are, in fact, dependent on new wealth industries for their long-term sustainability.

America cannot recover without focusing on sustainable new-wealth industries.

Biofuels, biopower and biothermal energy play a critical role in our future; and will succeed because they are the products of American agriculture and silvaculture industries with significant support from the aquaculture, hunting and open stream fishing, renewable energy, recycling and reuse, and human creativity sectors. Mining, of course provides, essential support products. Human creativity is the driving force that demands a nation-wide focus on health, education and encouragement.

These are factors we must focus on for the future of California and the nation, and the decisions surrounding land use are critical.

In older times, open field and stream hunting and fishing were not only vital to survival; they also represented the beginning of new-wealth industries. While today these particular new wealth industries have diminished in value due to the commercialization of food products, they have increased in value as sporting industries with major economic benefits. More importantly, hunters and those who fish are becoming increasingly valuable as wildlife and environmental stewards. Accessibility to land is imperative to their operations.

Accessibility to land is also essential to the biopower, biothermal energy, biobased products, oil, gas, coal, tar sands, oil shale, housing and commercial development adding to urban sprawl into land used for crops and forests/wood lots. All of these enterprises should be subject to the same iLUC as biofuels. Isn't it logical to avoid discriminating against biofuels by applying the process to all forms of industry simultaneously at a time when the involved science and modeling are far more certain than they are today?

Our recovery and livelihood are dependent on strengthening our lands through sustainable practices such as good stewardship, farming/forestry practices and new-wealth industries.

A historic review of agriculture, forestry and livestock contribution to California's economic well being is testimony to the importance of these industries. A CARB decision to curtail or eliminate the biofuels industry from the state's transportation portfolio will, in my judgment, jeopardize the economic vitality of the state. Including an iLUC factor in the LCFS at this time will do just that.

Please recognize that the CARB decision on iLUC will have enormous impacts on the future of California, America and the world. To base the CARB decision on iLUC on yet-to-be-proven

science and imprecise economic modeling is premature at best and bad public policy. Two important additional factors:

- If iLUC governs in biofuels, it should also govern in biopower, biothermal energy, oil, gas, and coal mining, tar sands, oil shale, commercialization of land as the result of urban sprawl and development, etc.
- American farmers, ranchers and foresters are among the world's best. If solid science actually supports the realistic evaluation of iLUC, they will respond with corrective actions and practices as long as they are not seriously handicapped in the process. Their response is what differentiates biofuels, biopower and biothermal energy from their fossil competitors. First, fossil resources are finite -- dangerous shortages will occur whether it's in decades, generations or centuries. Secondly, the economic investments in non renewables are large and will, because of depleting resources, become more expensive. In the world of biomass and the other renewable energy industries, the basic resource, the sun, is essentially inexhaustible and technologies will advance with reducing costs. If mistakes are made, they can be corrected if farmers, ranchers and foresters are free to proceed under the guidance of an enlightened government, and economic and environmental imperatives.

Consequently, I request that the iLUC issue be set aside until solid science justifies corrective action, giving the biofuels industries sufficient time to advance their technologies and join with a wide range of collaborators to significantly increase the growth of biomass on land that is currently contaminated, misused or underused. A sustainable focus on biomass enhancement will, in turn, improve watershed, wetlands, riparian buffer zones, and wildlife habitat and nature preservers. Western Europe provides a successful example of such sustainable land use practices.

This focus will bring together farmers, ranchers and foresters with environmentalists, public interest groups, naturalists, enlightened hunters and fishermen and others in common cause; whereas an unwise CARB decision will pit one factor against the other. Additionally an enlightened California decision on iLUM could well lead to a wide range of Americans working collaboratively with the people of the developing nations so they too can optimize land use, vitalize their soils, conserve their water, protect their wildlife and move forward into a fully sustainable world economy.

Respectfully,

Bill Holmberg
Chair, Biomass Coordinating Council
America Council On Renewable Energy; and
Chair, Renew the Earth

EXHIBIT 19

April 3, 2009

MARY D. NICHOLS, *Chairwoman,*
c/o Clerk of the Board
Air Resources Board,
1001 I Street,
Sacramento, CA.

Dear Ms. Nichols,

I am writing to comment on California's proposed low carbon fuel standard (LCFS).

While the LCFS clearly has noble intentions, it is flawed because it includes indirect land use charges to biofuels. These charges are unprecedented—for example, does CARB do any of the following?

- Charge electric or hybrid automobiles for the GHG emissions from the fossil energy power plants used to provide their electricity (or for the indirect heavy-metal emissions from mining operations needed to produce their batteries).
- Charge $100k electric automobiles with the indirect GHG emissions caused by their manufacture (probably ~7x those of a small gasoline powered vehicle).
- Charge bicycles (I'm a longtime bike commuter) for the indirect GHG emissions due to the longer life expectancies and bigger appetites of riders.
- Charge gasoline for the indirect GHG from the military actions aimed at securing Mideast oil.

How rational is the proposed policy if biofuels must account for their indirect GHG impacts while other fuels/modalities don't have to?

Indirect land use effects are real, but difficult to quantify. But indirect impacts of transportation fuel sources go ***far*** beyond what Searchinger *et al.*[1] and Fargione *et al.*[2] have captured in their analyses, and therefore regulation on this "partial truth" basis is wrong. A first step in the right direction might be to charge fuels for their direct GHG emissions—this would still drive us toward better solutions—but in a more rational manner.

Thank you for considering my comments. I would like to emphasize that they are mine alone, and not those of my university, institute, or department.

D RAJ RAMAN, PH.D., PE,
Associate Professor, Agricultural & Biosystems Engineering,
Associate Director of Educational Programs, Bioeconomy Institute,
Iowa State University.

EXHIBIT 20

Comment Log Display

Below Is The Comment You Selected To Display.

Comment 5 For Low Carbon Fuel Standard (LCFS09)—45 Day.

First Name: RICHARD
Last Name: OTTINGER
E-mail Address: *rottinger@law.pace.edu*
Affiliation: *Dean Emeritus,* Pace Law School

Subject: Land Use Valuation for LCFS
Comment:

I strongly endorse the views expressed in the letter to The ARB submitted by Carol Werner, Executive Director of the Environmental and Energy Study Institute. While I am Chair of the EESI Board of Directors, I also am a Former Member of Congress (1964–1985), chairing its Energy, Conservation & Power Subcommittee; Faculty Member of Pace Law School and Chair of its Energy and Climate Center;

[1] Searchinger, T., Heimlich, R., Houghton, R. A., Dong, F., Elobeid, A., Fabiosa, J., Tokgoz, S., Hayes, D., and Yu, T.-H. (2008) *Use of U.S. Croplands for Biofuels Increases Greenhouse Gases Through Emissions from Land-Use Change,* SCIENCE 319 (5867) pp. 1238–1240.

[2] Fargione, J., Hill, J., Tilman, D., Polasky, S., Hawthorne, P. (2008) *Land Clearing and the Biofuel Carbon Debt,* SCIENCE 319 (5867) pp. 1235–1238.

and Chair of the Energy and Climate Specialty Group of the IUCN Commission on Environmental Law.

The views expressed by Ms. Werner on the unreliability of land use valuations in determining the costs and benefits of bioenergy production are sound. There is no sound way of knowing what value to be placed on the indirect effects of land use on biofuels production in light of the inability to ascertain the effects of other land use demands. Also it is unwise to single out biofuels for such a valuation, ignoring the land use consequences of fossil fuel, nuclear and other energy resources; even solar and wind projects have land use consequences, equally unmeasurable.

Bioenergy unfortunately has achieved strong negative bias from many environmental organizations because of the ill food effects of U.S. corn crop as a biofuel feedstock and the Indonesian catastrophe of using deforested areas and peat bog destructions to plant palm plantations for biodiesel. Standards need to be adopted to prevent such practices and are being developed, most particularly by the Roundtable on Sustainable Biofuels of the École Polytechnique Fédérale de Lausanne. But putting a false value on land use just for Bioenergy, practically making it unmarketable, is bad energy and climate policy.

Respectfully submitted

RICHARD OTTINGER,
Dean Emeritus,
Pace Law School.

Attachment:
Original File Name:
Date and Time Comment Was Submitted: 2009–03–19 07:27:39

EXHIBIT 21

UNIVERSITY OF ILLINOIS
AT URBANA-CHAMPAIGN

Department of Animal Sciences
College of Agricultural, Consumer and Environmental Sciences
132 Animal Sciences Laboratory
1207 West Gregory Drive
Urbana, IL 61801

April 7, 2009

Mary D. Nichols, Chairwoman
c/o Clerk of the Board
Air Resources Board
1001 I Street
Sacramento, CA 95814

Chairwoman Nichols:

I am writing to express my concern with the inaccuracies regarding the assessment of the fuel ethanol co-product, Distiller's Dried Grain with Solubles (DDGS) presented in the California Air Resource Board's (CARB) proposed rule for the development of a Low Carbon Fuel Standard (LCFS).

I provide these comments as an animal nutritionist with 28 years of internationally recognized research and extension work in the field of poultry nutrition as a faculty member in the Department of Animal Sciences at the University of Illinois. A significant area of focus of my research has been in the area of protein quality and amino acid availability.

My concerns arise from the lack of accurate information, and thus conclusions drawn from that information, on the treatment of DDGS provided in Appendix C11 of the proposed rule. These inaccuracies are as follows:

1. CARB suggest that "livestock are only able to digest and metabolize 16.8-28.8 percent of the DDGS protein fraction.

   Comments: This statement is grossly incorrect. Typical DDGS protein and amino acid digestibility for poultry and swine range from 70-80%. CARB did not utilize the bulk of the data available from conventional DDGS studies on protein and amino acid digestibility.

2. CARB suggests that "High phosphorous levels in DDGS also lead to increased excretory phosphorous, a likely manure management issue for the livestock farmer."

   Comments: A benefit of DDGS over conventional corn is the presence of phosphorous in a form that is more digestible in the poultry and swine diet. Because of this, there is less

of a requirement for adding additional phosphorous to these diets. Environmentally phosphorous would be present whether provided from the feed or as an added nutrient and can be effectively managed. Phosphorous is a very expensive nutrient, its available in DDGS at the 65-75% level, versus at the 25-30% level in corn. This minimizes the requirements and cost for adding phosphorous to the diet.

3. CARB Staff summarizes that "From the analysis presented, it is evident that significant barriers to the widespread adoption of DDGS as a livestock feed exist."

   Comments: Again, this statement is grossly incorrect and has no basis. DDGS has been used for over a century, first in the form of brewers' grains, and more recently, from ethanol plants. There is now broad spread adoption and broad use. The product provides a value added option for nutritionists in ration development.

4. CARB Staff summarizes that, "One factor not discussed to this point is the price of DDGS. With rising corn prices from increased demand for ethanol, prices are likely to rise for DDGS. Higher prices render DDGS less cost-effective as a replacement feed, particularly where soybean meal is to be replaced.

   Comments: This comment again makes no sense. DDGS is used broadly because it is cost effective. Nutritionists wouldn't use it if it were not. Market values for animal feed products compete based on the nutritional value they provide. DDGS competes in this market with corn, soybean meal and other products.

Animal nutritionists, agricultural extension agents and livestock managers have spent decades studying, incorporating, and optimizing DDGS in the animal feed. It is disappointing, at best, that CARB has not utilized the expertise and knowledge of the scientific community in their recommendations for the appropriate treatment of corn based ethanol in its LCFS determinations. With the consequences of inaccurate analysis leading to conclusions that could harm, rather than help our environment, I would consider it prudent to ensure appropriate expertise and knowledge are brought to bear for the benefit of us all.

Sincerely,

Carl M. Parsons

Dr. Carl Parsons
Professor

EXHIBIT 22

University of Illinois at Chicago

Energy Resources Center (MC 156)

College of Engineering

April 15, 2009

California Environmental Protection Agency,
Air Resources Board,
Byron Sher Auditorium, Second Floor,
1001 I Street
Sacramento, CA

Subject: Comments on Corn Ethanol Land Use Change Analysis in the Proposed Regulation to Adopt the Low Carbon Fuel Standard

Dear Air Resources Board:

Page IV–19 of the "Proposed Regulation to Implement the Low Carbon Fuel Standard" states:

> *"A sufficiently large increase in biofuels demand in the U.S. will cause non-agricultural land to be converted to crop land both in the U.S. and in countries with agricultural trade relations with the U.S. Models used to estimate land use change impacts must, therefore, be international in scope"*

We disagree with the above statement and believe that a thorough regional analysis of direct and indirect land use change is superior to the employment of models that are international in scope. These international models require a host of input variables (some of which are shown in Table C5–1) with unknown probability distribution functions. A localized, or bottom-up modeling approach detailed below is superior and consistent with the look up tables provided in Table IV–20. The bottom up approach demonstrates that there is no reason why the "Land Use or Other Effect" values in the look up table cannot vary by pathway similar to "Direct Emissions."

In most cases, ethanol plants source corn from localized, geographically distinct areas surrounding the plants. Our study at the Illinois River Energy Center (IRE) ethanol plant in Illinois which includes a survey of 30 growers delivering corn to this 58 mgpy plant shows that farmers deliver corn within a 40 mile radius "corn draw area" or "CDA" (see Mueller, October 2008). ProExporter Network, a grains flow consulting firm also regularly establishes CDA's based on local transport conditions and grain commodity prices. Since an ethanol plant's effect on corn supply starts with an easy to establish, geographically limited area we argue that any land use analysis of corn ethanol must start with an analysis of the yields, crop rotations, and land use conversions in that CDA.

As a modeling example we assess land use for IRE's CDA using high resolution satellite imagery with additional vetting routines (see Mueller, December 2008). We find that (a) no significant conversion of non agricultural land to corn occurs, (b) yield increases surveyed for the CDA are sufficient to meet the ethanol plant's corn demand, and (c) changes in crop rotations are not explained by the ethanol plant's corn demand. The study concludes that the operation of the Rochelle Illinois ethanol plant does not contribute to land use change. Therefore, greenhouse gas emissions from IRE related land use change are insignificant. The lifecycle global warming analysis for IRE produced corn ethanol (including farming, conversion, distribution, denaturing) totals 54.8 gCO_2e/MJ as established by parameterizing GREET for the surveyed agricultural practices in the CDA and IRE's corn processing technologies (N-inputs, yields, plant fuel and electric use, *etc.*). IRE started operation in December 2006 and the plant technology is representative of approximately 3 billion gallons of corn ethanol produced today.

We realize that this is a case study of one particular plant. And, we do agree that a different ethanol plant built in a less productive agricultural area and different commodity flows may contribute to land use change. It follows that the share of land use effect from each ethanol plant differs from plant to plant but that these different shares cannot be captured by international trade models. High resolution satellite imagery is available to assess the land use effect for each plant from the bottom up. In contrast, high resolution satellite imagery is not available to model international land use change prompted by biofuels production (see Mueller, March 2009). Therefore, it is scientifically unsound to assign one land use effect value (30 gCO_2e/MJ) to all corn ethanol produced, a value that is derived with an international trade model with input variables of unknown probability distributions.

We are currently expanding our bottom-up modeling approach to include more ethanol plants. We urge CARB to provide a mechanism to allow individual ethanol producers to demonstrate their plant's impact on land use change.

Best Regards,

STEFFEN MUELLER, PH.D.,
Principal Economist;

KEN COPENHAVER,
Senior Engineer.

Attached References:

Mueller, S. and K. Copenhaver, M. Wander. "The Global Warming Impact and Land Use Impact of Corn Ethanol Produced at the Illinois River Energy Center"; October 20, 2008.

Mueller, S. and K. Copenhaver. "A Bottom-Up Assessment of Land Use Related to Corn Ethanol Production"; December 11, 2008.

Mueller, S. and K. Copenhaver. "Use of Remote Sensing to Measure Land Use Change from Biofuels Production"; March 26, 2009.

ATTACHMENT 1

The Global Warming and Land Use Impact of Corn Ethanol Produced at the Illinois River Energy Center

Prepared By:
Steffen Mueller, University of Illinois at Chicago,
Energy Resources Center
muellers@uic.edu
(Principal Investigator)

Ken Copenhaver, Institute for Technology Development
Michelle Wander, University of Illinois at Urbana-Champaign

Modeling support provided by:
Life Cycle Associates LLC

Prepared For:
Illinois Corn Marketing Board
David Loos
and
Illinois River Energy
Martha Schlicher

Revised October 20, 2008

Executive Summary

This study assessed the global warming impact (GWI) of ethanol produced at the Illinois River Energy ethanol plant (IRE) on a life cycle basis. IRE is located 80 miles west of Chicago. The plant currently produces 58 million gallon per year of ethanol with an expansion underway to double capacity.

The life cycle assessment includes the GWI contributions from corn agriculture, corn to ethanol conversion at the IRE biorefinery, distribution to the terminal, and combustion.
The analysis was performed using Argonne National Laboratory's GREET model with customizations based on different data sets:

1. We collected detailed data on agricultural practices within the corn draw area around IRE. A survey was conducted with 29 corn growers supplying 2,528,850 bushels of corn to IRE or 12% of all delivered bushels (representative of about 6.9 million gallon of ethanol production). The survey assessed key agricultural variables including fertilizer application rates, tractor fuel use and other on-farm fuel consumption, and yields.

2. Using the USDA NASS Cropland Data Layer (developed from satellite imagery) combined with the National Land Cover Dataset we determined the crop rotations and land use changes (including land conversions from non agricultural uses) within the IRE corn draw area.

3. From a literature survey we determined different methodologies that account for the nitrogen and carbon adjustments from land use changes. Based on these methodologies we determined nitrogen emissions and carbon sequestration rates for the IRE corn draw area.

The three data sets were used to parameterize GREET. The results show that IRE produced corn ethanol has a substantially lower GWI of 54.8 g CO_2e/MJ than the current GREET default value for corn ethanol of 69.1 g CO_2e/MJ (a 21% reduction). This reduction is primarily due to higher corn yields, reduced on-farm energy consumption, and reduced energy consumption at the biorefinery. Compared to gasoline, the GWI of IRE corn ethanol is 40% lower (54.8 g CO_2e/MJ vs. 92.1 g CO_2e/MJ for gasoline). These results exclude the impact from indirect and international land use changes. Including the current GREET default factor for land use change would increase the GWI of IRE ethanol by 0.7 g CO_2e/MJ to 55.5 g CO_2e/MJ.

IRE is currently exploring advanced technologies that may further reduce the GWI of its ethanol product including corn fractionation and a digester to offset natural gas consumption with biogas. The results also indicate that if advanced agricultural management practices such as no-till and winter crops were promoted, the GWI of IRE corn ethanol could drop to as low as 41.4 g CO_2e/MJ or a 55% reduction from gasoline.

Finally, the study finds a much lower on-farm energy consumption of 7,855 Btu per bushel for IRE supplied corn than the current GREET default value of 22,500 Btu per bushel (representing US national average). The large difference should prompt a reassessment of GREET's agricultural energy default value.

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Introduction

This study assessed the global warming impact (GWI) of ethanol produced at the Illinois River Energy ethanol plant (IRE) on a life cycle basis. The life cycle assessment includes the GWI contributions from corn agriculture, corn to ethanol conversion at the IRE biorefinery, distribution to the terminal, and combustion. The analysis was performed using Argonne National Laboratory's GREET model. The GREET model was customized using data collected from a survey on agricultural practices around the IRE plant, an assessment of crop rotations using satellite imagery, and an assessment of N_2O emissions and carbon sequestration processes based on published literature. The individual data sets and the GREET modeling approach are detailed in this report.

1. Survey Data

1.1 Survey Variables

The survey instrument (see Appendix A) was designed to explore agricultural practice variables included in global warming impact (GWI) assessments. The survey instrument was designed by IRE plant personnel and reviewed by representatives from the Illinois Corn Growers Association and the University of Illinois at Chicago.

The survey asked each respondent a total of 12 questions, grouped into three types in the following order on the survey instrument.

Type A: Agricultural Productivity Variables
These types of variables explore the acreages planted, the crop rotations, and the current and historical yields. For the purpose of a GWI assessment these variables are particularly relevant in an assessment of the direct and indirect emissions from land use change.

Type B: Corn Cultivation Practices
These types of variables assess the tillage practices and agricultural chemical use (fertilizer pesticide, fungicide) as well as the type of corn traits planted. The GWI varies with agricultural practices since, for example, conservation tillage allows for more carbon sequestration in the soil. The types and amount of agricultural chemicals are important since the different chemical compounds applied to the land not only require significant amounts of energy during their production process (a contributor to GWI) but these chemicals may also be greenhouse gases themselves or transform into a greenhouse gas. For example, nitrogen in the fertilizer is transformed into the powerful greenhouse gas nitrous oxide.

Type C: Farm Energy Use
These types of variables explore the fossil fuel consumed by each grower for corn planting, harvesting and transportation to IRE as well as that used for corn drying. The fossil energy used for these purposes is a direct contributor to the GWI of biofuels.

1.2 Survey Sample Frame

IRE has a database of all growers delivering to the ethanol plant. To assure that growers from each county would be selected a stratified random sampling process by county was employed.

A pre-test of the survey instrument was performed during a growers meeting at the IRE plant on March 26, 2008. About 20 growers attended the meeting. The feedback obtained on the survey instrument at the growers meeting was incorporated into the actual survey instrument.

1.3 Survey Response Characteristics

During the time frame of March 2007 through February 2008 a total of 272 growers delivered directly to IRE. Grower direct delivered corn accounts for about 75% of IRE's total corn feedstock of 20,450,000 bushels. The remainder is sourced from grain elevators. Tracing the agricultural practices of corn from grain elevators is difficult due to the mixing of corn from many farmers at these facilities. Therefore, only the agricultural practices of corn directly delivered to the facility by growers was assessed.

The survey was sent out by mail to a total of 100 growers. The following "response facilitators" were incorporated into the survey to increase response rates: a) the survey was sent out with a personalized cover letter, b) a return postage envelope was provided, and c) a prior request to fill out the mailed survey was made by email and/or a telephone call. In addition, about 25% of the surveys were completed during follow up telephone calls and direct visits with the individual growers. Out of the 100 mailed surveys 31 surveys were returned resulting in a response rate of 31%. Two of the returned surveys had to be excluded: one was missing basic classification information (in this case the total amount of delivered bushels), the other respondent did not deliver corn to IRE during the time frame.

The 29 returned survey respondents delivered 2,528,850 bushels to IRE or 12% of all delivered bushels (representative of about 6.9 million gallon of ethanol production). Individual survey respondents delivered between 8,000 to 355,000 bushels. The respondent with the largest delivery (355,000 bushels) accounts for 14% of the surveyed quantity of corn. This relatively low number assures that no individual survey can introduce a significant bias to the survey results based on size of bushels delivered.

One survey question asked the respondents in which county/counties they grow corn. Figure 1 below shows the results. As can be seen growers from all surrounding counties

responded to the survey, as would be expected from a stratified random sampling procedure.

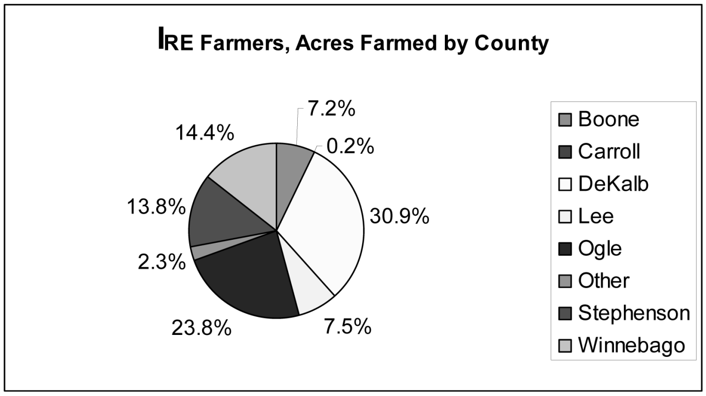

Figure 1: Survey Responses by County

2 Survey Data Analysis

The data obtained from the survey instrument is analyzed below.

2.1 Yield

The survey respondents report steady average yield increases between the 2005, 2006, and 2007 growing seasons. Table 1 and Figure 2 below summarize the results. Yields in 2007 at 196.1 bushels per acre are on average 17% higher than those in 2005. The consistent standard deviations indicate that no single farmer introduced a significant bias in any one year.

Table 1: Surveyed Yields

	2005 Bu/acre	2006 Bu/acre	2007 Bu/acre
Yield	167.4	183.1	196.1
STD	23.3	23.3	19.5
N=28			

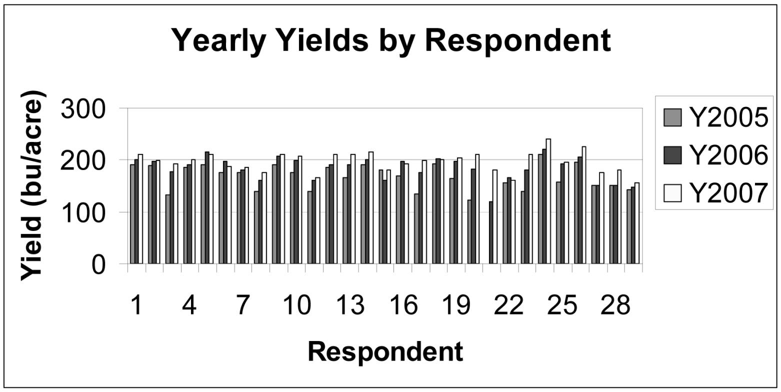

Figure 2: Yields by Respondent

2.2 Tillage Practices

The respondents were asked whether they employ a) conventional tillage, b) minimum tillage, c) no till, or d) strip till. The tillage methods differ by the amount of biomass left above ground: Conventional tillage leaves less than 10% of biomass above ground, minimum till leaves 30%-60% above ground, strip till about 70-80%, and with no till about 90% of the biomass remains on top. Applying the surveyed percentages of practiced tilling to the amount of corn delivered to IRE results in a conservation tillage rate (generally defined as no-till plus strip till) of 13%. The results are shown in Figure 3. The analysis assumes that farmers apply the same tillage practices to all of their farm land including land used for IRE production.

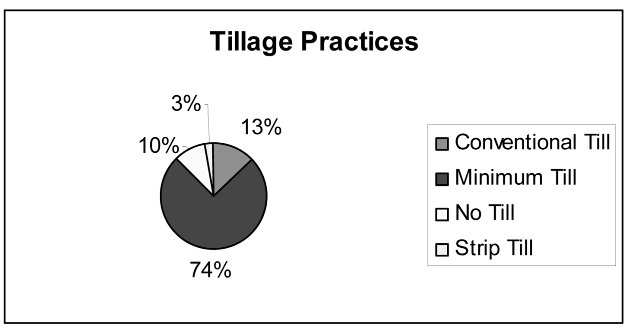

Figure 3: Tillage Practices around IRE
Note: Graph is based on 2,478,850 delivered bushels. One farm did not report tillage practices

The survey also asked respondents about the number of tractor trips made each year across the field. Table 2 below indicates that the till practices correlate with the reported tractor trips across the fields.

The respondents that utilize majority no till reported on average fewer tractor trips (4.7) than those employing conventional till (6.1 tractor trips). Note that these values are based on relatively few respondents.

Table 2: Tractor Trips and Tillage Practices

	Conventional Till Tractor Trips	No-Till Tractor Trips
Mean	6.1	4.7
STD	1.9	1.2
N=	8	19

2.3 Corn Transportation to IRE

On average corn is transported 29.5 miles one-way by truck to the plant. While the survey instrument asked for the one-way hauling distance to IRE we suspect that some respondents may have answered this question on a per trip- or round trip-basis. For example, one grower reported a 90 mile one-way transportation distance that is likely a round trip distance based on the indicated farmed counties. The stated fuel economy is also very low at 3.4 miles/gallon. While surveyed transportation distances are high and the fuel consumption is likely low, no adjustments to the data was made as a conservative measure.

Table 3: Corn Transportation

	Transportation Distance to IRE	Corn Transportation Fuel Consumption
Mean	29.5	3.4
STD	21.6	1.5
N=	29	9

2.4 Fertilizer Program

The survey asked respondents what type of fertilizer products they use. Table 4 shows the results.

Table 4: Type of Fertilizer Product Used

	Nitrogen as NH_3	Nitrogen as 28%	Nitrogen as 32%	N-P-K as 18-46-0	N-P-K as 0-46-0	N-P-K as 0-0-60	Ammonium Sulfite	Ag-Lime
Number of Growers	17	5	13	14	6	21	1	8
N=27								

All surveyed growers apply nitrogen fertilizer to the crop. The most common form of nitrogen fertilizer used is in anhydrous form as NH_3 (ammonia). Some growers use 32% liquid N fertilizer and 28% liquid N fertilizer, often in combination with NH_3.
On average 368 g/bu of nitrogen are applied. Where growers apply nitrogen via a combination of NH_3, 28%, 32%, or 18-46-0 the total amount of N is calculated based on the mass fraction of N.[1]

Table 5: Nitrogen Application

	lb/acre	g/bu
Mean	159	368
STD	40	90
N=27		

Most growers also apply phosphorus and potash nutrients to the crop using 18-46-0 and 0-0-60 fertilizer and respectively. Some growers also use 0-46-0 for phosphorus applications. Table 6 below shows the application rates for phosphorus. Rates are consistent with the U of I Agronomy Guide.

Table 6: Phosphorus Application

	lb/acre	g/bu
Mean	64	147
STD	51	109
N=26		

Note: 5 respondents do not apply P

Table 7 below shows the potash application rates.

[1] The correlation coefficient between N applied and yield was calculated. At -0.12 the correlation coefficient is weak. The negative sign may indicate that further N application may not increase yield. However, the study design and collected data is likely insufficient to perform a yield response analysis.

Table 7: Potash Application

	lb/acre	g/bu
Mean	118	278
STD	72	164
N=26		

Note: 3 respondents do not apply K

Only 8 growers reported the application of lime on an "as needed" basis. Based on the assumption that farmers apply lime one in five years, we divided the value by 5 and assume that this amount is used for all acres within the area of concern. The reported lime application rates are likely of low reliability.

Table 8: Agricultural Lime Application

	lb/acre	g/bu
Mean	449	1,095
STD	1297	3268
N=27		

Note: 21 respondents do not apply lime

2.5 Corn Trait Selection

Another survey section assessed the growers' corn trait selection. Respondents indicated that the vast majority of delivered bushels have genetically enhanced organisms (GEO) traits (89%) and the vast majority of GEO corn is triple stack type. Figure 4 below indicates the make up of the corn trait by bushel.

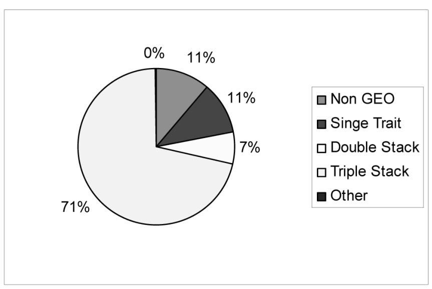

Figure 4: Corn Trait Selection of Farmers Supplying to IRE
Note: N=27

2.6 Insecticide and Herbicide Programs:

This section of the survey asked about the insecticide and herbicide program employed by growers. Aztec (tebupirimphos and cyfluthrin) and Roundup (glyphosate) are the most commonly used insecticides and herbicides, respectively. The application rate for insecticides ranges from 4 to 8.5 lbs per acre. The rate for herbicides ranges between 2-4 quarts. These values were not statistically evaluated.

2.7 Corn Drying

The majority of respondents (26 out of 29) indicated some form of propane or natural gas drying. However, the dataset was difficult to evaluate since some stated the propane/natural gas cost and some stated the total use in gallons. For the purpose of this study the respondents that stated the use in gallons were evaluated and the mean gal/bu was calculated. The results are shown in Table 9 below. The derived number was supported by an additional, in person, interview with an IRE corn grower. The calculation assumes that corn delivered to IRE is treated the same as corn handled for other markets. In a separate personal conversation with a corn grower delivering to IRE it was pointed out that IRE may have a slightly stricter standard for accepting partially dried corn than other markets. The average gallons of fuel for drying are shown in Table 9 below.

Table 9: Fuel Consumption for Corn Drying

	gal/bu
Mean	0.029
STD	0.012
N=6	

Electricity is also used during the drying process primarily to run fans and pumps. Table 10 below lists the average use of electricity reported by the respondents. Note that electricity use was surveyed on a cost basis and converted to kWh based on an assumed rate of $0.1/kWh.

Table 10: Electricity Consumption for Corn Drying

	kWh/bu
Mean	0.31
STD	0.29
N=8	

2.8 Growing Cycle Fuel Use

Growing cycle fuel use falls into three categories: fuel used by the grower in tractor trips across the field, fuel used by contractors (referred to as custom machine hire) and for hauling corn back to the farm. Table 11 below shows the fuel used by the grower.

Table 11: Grower Fuel Use

	gal/acre	gal/bu
Mean	5.5	0.028
STD	2.2	0.011
N=18		

In a second analysis of grower fuel use the correlation coefficient between surveyed fuel consumption and the surveyed number of trips was calculated. While the coefficient is weak at 0.35 it is positively correlated meaning that, as expected, fuel consumption increases with increasing number of trips.

Custom machine hire varies by task. Table 12 below shows the percent of acres that farmers hire out by task. Fertilizer and pesticide applications are contracted out the most.

Table 12: Custom Machine Hire by Task

	Fertilizer Application	Pesticide Application	Combining of Crop	Crop Hauling
Mean	55.8%	28.0%	14.3%	16.9%
STD	48.0%	53.6%	33.1%	37.2%
N=24				

The fuel consumption for custom machine hire is calculated by first calculating the value of fuel consumption per custom machine hire trip. This value is derived by dividing the total fuel consumption per bushel in Table 11 above by the number of trips across the field. Then, the ratio of custom farmed acres to total farmed acres for each farm is calculated and multiplied by the gal/bu/trip to derive the gal/bu of custom machine hire for each type of machine hired. This value assumes that the acres dedicated to IRE corn farming are treated the same as the rest of the farm acres. The results are shown in Table 13 below.

Table 13: Fuel Consumption for Custom Machine Hire

	Fertilizer Application (gal/bu)	Pesticide Application (gal/bu)	Combining of Crop (gal/bu)	Crop Hauling (gal/bu)	Total Custom Machine Hire (gal/bu)	Total Custom Machine Hire (Btu/bu)
Mean	0.0026	0.0024	0.0012	0.0011	0.0073	933
STD	0.003381	0.005616	0.002957	0.002878		
N=14						

The fuel share of grower fuel and custom machine hire is about 95% diesel and 5% gasoline.[2] Based on these fuel shares and the respective heating values for diesel and gasoline Table 13 also shows combined custom machine hire fuel consumption in Btu/bu.

Corn transportation from the field to the farm (input hauling) was not assessed in the survey. Based on a personal interview with a farmer delivering to IRE on average hauling will include a 5 mile trip (10 miles roundtrip) by truck.[3] Utilizing the above surveyed fuel economy of 3.4 miles/gallon and 950 bu/trip results in an adder of 0.003 gallons/bu or 384 Btu/bu (converted based on fuel shares and respective heating values, see above). This number can be considered conservative since it is a) based on a very conservative (high) truck fuel economy b) some farmers may deliver corn directly to IRE rather than first hauling it back to the farm.

2.9 Irrigation Energy Use

The respondents were asked about irrigation practices. None of the respondents indicated using any form of irrigation.

[2] Personal conversation with Paul Taylor, Rochelle, IL
[3] Personal conversation with Paul Taylor, Rochelle, IL

3. Ethanol Plant Production and Logistic Data

The IRE ethanol plant started operation in December 2006. The plant utilizes a natural gas fired boiler for steam generation and natural gas fired rotary drum dryers. Table 14 below lists the plant production and logistics data for the first 12 months of operation at full capacity (March 2007 through February 2008).

The majority of whole stillage is converted and sold as DDGS, a small fraction of WDG is also sold. All of the DDGS is sold to Asia. The DDGS is sold via backhaul arrangements (if the containers were not loaded with DDGS they would likely go back empty). All corn is shipped to the ethanol plant by truck. Likewise, the majority of ethanol is shipped to the terminal by truck, a smaller fraction by rail. In March, IRE started selling E85 ethanol directly to a retail gas station approximately 10 miles away. The fraction of retail sales and associated logistics are not considered in this study.

Table 14: Ethanol Plant Production and Logistic Data

	Unit	Value
Plant Performance:		
Annual total anhydrous ethanol production	gallon per year	55,820,804
Annual total denatured ethanol production	gallon per year	57,812,280
Description of denaturant used (type)	Debutinized Natural Gasoline	
Average ethanol yield per bushel (anhydrous)	gal/bu	2.73
Plant Energy Systems:		
Annual total natural gas consumption HHV	Btu	1,671,765,900,000
Annaul total electricity consumption	kWh	39,898,320
Natural Gas (HHV) per unit Anhydrous Ethanol Production	Btu/gal	29,949
Natural Gas (HHV) per unit Denatured Ethanol Production	Btu/gal	28,917
Natural Gas (LHV) per unit Anhydrous Ethanol Production		26,981
Natural Gas (LHV) per unit Denatured Ethanol Production		26,051
Electricity per unit Anhydrous Ethanol Production	kWh/gal	0.71
Electricity per unit Denatured Ethanol Production	kWh/gal	0.69
By-Products:		
Annual total DDGS production	tons	153,213
Annual avg DDGS moisture	%	11
Annual total WDG(S) production	tons	13,488
Annual avg WDG(S) moisture	%	30

Annual total S production - as product sold	tons	5,036
Annual avg S moisture	%	60
Transportation Logistics:		
Corn by truck	%	100
Corn by rail	%	0
DDGS shipments by truck	%	Backhaul Shipment
DDGS shipments by rail	%	Backhaul Shipment
DDGS shipments by ship	%	Backhaul Shipment
WDGS shipments by truck	%	100
Ethanol shipments by truck	%	98
Ethanol shipments by rail	%	2
Ethanol shipments by barge	%	0
Avg ethanol distance transported by truck (per trip - one way)	mi	80
Avg ethanol distance transported by rail (per trip - one way)	mi	1,000
Avg ethanol distance transport from terminal to retail outlet (per trip one way)	mi	10

4. Global Warming Impact Modeling of IRE Corn Ethanol Using the GREET Model

The agriculture on-farm energy assumptions in the current GREET 1.8b version are based on USDA data collected in 1996 (Shapouri, Duffield et al. 2002). Although more recent data has been collected by the same group and summarized based on 2001 USDA surveys GREET has not been updated to reflect the newer data (Shapouri, Duffield et al. 2004). Instead, it appears that adjustment factors to the 1996 data set were applied to derive the current GREET on-farm energy value of 22,500 Btu/bu. Yield and fertilizer inputs are updated frequently: GREET 1.8b yield and fertilizer data is based on 2006 USDA statistics.

For this analysis, the agricultural energy input tables for both USDA data sets (1996 and 2001) were recreated to allow substitution with surveyed IRE corn agriculture values. The results are shown in Table 15. The fist and third columns show the average corn farming values for the state of Illinois and the United States from the 1996 USDA data set, respectively. Substituted IRE surveyed data are shown in bold in the second column. As can be seen a much higher yield of 196.1 bu/acre was substituted for the 126 bu/acre published in the IL-1996 data set and the 125 bu/acre in the US average-1996 data while nitrogen application rates per acre are similar for IRE compared to Illinois average (159 vs 160 lbs/acre). Also, diesel and gasoline consumption at 5.5 gal/acre for IRE corn agriculture are lower than the Illinois average of 10 gal/acre. The default values for LPG, electricity, and natural gas from the USDA Illinois average were used since the survey

results for these data points are less reliable.[4] This is also the case for agricultural lime application (not shown). In summary the overall IRE corn agriculture energy consumption is much lower at 7,855 Btu/bu than Illinois average 18,230 Btu/bu and US average 23,075 Btu/bu for US average.

The fourth column shows the updated farming energy assumptions (USDA 2001 data) resulting in already substantially lower energy assumptions (16,176 Btu/bu) than currently used in GREET (22,500 Btu/bu). Substituting IRE surveyed values into this template results in IRE agricultural energy consumption of 7,192 Btu/bu.

Table 15: IRE and USDA Agriculture Parameters

Corn Farming Energy Inputs		IL Avg	IRE Avg	US Avg	US Avg	IRE Avg	GREET 2010
Data Source:		**1996 USDA**	**1996 USDA**	**1996 USDA**	**2001 USDA**	**2001 USDA**	**1996 USDA Mod**
Yield	bu/acre	126.0	**196.1**	125.0	139.3	**196.1**	158
Seed	kernels/acre	25384.0	*25384.0*	25495.0	28739.0	28739.0	
Fertilizer:							
Nitrogen	lb/acre	160.0	**159.0**	129.4	133.5	**159.0**	146
Potash	lb/acre	102.0	**118.0**	59.3	88.2	**118.0**	51
Phosphate	lb/acre	71.0	**64.0**	48.2	56.8	**64.0**	62
Energy:							
Diesel	gal/acre	7.0	**5.2**	8.6	6.9	**5.2**	
Gasoline	gal/acre	3.0	**0.3**	3.1	3.4	**0.3**	
LPG	gal/acre	5.0	*5.0*	6.4	3.4	3.4	
Electricity	kWh/acre	15.0	15.0	77.1	33.6	33.6	
Natural gas	cu ft/acre	150.0	150.0	200.0	246.0	246.0	
Custom work	Btu/bu	3146.0	**933.0**	3366.0	1581.0	**933.0**	
Input hauling	Btu/bu	920.0	**384.0**	663.0	202.0	**384.0**	
Conversions to Btu/bu (LHV)							
Diesel	Btu/bu	7,136	3,422	8,837			
Gasoline	Btu/bu	2,764	163	2,870			
LPG	Btu/bu	3,371	2,166	4,322			
Electricity	Btu/bu	406	261	2,105			
Natural Gas	Btu/bu	1,170	752	1,573			
Custom work	Btu/bu	2,662	789	2,848			
Input hauling	Btu/bu	721	301	520			
Total Ag Energy (LHV)	Btu/bu	18,230	7,855	23,075	16,176	7,192	22,500

The agricultural on-farm energy consumption values were combined with the plant energy consumption at IRE and the ethanol yield. The IRE plant energy consumption totals 26,989 Btu/gal (LHV) from natural gas and 2,423 Btu/gal from electricity (0.71 kWh/gal) for a total of 29,404 Btu/gal. The GREET default value is 35,889 Btu/gal. The ethanol yield at IRE is 2.73 gal/bu compared to the 2.72 gal/bu GREET default value.

[4] Electricity and natural gas use for corn drying reported in the IRE survey is based on low respondent number.

The corn transportation distance was set to 30 miles (50 miles default value) and the surveyed IRE transportation distance from the plant to the bulk terminal at 80 miles was identical to the GREET default value.

The different agricultural energy input values as well as IRE plant energy consumption values were used to parameterize GREET. Modeling was performed with support from Life Cycle Associates using a macro tool that allows to substitute selected values in GREET and collect the GREET results into a separate spreadsheet. The advantage of this approach is that all parameters are replaced at once eliminating the error potential from forgetting to set/reset certain GREET values manually. The modeled cases are shown below. Figure 5 and Table 16 below show the results. For each case the individual GWI components from nitrogen fertilizer application, the GWI contribution from the ethanol plant energy consumption, and the remaining GWI contributions (remaining agricultural energy consumption, distribution, denaturant) are shown. The modeled cases do not include the relatively small GREET default factor for GWI emissions from land use change associated with corn ethanol production. This factor in GREET is less than 1 g/MJ. Land use change issues are discussed separately in this report.

IRE Case #1: This case represents the agricultural energy consumption detailed in Column 2, Table 15. In essence, this can be viewed as substituting current GREET derived agricultural input assumptions with IRE surveyed data including IRE plant energy consumption data. Total GWI for this case is 54.8 g CO_2e/MJ.

IRE Case #2: This case represents agricultural energy consumption detailed in Column 5 (IRE surveyed data substituted into the USDA 2001 template). As can be seen, the results are very close to Case #1 indicating that IRE surveyed data displaces a significant part of the original agricultural data sets. The GWI for this case is 54.5 g CO_2e/MJ.

IRE Case #3: This is a sensitivity case to Case 1 substituting the default Illinois SERC electricity region for the Exelon Generation dominated northern Illinois electricity grid to which IRE connects.[5] As can be seen the nuclear dominated northern Illinois grid results in a lower GWI of 46.7 g CO_2e/MJ.

GREET Agriculture Default with IRE Plant Energy Consumption: This case models the current GREET agriculture default values with the IRE plant energy consumption. The total GWI of this case is 60.8 g CO_2e/MJ.

GREET Agriculture Default with GREET Plant Energy Consumption: This models the current GREET agriculture default values (22,500 Btu/bu) with the current GREET natural gas fired default ethanol plant (33,330 Btu/gal from natural gas and 2559 Btu/gal

[5] Electricity Mix

Fuel	Oil	Natural Gas	Coal	Nuclear	Biomass	Total
IL SERC	1.8%	10.0%	57.3%	25.2%	1.9%	96.2%
Exelon (IL)	2.4%	5.5%	2.8%	88.2%	0.0%	98.9%

Source: eGrid

from electricity for a total of 35,889 Btu/gal). According to GREET, these values are considered representative of current US corn ethanol production from dry mill plants.

Gasoline: For comparison purposes the GWI of CA reformulated gasoline is listed. In summary the GWI for IRE produced corn ethanol is lower than the GREET default value of 92 g CO_2e/MJ.

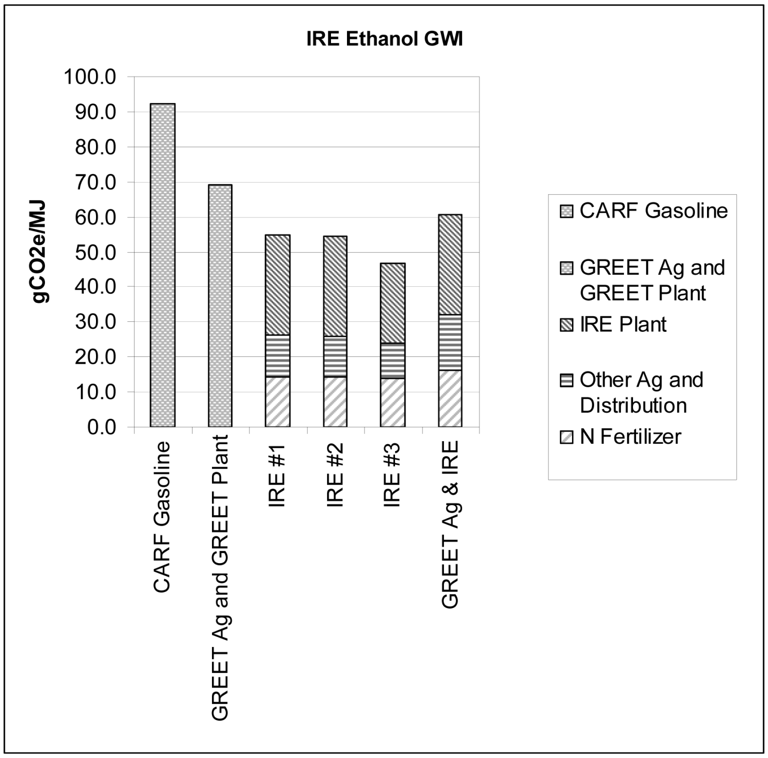

Figure 5: IRE Ethanol GWI

Cases
- Gasoline
- GREET Agriculture Default with GREET Default Plant Energy Consumption
- GREET Agriculture Default with IRE Plant Energy Consumption
- IRE Case #1: Substituting GREET derived ag. inputs (USDA-1996 template) with IRE Survey
- IRE Case #2: Substituting USDA-2001 template with IRE Survey
- IRE Case #3: Sensitivity to Case 1. Substituting Illinois SERC grid for northern Illinois grid

Table 16: IRE Ethanol GWI

	CARF Gasoline	GREET Ag and GREET Plant	IRE #1	IRE #2	IRE #3	GREET Ag & IRE
			GWI (g/MJ)			
N Fertilizer			14.2	14.2	13.9	16.3
Other Ag and Distribution			11.9	11.6	9.9	15.8
IRE Plant			28.7	28.7	22.9	28.7
GREET Ag and GREET Plant		69.1				
CARF Gasoline	92.1					
Total GWI:	92.1	69.1	54.8	54.5	46.7	60.8
Red. GREET Default:			-20.7%	-21.2%	-32.4%	-12.0%

In summary IRE ethanol offers significantly reduced life cycle global warming emissions compared to the current GREET default values for current US average corn ethanol. Depending on the assumptions GWI reductions range between 21% to 32%.
The key components contributing to the GWI reduction are high prevailing yields resulting in reduced nitrogen application rates (368 vs 420 gN/bu), reduced agricultural energy consumption in IRE's corn draw area (5.5 gal/acre vs. >10 gal/acre), lower custom work and input hauling energy consumption, and lower ethanol plant energy consumption (29,404 Btu/gal vs. 35,889 Btu/gal, LHV inclusive of electricity).

5. Land Use Emissions and Carbon Sequestration

The GWI results from ethanol life cycle analyses depend on system boundaries, input parameters, modeling scope, and other factors. Recent ethanol life cycle studies have expanded the boundaries and have included the impact of international land use as well as the impact of secondary agricultural sector GWI impacts from increased ethanol production such as changes in livestock emissions due to changes in agricultural commodity prices (Searchinger, Heimlich et al. 2008), (Fargione, Hill et al. 2008). These studies incorporate one or a combination of several models including the U.S. Forest and Agricultural Sector Optimization Model (FASOM), the Food and Agricultural Policy Research Institute (FAPRI) modeling system, or the Global Trade Analysis Project (GTAP) model. The accuracy of GWI analyses that rely on these models is only as good as the statistical summary data going into these models.

The present ethanol GWI study does not take international land use data or agricultural commodity prices into account but instead correlates very localized data sets that include in-ground measurements, a survey with growers, and local remote sensing data. More specifically, the present study looks at the GWI contributions to corn ethanol produced at the IRE ethanol plant from N_2O emissions and soil carbon sequestration.

N_2O emission and soil carbon sequestration rates depend largely on land management practice and geographic region. We have compiled a very detailed data set to account for the influence of these variables:

- We used USDA satellite data to determine the crop and land use practices in the vicinity of the ethanol plant.
- From the survey of growers delivering corn to IRE we have data on actual applied nitrogen fertilizer rates and derived yields.
- From the survey we have also land management data and, in particular, the practiced type and share of conservation tillage.
- We have actually measured carbon sequestration rates for soils within the IRE corn draw area.

5.1 Land Use Rotations Within the IRE Corn Draw Area

N_2O emissions and carbon sequestration of soil depend on the current and historic land use. This section assesses the land use within the IRE corn draw area. The derived land use pattern is representative of the acres used for IRE corn supply.

The land use change for a particular parcel of land can be determined by either using remote sensing (via satellite data) or by conducting a census. The Farm Services Agency does indeed conduct a census and assesses the land use for each field. However, this data is not publicly available. Therefore, this study used remote sensing.

The first step in the process was to create a draw area boundary for the Rochelle ethanol plant. This was performed in ArcGIS. Using the address for the ethanol plant as the center point, a circle with a 40 mile radius was developed as a geographic information system (GIS) polygon file (see Figure 6). This circle represented the approximate draw area for corn required for the production of ethanol by the plant for one year.

The second step of the analysis combined USDA NASS Cropland Data Layer with the polygon file. The USDA NASS Cropland Data Layer is a spatial crop type map developed from satellite imagery. Classification of all land other than crop was performed using the national land cover dataset which was developed in 2001 also using remote sensing via satellite. (Homer 2007).

In the third step of the analysis the crop types were extracted for the ethanol plant draw area using the 2005, 2006, and 2007 Cropland Data Layers. The analysis was performed to calculate the acres in corn in 2005, 2006, and the acres in corn in 2007. Next a model routine was created to determine the crop rotations (of each 30 square meter location). In contrast to the above analysis, the model allows a location specific correlation: what was the specific land use of one particular acre in 2005 and 2006 (as opposed to how did the land use change within a masked area analyzed above). The results showed that the total area in corn within the corn draw circle in 2007 totaled 1,487,560 acres. The crop rotations by percent acreage are shown in Figure 7. All land use changes aside from corn and soy are summarized into the "diversified" category. As can be seen, the crop rotations are dominated by corn-soy-corn (33%) followed by corn-corn-corn (24%).

The study found that the "diversified" area (land use changes from non-crop land such as pasture land, woodland, etc. to crop land) must be viewed with great caution. While the USDA Cropland Data Layer has been shown to have accurate methods of around 95% for the delineation of corn and soybeans (Johnson 2007) and that dataset is updated every year, the national land cover data set dates back to 2001 and introduces much higher uncertainties.

An analysis was performed to demonstrate this finding. As can be seen in Figure 8, according to USDA NASS approximately 30,000 acres would have gone from corn (in 2005) to "diversified" (in 2006) and back to corn (in 2007), an unlikely scenario. A more likely scenario in this case suggests that the land was consistently used for crop production. Therefore, the "diversified" data point must be viewed with caution and likely overestimates the conversion from non-cropland to cropland. This finding prompted the requisition of a separate study that specifically addresses the uncertainties associated with assessments of land use change given the currently available statistical data sets. The study will be released shortly. For the purpose of the present study, the derived acreage for the "diversified" category will be viewed as a conservative (overestimation) of non-cropland to cropland conversion. It follows that the carbon sequestration values based on this data and assessed in the next sections are therefore conservative and likely low.

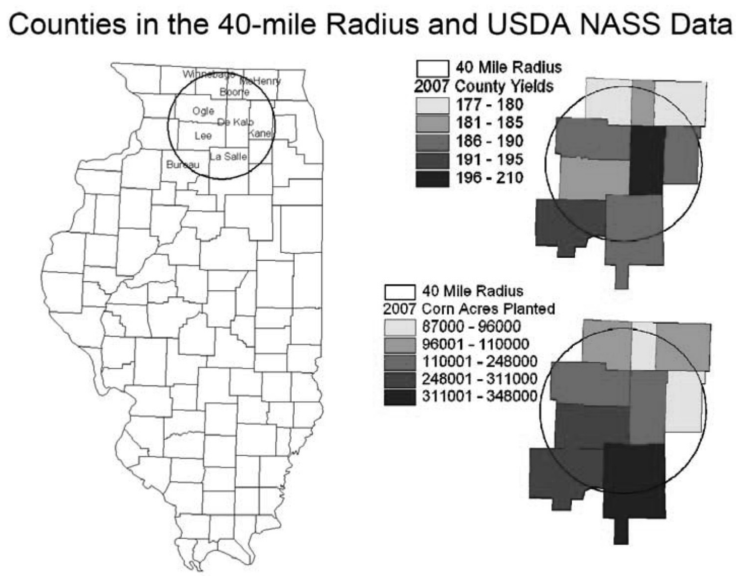

Figure 6: GIS Corn Draw Area

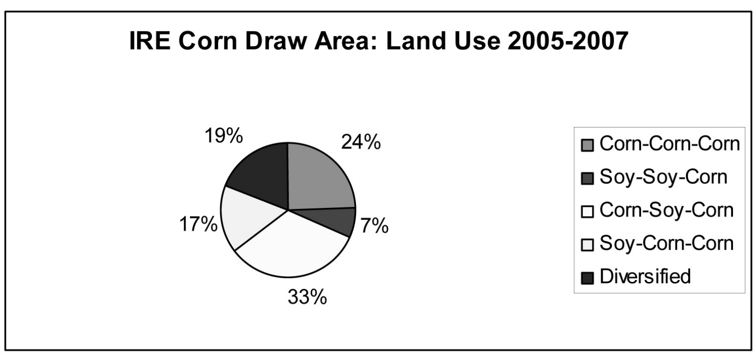

Figure 7: Crop Rotations by Percent of Acreage

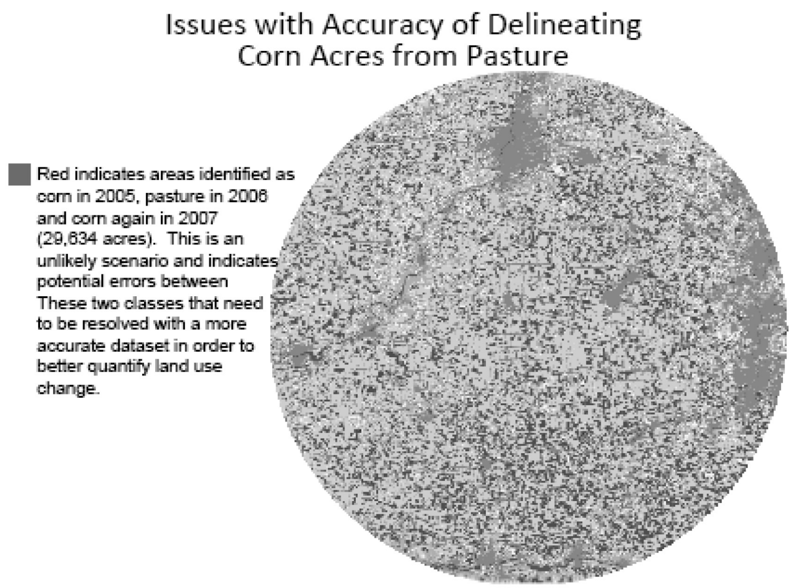

Figure 8: Accuracy of Delineating Corn Acres from Pasture

5.2 N_2O Emissions

The earth's atmosphere contains about 78% dinitrogen (N_2) (Mc Isaac et al, 2007). N fixation is the transformation of dinitrogen to biologically useful forms for organisms such as NH_3 (Hofstra and Bouwman 2005). Denitrification removes fixed N through microbial respiration when oxygen is limiting whereby N_2O production is a major by-product. The proportion of N denitrified as N_2O varies. Emphasis is placed on N_2O because it is a gas contributing to GWI where N_2 is not.

Denitrification is often difficult to measure in the field since one of the main end products, N_2, constitutes such a high percentage of the atmosphere and thus small changes in N_2 concentrations are hard if not impossible to detect (McIsaac 2007). Sampling is generally conducted with measurement chambers placed over the soil surface for a period of time or by taking a soil core sample back to the lab for evaluation of denitrification potential. Another method to assess denitrification is the N-balance approach. In the N-balance approach the inputs and outputs for a given area can be measured and denitrification is the unaccounted part of the equation (Hofstra and Bouwman 2005). The difficulty with the N-balance approach is that it is very complex to determine all sources and sinks thus introducing uncertainties. The denitrification amounts determined with these methods provide the data behind different models.

The IPCC (1997) Good Practice Amendment provides an emissions factor based model. In this model the calculation of N_2O emissions from crop production assumes that 1.25% +/- 1% of N inputs are lost from soil as direct N_2O emissions and 30% of applied N is leached or runs off into ground and/or surface waters contributing to indirect emissions (Del Grosso, Mosier et al. 2005). This modeling approach does not take into account detailed variations in agricultural system, crop types, climates, soil types and management practices. The GREET model is also based on an emissions factor approach.

In contrast, process based models such as DAYCENT attempt to account for these variables (Del Grosso, Mosier et al. 2005). Mummey et al using process-based modeling provides N_2O emission rates by crop rotation and management practices (till vs. no-till) (Mummey, Smith et al. 1998). Oftentimes, indirect effects are not included in process based models and must be added for comparison purposes with emissions factor based modeling results.

Using the land use management practices surveyed for the IRE corn draw area, we compare the sensitivity of these practices under two modeling approaches and actual measured N_2O emissions rates for Illinois soils.

5.2.1 GREET N_2O Emissions Calculations

As discussed above, GREET employs an emissions factor model based on IPCC. The current GREET Version 1.8b uses the following equation for N_2O emissions estimates from fertilizer application.

N_2O from nitrogen fertilizer, and above and below ground biomass =
(420 g/bu of N + 141.6 g/bu of N) * 0.01325 *44/28 = 11.7 g/bu

Where:

420 g/bu of N is the default value for N applied in fertilizer

141.6 g/bu of N is N content of above and below ground biomass (ie corn stover left on the field).

0.01325 is a factor for N in N_2O as fraction of N in N fertilizer and biomass. GREET assumes that 1.3% (including 0.2% from leaching) of the available N is converted to N in N_2O.

44/28 is the mass fraction of N_2O and N_2 in the molecule

Substituting the GREET default value of 420 g/bu of N applied in the above equation for the actual N application rate of the IRE corn draw area of 368 g/bu from the survey, we calculate N_2O emissions of 10.6 g/bu. This is a 10% reduction from the GREET default value of 11.7 g/bu.

GREET implicitly assumes that the N_2O conversion rate is relatively constant among different nitrogen sources (eg fertilizer, soil material, etc.). Process models such as the one used by Mummey et al attempt to control for these additional variables.

5.2.2 N_2O Emissions According to Mummey et. al

The amount of N_2O released from agriculture depends on different factors including tillage practices and crop rotations. Mummey et al used a process based modeling approach to control for these variables. Mummey points out that in most soil types N_2O emissions may actually increase with low tillage practices primarily due to the higher moisture levels. Mummey's emissions factors are reproduced in Table 17 (Mummey, Smith et al. 1998).

Table 17: N_2O Emission Factors by Mummey et al

	CSC and SSC kg N_2O-N/ha per y	SCC and CCC kg N_2O-N/ha per y	Diversified kg N_2O-N/ha per y
Conv.Till	3.7	2.9	4.8
No Till	4.2	3.6	4.6

The N emissions factors listed in Table 17 were applied to the surveyed tillage practices to derive a blended N emissions factor by crop rotation for the IRE corn draw area. Then, the N emissions factors by crop rotation were applied to the number of acres in that particular crop rotation that supply corn to IRE to derive N emitted per year.
The results indicate that based on the crop rotations and other land use changes (pasture land to corn), the acres that deliver corn IRE may emit approximately 154 metric tons of N_2O-N per year and based on the surveyed yield or 7.5 g/bu N_2O-N (direct and indirect emissions).

The Mummey et al factors only take direct dinitrification effects into account. Applying an additional 30% indirect denitrification factor results in total N_2O emissions of 15.4 g/bu. These emissions are substantially higher than the GREET derived emissions. However, one must be careful. While these factors take IRE corn draw area rotation and tillage practices into account, these factors do not account for other IRE conditions (including the actual soil type and fertilizer application rates). The results do indicate however the range of possible N_2O emissions estimates under different assumptions.

Table 18: N_2O Emissions of IRE Corn Acres According to Mummey Factors

		CSC/SSC	SCC/CCC	Diversified
N-Emissions Factors		kg N_2O-N/ha per year	kg N_2O -N/ha per year	kg N_2O-N/ha per year
Conventional Till		3.7	2.9	4.8
No Till		4.2	3.6	4.6
Surveyed Tillage Practice				
Conventional Till (%)	0.87			
No Till, Strip Till (%)	0.13			
Blended Emissions Factor (kg N_2O -N/ha per y)		3.765	2.991	4.774
Blended Emissions Factor (kg N_2O -N/acre per y)		1.524	1.210	1.932
Bushels Delivered to IRE	20,450,000			
Average Yield	196			0
Corn Acres Needed for IRE Supply	104,337			
Surveyed Crop Rotation (%)		40%	41%	19%
IRE Acres in Crop Rotation (acres)		41,496	42,909	19,931
Emitted N_2O -N (kg/y)		63,228	51,939	38,508
Total Emitted N_2O -N on IRE Acres (kg/y)	153,676			
Total Emitted N_2O -N of IRE Del. Corn (g/bu)	7.51			
Total Emitted N_2O of IRE Del. Corn (g/bu)	11.81			
Indirect Emissions Factor	30%			
Total direct and indirect emissions (g/bu)	15.35			

5.2.3 N_2O Emissions according to Measurements

A third assessment of N_2O emissions was made based on actual measurements on Illinois soil. These measurements were conducted in a conventionally managed field during corn and soybean phases at the University of Illinois at Urbana Champaign. Gas samples were collected using chambers sampled intermittently during the growing season with N_2O then quantified by gas chromatography. The measured values range from 4 to 6 micro gram per m^2 per hour. Converting these measurements to a g N_2O /bu basis based on the surveyed yield and adding indirect effects results in emissions of 1.41 g N_2O /bu on the high end. The results are summarized in Table 19. The low values observed by direct-in field measurement reflect the reality of the denitrification process, which is highly variable in space and time, with long periods of low–efflux being punctuated by brief episodes of high denitification. Weather conditions that promote high denitrification rates frequently do not accommodate the measurement process. This weakness in direct measurement techniques explains the need to rely on models and/or interest in extrapolating measured "real" values with data on climate and agricultural practices.

Table 19: N_2O Emissions of IRE Corn Acres According to Illinois Measurements

	Range	
Measured micro gram N_2O per m^2 per h	4	6
Measured gram N_2O per m^2 per h	0.000004	0.000006
Measured gram N_2O per m^2 per y	0.0350	0.0526
Measured gram N_2O per ha per y	350.40	525.60
Measured gram N_2O per acre per y	141.80	212.70
Converted to gram N_2O /bu at IRE Yield	0.72	1.08
Including Indirect effects (gN_2O/bu)	0.94	1.41

An attempt was made to customize some of the available N_2O emissions assessment approaches with data surveyed at IRE. While this customization provides likely a better estimate than the default values used in these models a wide range of values is possible.

5.3 Soil Carbon Sequestration

5.3.1 GREET Soil Carbon Sequestration

GREET includes a land use change factor of 195 gCO_2e/bu of net emissions additions. It is not documented what fractions of this number represent direct and indirect land use changes or N_2O emissions and CO_2 sequestration.

5.3.2 Carbon Sequestration with Data from University of Illinois at Urbana Champaign

The amount of carbon stored in soil depends on soil type, climate, vegetation, and historical land use and land management. Eve et. al take U.S. national carbon inventory factors developed by the Intergovernmental Panel on Climate Change and adjust these factors to account for various management options of cropland as well as climate and soil types (Eve, Sperow et al. 2002). Eve et al. report weighted average soil carbon accumulation resulting from a reduction in tillage intensity from conventional till to no-till of 0.43 metric tonnes of carbon per hectare per year (0.17 MT C per acre per year). Eve et al. also report that their finding is identical to values measured by Wander for Illinois locations (Wander, Bidart et al. 1998). Coincidentally, one of these locations happened to be in DeKalb within the corn draw area of IRE.

Since these measurements were performed for various crop rotations and management practices of soil in Illinois including DeKalb, we asked Wander to provide a summary of first order sequestration factors for the present study. The factors are informed by Eve et al. and are listed in Table 20. The diversified category represents net carbon emissions from conversion of pasture land and small grains to corn/soy crop land. It should be noted that carbon gains generally occur in surface depth (0-30 cm). At deeper depths gains disappear which means that conversions away from carbon storing management practices may have a reversible effect. Furthermore, these are so-called linear rates that are applicable for about 10 years of a particular land use practice.

Table 20: CO_2 Sequestration Factors by Eve et al

	CSC and SSC MT C/acre per year	SCC and CCC MT C/acre per year	Diversified MT C/acre per year
Conventional Till	0.01	0.05	-0.15
No Till	0.02	0.2	-0.1

The sequestration factors listed in Table 20 were applied to the surveyed tillage practices to derive a blended sequestration factor by crop rotation for the IRE corn draw area. Then, the sequestration factors by crop rotation were applied to the number of acres in that particular crop rotation that supply corn to IRE to derive carbon sequestered per year. The results indicate that based on the crop rotations and other land use changes (pasture land to corn), the acres that deliver corn to IRE may sequester approximately 2,167 tonnes of CO_2 per year. Based on the surveyed yield for these acres, this amounts to 106 gCO_2/bu. Note that a relative large amount of net emissions (2,860 tonnes) are released from converting diversified land to corn agriculture. As demonstrated above high uncertainties exist in the data accuracy of diversified land conversions to corn. Therefore, the net emissions shown from the conversion of diversified land are likely too high.

There is further room for improvement. Going to 100% no-till (as opposed to the currently practiced 13%) would increase CO_2 sequestration to 27,200 tonnes on IRE supply acres or 1,330 g/bu (but it would in turn increase N_2O emissions from 15.35 to 17

g/bu in the Mummey model). Eve et al and direct measures show that adding winter cover crops could additionally double the carbon sequestration rates.

Table 21: Carbon Sequestration of IRE Acres According to Eve et al Factors

		CSC MT C/acre per year	SCC MT C/acre per year	Diversified MT C/acre per year
CO_2 Sequestration Factors				
Conventional Till		0.01	0.05	-0.15
No Till		0.02	0.2	-0.1
Surveyed Tillage Practice				
Conventional Till (%)	0.87			
No Till, Strip Till, Minimum Till (%)	0.13			
Blended Sequestration Factor		0.011	0.070	-0.144
Bushels Delivered to IRE	20,450,000			
Average Yield	196			0
Corn Acres Needed for IRE Supply	104,337			
Surveyed Crop Rotation (%)		40%	41%	19%
IRE Acres in Crop Rotation (acres)		41,496	42,909	19,931
Sequestered Carbon (MT/y)		469	2,982	-2,860
Total Sequestered Carbon on IRE Acres (MT C/y)	591			
Total Sequestered Carbon on IRE Acres (MT CO_2/y)	2,167			
Total Sequestered Carbon on IRE Acres (MT CO_2/acre)	0.02			
Total Sequestered Carbon of IRE Del. Corn (g CO_2/bu)	106			

5.3.3 Chicago Climate Exchange Soil Carbon Management Offsets

The Chicago Climate Exchange offers soil carbon management offsets for agricultural land treated with conservation tillage practices (CCX 2007). The basic specifications for Soil Carbon Management Offset as stated by CCX are listed below. Information regarding registering offsets with CCX is listed in Appendix B.

- Minimum five year contractual commitment to continuous no-till or striptill (conservation tillage) on enrolled acres.
- Tillage practice must leave at least two-thirds of the soil surface undisturbed and at least two-thirds of the residue remaining on the field surface.
- CCX contracts are issued for conservation tillage at a rate between 0.2 and 0.6 metric tons CO_2 per acre per year. Figure 9 indicates Illinois belongs to Zone A where 0.6 metric tons CO_2 per acre per year are issued for conservation tillage.
- Carbon sequestration projects must be enrolled through a CCX registered Offset Aggregator.

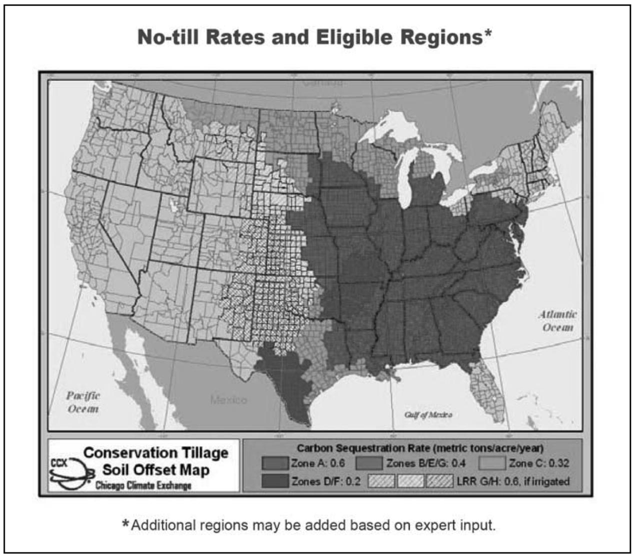

Figure 9: CCX Carbon Sequestration Factors

The survey results indicate that 10% of delivered bushels are no-till and 3% of bushels are strip till, which means about 2,658,500 bushels (13% of 20,450,000 bushels) would be produced by conservation tillage practices. Since farmers did not report yields per acre and the corresponding tillage practices for that acre (instead they reported the different tillage practices applied as a percentage to their total acres) we cannot say whether conservation tillage resulted in lower yields. However, anecdotally, one farmer (delivering 34,000 bu to IRE) reported 100% no till and a yield of 199 bu/acre, which is close to the average surveyed yield of 196.1 bu/acre. With that we use the average yield and convert 2,658,500 bushels to 13,557 acres farmed for IRE supply with conservation tillage practices. At a CCX rate of 0.6 metric tonnes per acre per year this would result in soil carbon management offsets of 8,134 tonnes per year.

If we include minimum tillage practices reported in the survey as a form of conservation tillage (minimum till may meet the 2/3 of residues left on field CCX specification in many cases) then 87% of bushels are farmed under CCX conservation tillage or 90,727 acres resulting in carbon management offsets of 54,436 tonnes per year. If we assume 100% no till on all IRE supply acres we calculate 62,570 metric tons of carbon management offsets. It is widely recognized that actual carbon sequestration rates in the

field may be lower than what is theoretically possible or what is awarded in contracts by carbon trading organizations (Eve et al.).

5.4 GWI Accounting for Carbon Sequestration

Table 22 and Figure 10 below summarize the derived N_2O emissions and carbon sequestration values in tonnes of CO_2e per year for the corn acres supplying to IRE. Carbon sequestration values are shown as negative numbers. N_2O emissions and carbon sequestration from IRE corn supply contribute to the GWI of the 57.8 mgpy of corn ethanol produced at IRE. The contribution of N_2O emissions and carbon sequestration per MJ of ethanol produced are also shown in the table and the figure below. Depending on the employed assessment methodology and agricultural practice N_2O emissions can contribute between 1.5 g CO_2e/MJ to 20 g CO_2e/MJ to the GWI of IRE ethanol, whereas carbon sequestration can reduce the GWI by between 1.7 g CO_2e/MJ to 13.4 g CO_2e/MJ.

Table 22: Summary of N_2O Emissions and Carbon Sequestration Rates

Metric Tons Sequestered on IRE Acres	CO_2e (tonnes/y)	IRE Ethanol GWI Contribution (g/MJ LHV)*
N_2O: Mummey Factors	92,917	20.0
N_2O: GREET Default	70,822	15.2
N_2O: GREET Customized	64,164	13.9 - 14.2
N_2O IL Measured	7,113	1.5
Sequestr.: UIUC Factors, 13% no till	-2,160	-0.5
Sequestr.: CCX CMO, 13% no till	-8,134	-1.7
Sequestr.: UIUC Factors, 100% no till	-27,200	-5.8
Sequestr.: UIUC Factors, 100% no till, Winter Cover	-54,400	-11.7
Sequestr.: CCX CMO, 100% no till	-62,570	-13.4

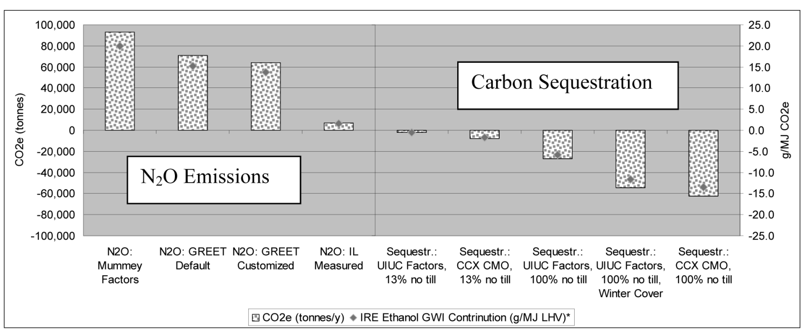

Figure 10: N_2O Emissions and Carbon Sequestration Rates of IRE Supplied Corn

GREET does take N_2O Emissions into account but does not account for carbon sequestration. Therefore, we subtracted the carbon sequestration potential assessed with satellite imagery within the IRE corn draw area from the previously determine GWI for IRE ethanol. Since we determined the GWI for IRE ethanol under different scenarios (IRE Case #1 reflected SERC electricity grid, IRE Case #3 reflected Exelon Generation grid) we subtracted the carbon sequestration potential from these different cases.

Figure 11 and Table 23 show the GWI of IRE Case#1 accounting for carbon sequestration assessed a) with UIUC supplied sequestration factors for no-till and winter cover and b) CCX sequestration factors for no-till. The results indicate that, if farmers were enticed to practice no till and/or winter cover, the GWI of IRE ethanol would drop by between 11.7 to 13.4 g CO_2e/MJ and in the IRE Case#1 a reduction down to 41.4 g CO_2e/MJ to 43.1 g CO_2e/MJ would be incurred.

Table 23: GWI Accounting for Carbon Sequestration (IRE Case #1)

	IRE #1	IRE #1 UIUC 100% no-till & winter cover	IRE #1 CCX 100% no-till
		g CO_2e/MJ	
N Fertilizer	14.2	14.2	14.2
Other Ag and Distribution	11.9	11.9	11.9
IRE Plant	28.7	28.7	28.7
C-Sequestration	0	-11.7	-13.4
Net GWI		43.1	41.4

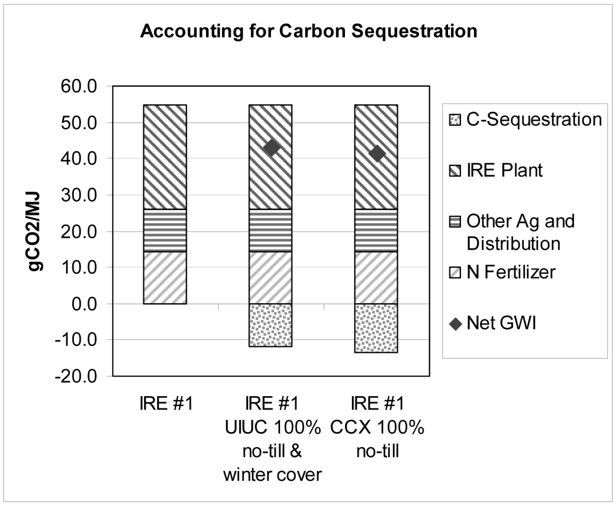

Figure 11: GWI Accounting for Carbon Sequestration (IRE Case #1)

Figure 12 and Table 24 show the GWI of IRE Case#3 accounting for carbon sequestration assessed a) with UIUC supplied sequestration factors for no-till and winter cover and b) CCX sequestration factors for no-till. The results indicate that, if farmers were enticed to practice no till and/or winter cover, the GWI of IRE ethanol would drop by between 11.7 to 13.4 g CO_2e/MJ and in the IRE Case#3 a reduction down to 33.3 g CO_2e/MJ to 35.0 g CO_2e/MJ would be incurred.

Table 24: GWI Accounting for Carbon Sequestration (IRE Case #3)

	IRE #3	IRE #3 UIUC 100% no-till & winter cover	IRE #3 CCX 100% no-till
		g CO_2e/MJ	
N Fertilizer	13.9	13.9	13.9
Other Ag and Distribution	9.9	9.9	9.9
IRE Plant	22.9	22.9	22.9
C-Sequestration	0.0	-11.7	-13.4
Net GWI		35.0	33.3

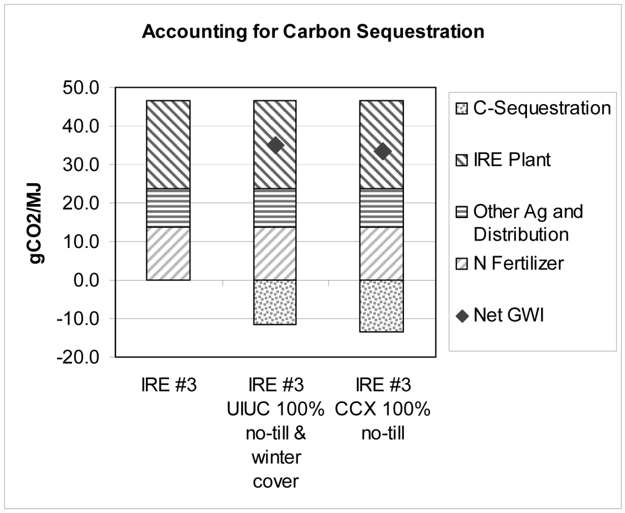

Figure 12: GWI Accounting for Carbon Sequestration (IRE Case#3)

In summary, the following conclusions can be made:

- The calculated N_2O emissions and sequestration values differ widely by the employed method.
- High uncertainties exist when determining land use conversions from non crop lands to crop lands (including pasture land) based on USDA statistics. The current statistical approach may result in over-estimating pasture to agricultural land conversions and therefore under-estimate carbon sequestration and over-estimate net emissions additions.
- Carbon sequestration effects could be of the same magnitude as N_2O emissions.
- Winter crops and no-till can significantly improve the overall GWI from land use change.
- However, the gain in carbon sequestration from no-till may be partially offset since N_2O emissions are expected to increase slightly with no-till in Illinois.
- The widely differing results for N_2O emissions and carbon sequestration based on different assessment methods combined with the uncertainties in determining land use change do not allow the conclusion that increased corn agriculture in the surrounding area of the IRE ethanol plant increases the global warming impact of ethanol produced at that facility from direct land use change.
- However, best management practices such as no-till and winter crops have a positive effect on the GWI of corn ethanol produced at IRE.
- IRE should promote no-till and winter crops practices among its corn suppliers.

- Models that assess the impact of corn ethanol production on an international level need to detail their assumptions for US domestic corn ethanol production as well as the geographic resolution of their data sets since the demonstrated high uncertainties with local data and methods may influence their results derived for international assessments.

Appendix A: Survey Instrument

1 Number of Bushels of corn delivered to Ethanol Plant in the past year ________

2 Surrounding Counties in which you grow crops
Acres per County

	Name	Acres/County		Name	Acres/County
County Name 1			County Name 5		
County Name 2			County Name 6		
County Name 3			County Name 7		
County Name 4			County Name 8		

3 Typical Crop Rotation for Corn Acres

(eg. 200A corn on corn; 50A corn/bean rotation)

Corn on Corn ________
Corn/Beans ________
Other (describe) ________

4 Average corn yield over the past three years (bu/A)

2005	2006	2007

5 Corn Acre Tillage Practices

	% 0f Corn Acres	% of Soy Acres
Conventional		
Minimum Till		
No Till		
Strip Till		

6 Irrigated Corn Acres (%) ________

7 Typical Fertilizer Program

7a Application Timing: Please state Amounts/Acre

	Fall	Spring	POST
N Lbs./A			
P Lbs./A			
K Lbs./A			
Ag lime Lbs./A			
MicroNutrients Lbs/A			
Manure: gal/A			
Other:			

7b What Products do you use: Please mark all that apply with an "x"

NH3	
28%	
32%	
18-46-0	
0-46-0	
0-0-60	
Others:	

8 Corn Hybrid Selection

		# of Acres
Non Biotech		
Biotech	Herbicide control	
	Insect control	
	Herb & insect	

9 Pesticide Program

Application timing: amounts/acres

	Name/type	Acres Treated	Fall	PPI/PRE	POST	Other
Example:	*Aztec*	*200*	*6.1#*			
Insecticide 1						
Insecticide 2						
Herbicide 1						
Herbicide 2						
Herbicide 3						
Additional						

10 Number of Trips Over Each Field ________

11 Annual Fuel Self Use (gal) per Acre ________

12 Annual Custom Machine Hire

	# of ACRES	Fuel Estimate (gal)
Fertilizer Application		
Pesticide Application		
Combining of Crop		
Crop Hauling		
Miles / Bushel		

13 Hauling Energy to Ethanol Plant (1 way)

Miles ________
bu transported/trip ________
gal/mile ________

14 Corn Drying

	Cost Per Bushel
Propane	
Electricity	
or Volume of Propane Used	

Appendix B: Chicago Climate Exchange Offset Registration

The following is reproduced from the CCX website. The contents can be found at: http://www.chicagoclimatex.com/content.jsf?id=104

Offset Project Registration, Verification & Crediting Procedure

While the various project types have different eligibility and quantification requirements, all CCX offset projects go through the same standardized registration, verification and crediting process. Members of the CCX staff are available to assist project owners in assessing the eligibility of their project(s), as well as provide technical support throughout the crediting process.

Steps:
1. Submit project proposal and/or project questionnaire to CCX: CCX staff will provide project questionnaires and/or guidance on the proposal specifications. This proposal will be submitted to the CCX Committee on Offsets for review and preliminary approval and may be further referred to scientific technical advisory committees.

2. Obtain independent project verification: Upon project approval by the Committee on Offsets, a project owner or aggregator must obtain independent verification by a CCX-approved verifier. Verifiers use information provided by the project owner or aggregator, combined with possible site visits, to accurately assess a project's actual, annual greenhouse gas (GHG) sequestration or destruction. Verification reports are reviewed by CCX staff as well as the CCX provider of regulatory services, FINRA, for completeness and accuracy.

3. Register as a CCX Offset Provider or Offset Aggregator: Join CCX as an Offset Provider, or enroll the project through an existing Offset Aggregator. Project owners or aggregators may enroll an unlimited number of eligible projects for offset credit. Each distinct project within the portfolio must be registered independently; aggregated projects are registered on a combined basis.

4. Receive Carbon Financial Instrument® (CFI®) contracts for project offsets: Upon approval by the Committee on Offsets, CCX issues the Offset Provider or Aggregator CFI contracts in a quantity equal to the project's GHG sequestration or destruction (net CFI contracts withheld for a reserve pool if applicable). Offset Projects are issued CFI contracts on an annual basis, with the CFI Vintage applying to the program year in which GHG mitigation took place. For example, a methane capture and destruction offset project for methane destruction that occurred during calendar year 2005 would earn a given quantity of 2005 Vintage CFI contracts.

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ATTACHMENT 2

A Bottom-Up Assessment of Land Use Related to Corn Ethanol Production

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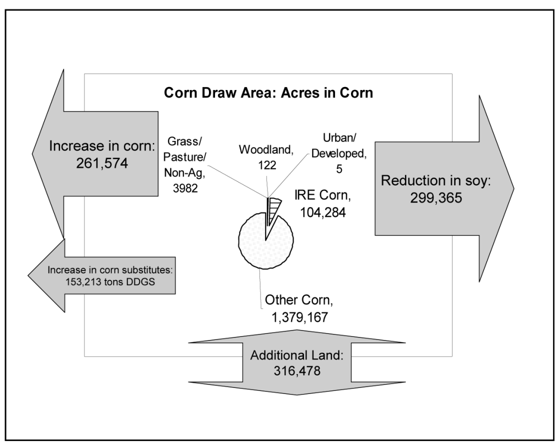
Executive Summary

This study conducted by the University of Illinois at Chicago Energy Resources Center determined if corn extensification (conversion of non agricultural land to corn) and corn intensification (conversion of non-corn crop acres to corn or increased yield in current corn acres) occurred within the vicinity of an ethanol plant and if the ethanol plant was the likely cause of these effects. In addition to land use change, the present study also examined the land carbon balance for corn produced to supply the plant. The selected ethanol plant is the Illinois River Energy Center (IRE) with a current capacity of 58 mgpy. The plant is located in Rochelle, Illinois and it started operating in February, 2006.

The study combined remote sensing (USDA NASS cropland data layer derived from AWiFS) with a survey of 29 growers supplying corn to the ethanol plant. The present study determined corn-ethanol related land use changes from the "bottom-up": by carefully examining changes to each acre of land in the vicinity of the selected ethanol plant.

The USDA Cropland Data layer imagery was evaluated by creating a mask of 2007 corn and using it to mask out the same locations in the 2005 and 2006 cropland data layer. Simultaneously, a routine was applied to subtract a ¾ acre buffer along roadways and field edges. This avoided incorrectly categorizing 85,329 acres of corn as land use changes from non agricultural land when in fact field edges and roadway buffers triggered a misclassification.

Besides field edges additional incorrect classifications were avoided for 26,616 acres by confirming that these acres were in continuous crop rotations rather than going from agricultural use to non-agricultural use and back to agricultural use as the NASS data originally suggested. Test samples confirmed that a) roadway buffers and field edges are often classified by NASS as land use changes and b) that ag to non-ag and back to ag land use changes are improbable. With that the study documented that there is a substantial possibility for errors with a tendency toward indicating a greater percentage of land use change (as most mis-classifications are wrongfully identified as change) when applying remote sensing to ethanol related land use studies. Pre-existing datasets should only be used in the context that they were developed with an understanding that errors from year to year will amplify when comparing land use change.



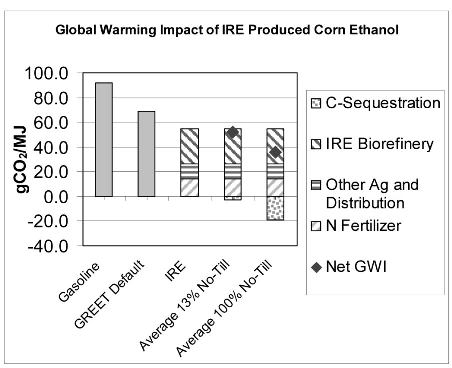
The figure illustrates the corn balance within the growing area as well as exports from the area. From the 2006/2007 growing season only 4,109 acres (3,982+122+5) were converted from non-ag use such as grass, pasture, or woodland to corn growing (0.28% of the 1.487 million acres in corn). Conversion did not occur despite the fact that an additional 316,478 acres of land would have been available for

conversion to agriculture within the corn draw area. Therefore, it can be concluded that the start-up of the IRE plant did not promote corn extensification (the conversion of non-ag acres to corn).

IRE requires 20,450,000 bushels of corn to produce 55 mgpy of corn ethanol on an annual basis. At the surveyed yield of 196.1 bu/acre the 2007 land requirements totaled 104,284 acres. However, corn production in the corn draw area went up by 261,574 acres (2.5 times the IRE corn requirements) while soy production went down by 299,365 acres (almost 3 times the acres required for IRE corn production). Clearly, while IRE may have had a small influence towards corn intensification, other variables (maybe economics, high export demand) seemed to drive corn intensification. Furthermore, counting DDGS production as a corn co-product, yield increases within the draw area were sufficient to meet IRE's corn requirements. We realize that yields change over time and that the current study presents a snapshot of events.

Finally, based on the assessed crop rotations and surveyed tillage practices, the study calculated N_2O emissions and carbon sequestration rates according to several methodologies documented in the literature. In summary, N_2O emissions and carbon sequestration effects could be of the same magnitude. The increased carbon sequestration from no-till and winter cover crops can provide significant reductions to the GWI of corn ethanol. Therefore, ethanol plant operators could encourage these practices in their region.

The IRE GWI Study found that the life cycle global warming impact of corn ethanol produced at the plant totals 54.8 gCO_2e/MJ, which is 21% lower than the current GREET default natural gas dry mill corn ethanol plant and 40% lower than gasoline. Subtracting the average sequestration numbers for the 13% of IRE supply acres under no-till/strip till (CCX, UIUC, UIES average values for 13% no-till) from the life cycle of IRE corn ethanol of 54.8 gCO_2e/MJ reduces it to 52.2 gCO_2e/MJ. Subtracting the average sequestration numbers for encouraging 100% no-till on IRE supply acres from the life cycle of IRE corn ethanol reduces it to 35.9 gCO_2e/MJ. Since, as a first order estimate, encouraging 100% no-till in this case is likely equivalent to encouraging 50% no-till and 50% winter cover crops these practices would alternatively result in a GWI of 35.9 gCO_2e/MJ at IRE. These values exclude GWI contributions from indirect/international land use changes since, as demonstrated, IRE did not measurably effect land use.



GWI of IRE Produced Corn Ethanol

1) Introduction

Land use change can be determined according to several methods including a) conducting a census, b) using economic indicators, and c) using remote sensing. The Farm Services Agency does indeed conduct a census and assesses the land use for each field. However, this data is not publicly available. Several economic models (global equilibrium models such as GTAP) use land rent value as a proxy for land use change. We believe that remote sensing provides the second most accurate method for land use change studies next to conducting a census.

The USDA uses satellite data combined with survey data to determine their Crop-Production Report (posted on www.nass.usda.gov). Furthermore, it is our understanding that future land use studies related to corn ethanol may utilize satellite based data sets instead of the land rent assumptions and combine these data sets with national and global economic models.[i]

The present study also utilizes remote sensing combined with survey data. However, in contrast to economic modeling the present study determines corn-ethanol related land use changes from the "bottom-up": by carefully examining changes to each acre of land in the vicinity of a selected ethanol plant.

The ethanol plant is the Illinois River Energy Center (IRE), located in Rochelle Illinois, about 80 miles west of Chicago. IRE produces about 58 million gallons per year with an expansion underway to double capacity. The plant started operation in February 2006. Therefore, the time horizon for the land use analysis spans the years 2005 through 2007.

The study attempts to determine if conversion of non-agricultural land to corn (corn extensification) occurred around IRE and if IRE is its likely cause. Secondly, the study attempts to determine if conversion of non-corn crop to corn (corn intensification) occurred and if IRE is its likely cause. In addition to land use change, the present study also examines the land carbon balance from IRE corn ethanol production. By using remote sensing for this type of "bottom-up" analyses the present study is able to determine the possibilities and limitations of remote sensing for other corn ethanol related land use studies.

The present study builds on an earlier study titled "The Global Warming and Land Use Impact of Corn Ethanol produced at the Illinois River Energy Center." The earlier study will be referred to as the "IRE GWI Study" throughout this report.

2) Data

The present study is based on two data sets: a survey of growers delivering corn to IRE and USDA NASS cropland data layer derived from satellite imagery. Both data sets are discussed below.

2.1) Grower Survey

This data was collected as part of the IRE GWI Study. Since some of the data is used in the present study we will summarize some of the key findings. A survey was conducted with 29 corn growers supplying 2,528,850 bushels of corn to IRE or 12% of all delivered bushels (representative of about 6.9 million gallon of ethanol production). The survey assessed key agricultural variables including yield, fertilizer inputs, and tillage practices.

a) Yield

As summarized in Table 1 the survey respondents report steady average yield increases between the 2005, 2006, and 2007 growing seasons. Yields in 2007 at 196.1 bushels per acre are on average 17% higher than those in 2005. The consistent standard deviations indicate that no single farmer introduced a significant bias in any one year.

Table 1: Surveyed Yields

	2005 Bu/acre	2006 Bu/acre	2007 Bu/acre
Yield	167.4	183.1	196.1
STD	23.3	23.3	19.5
N=28			

b) Tillage

The respondents were asked whether they employ a) conventional tillage, b) minimum tillage, c) no till, or d) strip till. The tillage methods differ by the amount of biomass left above ground: Conventional tillage leaves less than 10% of biomass above ground, minimum till leaves 30% to 60% above ground, strip till about 70-80%, and with no till about 90% of the biomass remains on top. Applying the surveyed percentages of practiced tilling to the amount of corn delivered to IRE results in a conservation tillage rate (generally defined as no-till plus strip till) of 13%. The results are shown in Table 2. The analysis assumes that farmers apply the same tillage practices to all of their farm land including land used for IRE production.

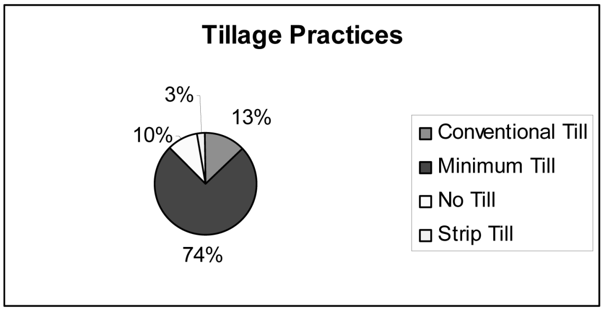


Figure 1: Surveyed Tillage Practices
Note: Graph is based on 2,478,850 delivered bushels. One farm did not report tillage practices

c) Nitrogen

The survey asked respondents what type of fertilizer products they use. Table 2 shows the results.

Table 2: Type of Fertilizer Product Used

	Nitrogen as NH_3	Nitrogen as 28%	Nitrogen as 32%	N-P-K as 18-46-0	N-P-K as 0-46-0	N-P-K as 0-0-60	Ammonium Sulfite	Ag-Lime
Number of Growers	17	5	13	14	6	21	1	8
N=27								

All surveyed growers apply nitrogen fertilizer to the crop. The most common form of nitrogen fertilizer used is in anhydrous form as NH_3 (ammonia). Some growers use 32% liquid N fertilizer and 28% liquid N fertilizer, often in combination with NH_3.
On average 368 g/bu of nitrogen are applied. Where growers apply nitrogen via a combination of NH_3, 28%, 32%, or 18-46-0 the total amount of N is calculated based on the mass fraction of N.[ii] The resulting fertilizer input values are listed in Table 3.

Table 3: Nitrogen Application

	lb/acre	g/bu
Mean	159	368
STD	40	90
N=27		

2.2) Satellite Imagery

Land use change can be determined according to several methods including a) conducting a census, b) using economic indicators, and c) using remote sensing. The Farm Services Agency does indeed conduct a census and assesses the land use for each field. However, this data is not publicly available. Several economic models (global equilibrium models such as GTAP) use land rent value as a proxy for land use change. We believe that remote sensing provides the second most accurate method for land use change studies next to conducting a census. Therefore, the IRE GWI study used remote sensing in its analysis.

The original IRE GWI Study identified land use change and crop rotation practices over the last three years by correlating the USDA NASS Cropland Data Layer (for crop types) and the national land cover dataset (for non-cropland conversions). While the USDA Cropland Data Layer has been shown to have accurate methods of around 95% for the delineation of corn and soybeans (Johnson 2007a,b) and that dataset is updated every year, the national land cover data set dates back to 2001 and introduces much higher uncertainties for non-agricultural areas.

The IRE GWI Study found that the NASS data suggests land use changes from non-crop land such as pasture land, woodland, etc. to crop land, which must be viewed with great caution. In fact the analysis conducted for the original IRE GWI Study identified several thousand acres of land converting from non ag use to ag use within the corn draw circle. Furthermore, the study found that significant additional acres would have rotated from ag use to non-ag use and back to ag use over the last 3 years, an unlikely scenario. Therefore, the present study analyzes NASS cropland data layers by a) applying an algorithm to the data that subtracts roadway buffers and field edges from the land use data, and b) sampling and closely examining illogical land use changes such as ag to non-ag to ag conversions.

3) Analysis

3.1) Corn Draw Area

The first step in the process was to create a draw area boundary for the Rochelle ethanol plant. Two different methods were used: a circle method and the ProExporter Network Polygon approach. Both methods are detailed below.

The circle method uses the address of the ethanol plant as the center point and survey information on growers delivering from farthest away as the radius. The surveys showed that growers deliver from as far as 40 miles away to the plant. Therefore, a 40 mile radius was developed as a geographic information system (GIS) polygon file (see Figure 2). This circle represents the approximate draw area for corn required for the production of ethanol by the plant.

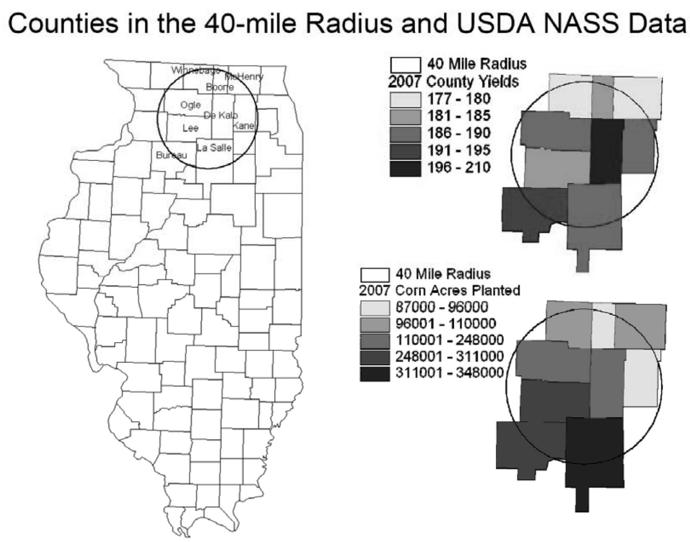


Figure 2: GIS Corn Draw Area

While the circle approach above uses survey information from the growers delivering from furthest away, the PRX Polygon combines survey information with geographic and economic variables.[iii] Geographic variables, for example, include the influence of urban areas on corn draw areas; sample economic variables include competition for grain between grain elevators and ports or railroads supporting export markets. It should be

noted that, since this analysis is done at the plant level, the approach fits well within the bottom-up land use assessment context. The PRX Polygon development is offered as a for fee service to grain producers and ethanol plants. Courtesy of PRX, we have obtained the Polygon for the IRE plant in order to compare the Polygon approach to the circle approach.

As can be seen in Figure 3 the PRX Polygon for IRE differs from the circle: The Rockford urban area in the north and the Chicago urban area to the east push the corn draw area asymmetrically to the south. Furthermore, access to highways shape the draw area primarily on the southwestern fringe. However, as can be seen, the 40 mile radius circle chosen in our analysis substantially encompasses the PRX polygon. Therefore, a good match between the PRX Polygon and the 40 mile circle confirms that the analysis substantially covers the IRE corn draw area. For further analysis, the circle method was chosen because we felt that this method could be replicated more easily for future, additional corn draw area studies.

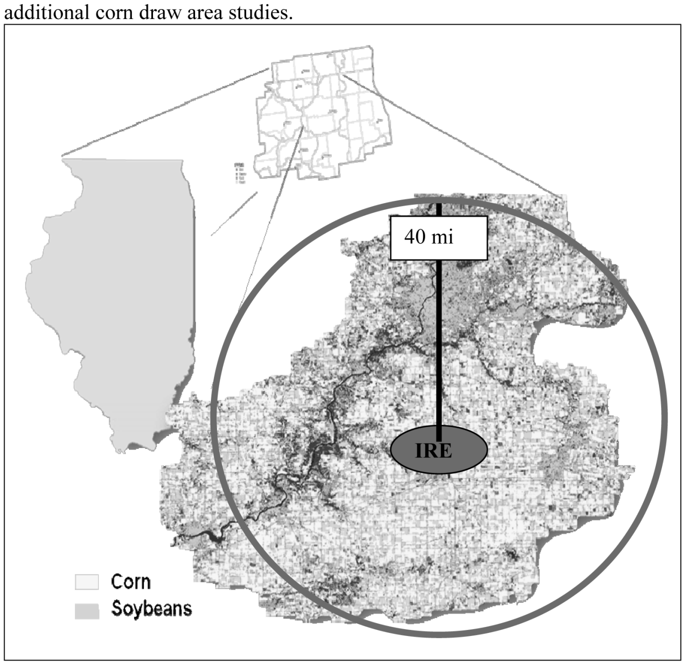


Figure 3: ProExporter polygon for Illinois River Energy plant

3.2) Corn Extensification

Based on the established corn draw area, the analysis in this section determines conversion of non-ag land to corn. The first step of this analysis combined USDA NASS Cropland Data Layer with the circle file (see Figure 4). The USDA NASS Cropland Data

Layer is a spatial crop type map developed from satellite imagery. The Cropland Data Layer has been shown to have accurate methods of around 95% for the delineation of corn and soybeans (Johnson 2007). NASS is only interested in crop land acreage and that data is updated every year. Classification of all land other than crop was performed using the national land cover dataset which was developed in 2001 also using remote sensing via satellite. (Homer 2007). Since the national land cover data set is dated higher uncertainties exist for land covers other than crops assessed in this study.

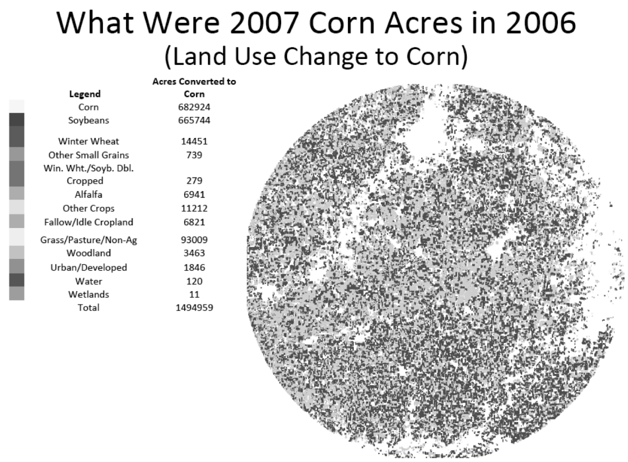


Figure 4: Land Use of 2007 Corn Acres in 2006

Once the crop types were extracted for the ethanol plant draw area using the 2005, 2006, and 2007 Cropland Data Layers, analysis was performed to calculate the acres in corn in 2005, 2006, and the acres in corn in 2007. This is a straightforward process using the spatial data from the satellite classification. Each pixel (minimum discernable ground unit) of the satellite was 30 square meters in 2005 (Landsat satellite) and 56 square meters in 2007 (AWiFS sensor). AWIFS data has a revisit time for every location of every 5 days whereas Landsat has a revisit time of 16 days. Therefore AWIFS exhibits a higher accuracy for crop type detection. Going forward USDA will use AWiFS imagery.

A simple equation converted each pixel to acres to derive the spatial "mask" of corn acres in 2007. The mask of corn acres from the 2007 Cropland Data Layer was used to mask out the same locations in the 2005 and 2006 Cropland Data Layer. Again, the pixels were multiplied by acres to derive acreage for the land use of the masked area in previous years. The acres for each crop type derived with the above approach are listed in column 1 of Table 4 (NASS Unvetted). This data is identical to the data used in the IRE GWI study.

As part of the present study additional vetting of the data was performed by applying a routine to the masked area that subtracted a ¾ acre buffer along the roadways. As a result a total of 85,329 acres that were originally primarily categorized as grass/pasture/non-ag conversion to corn were now correctly identified as a mix of nonag use and corn and treated as neutral. It is generally the case that a mixed parcel consists of small strips of roadway, for example, and a larger area of corn with the roadway prompting the misclassification. The test samples in Figure 6 confirm that these parcels were indeed roadway buffers around agricultural land. Furthermore, an additional 26,616 acres which, in the imagery evaluation routine were classified as ag to non-ag to ag conversion (an unlikely scenario) were categorized separately. Test samples again confirmed that ag to non-ag to ag conversions are misclassifications and that the land was in fact in continuous agriculture (see Figure 6). With 111,945 acres in these two categories a corresponding decrease in the following categories was observed: urban areas to corn; woodland conversions to corn; grass pasture to corn conversions; grass/clover wildflowers to corn; fallow/idle cropland to corn. Additional test samples in each of these categories were taken and analyzed to confirm that, in fact, the decreases in these categories from the applied data vetting routines are justified. All samples showed that no actual land use change had taken place. These test samples are shown in Appendix A.

Table 4: Rotations into Corn from 2006 to 2007

Land Use	2007 Crop Acres in 2006		
	NASS Unvetted Acres	NASS Vetted Acres	
Corn	682,924	680,340	
Soybeans	665,744	661,660	
Winter Wheat	14,451	15,026	
Other Small Grains	739	274	
Win. Wht./Soyb. Dbl. Cropped	279	110	
Alfalfa	6,941	3,060	
Other Crops	11,212	9,428	
Fallow/Idle Cropland	6,821	1,608	
Grass/Pasture/Non-Ag	93,009	3,982	Non-ag to corn
Woodland	3,463	122	
Urban/Developed	1,846	5	
Water	120	0	
Wetlands	11	0	
Ag 2005 to Non-Ag to Ag Land		26,616	
Field and Roadway Fringes		85,329	
Total Analyzed	1,487,560	1,487,560	

The vetted data in column 2 of Table 4 indicates that only 4,109 acres were potentially converted from non-ag use to corn growing (0.28% of the 1.487 million acres in corn). Therefore, it can be concluded that the start-up of the IRE plant did not promote corn extensification (the conversion of non-ag acres to corn). Furthermore, conversion did not occur despite the fact that additional land would have been available for conversion to agriculture within the corn draw area. Table 5 below lists all acres additional categories

that did not convert into cropland from 2006 to 2007.[iv] As can be seen more than 315,000 acres of additional land in categories where one could have expected a substantial conversion to corn. These conversions did not occur.

Finally, the study documented that there is a substantial possibility for errors when applying remote sensing to ethanol related land use studies. Without applying sophisticated masking routines, 111,945 acres (85,329+26,616) would haven been incorrectly identified as land use changes to corn.

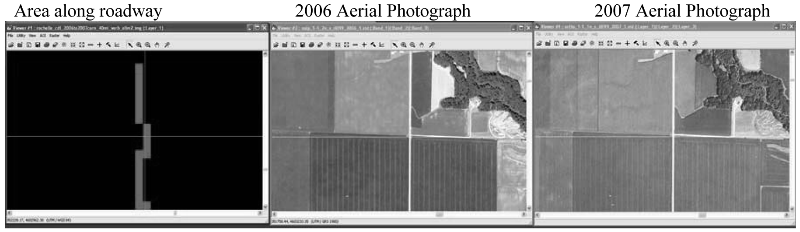
Table 5: Non-ag Land within the IRE Corn Draw Area

Land Use	Acres
Fallow/Idle Cropland	5,227
Grassland herbaceous:	35,359
Grass/Pasture/Non-Ag	16,782
Pasture/hay	259,110
Total:	316,478

Test Samples: Errors from Roadways, Field Edges, and Building Structures were Eliminated with Buffer Routine

Pixels along field edges, roadways, and building structures are often a mixture of signals. These areas may fluctuate between agriculture and non-agriculture from year to year.

Area along roadway — 2006 Aerial Photograph — 2007 Aerial Photograph



This 11 acre area of roadway between two agricultural fields was identified as agriculture in 2006 and urban in 2007. Areas like this are often mis-classified when assessing land use change and were therefore removed from the project analysis.

Areas identified as woodlands in 2006 and corn in 2007 (122 acres were estimated)

Area identified as woodlands to corn — 2006 Aerial Photograph — 2007 Aerial Photograph

This seven acre area was classified as woodlands in 2006 and corn in 2007 but appears to have been in agricultural production both years. Trees surrounding the field may have led to the mis-classification in 2006.

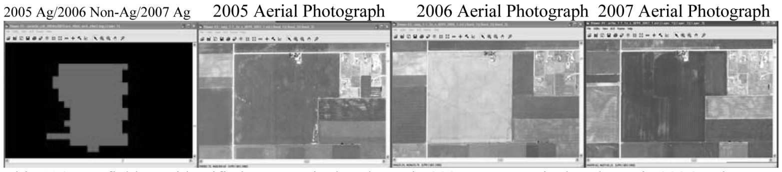
Area identified as urban to corn — 2006 Aerial Photograph — 2007 Aerial Photograph

This five acre area (in red to the left) was identified as a land use change from urban in 2006 to corn in 2007. Aerial photography from each year indicates that the area was an agricultural field in both years. Its proximity to the buildings to the right probably caused the confusion in the classification.

Figure 5: Errors in Land Use Changes from Roadways and Field Edges

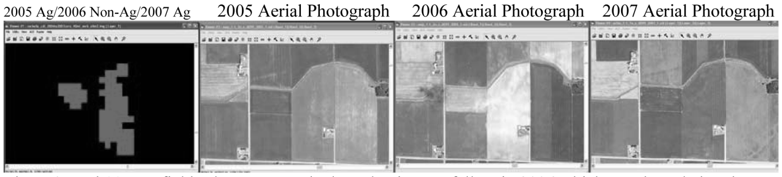
Test Samples: Ag to Non-Ag to Ag Conversions Were Excluded as Improbable
Areas identified as agriculture in 2005 to a non-agricultural area in 2006 and then back to an agricultural area in 2007 were excluded from the analysis as improbable scenarios

2005 Ag/2006 Non-Ag/2007 Ag 2005 Aerial Photograph 2006 Aerial Photograph 2007 Aerial Photograph



This 114 acre field was identified as an agricultural area in 2005, a non-agricultural area in 2006 and an agricultural area in 2007. Based on the aerial photography, the area remained in agriculture in 2006. Likely, the field was planted late but even if it was left fallow it would still be considered agriculture.

2005 Ag/2006 Non-Ag/2007 Ag 2005 Aerial Photograph 2006 Aerial Photograph 2007 Aerial Photograph



These 45 and 11 acre fields also appear to be late plantings or fallow in 2006 which may have led to the mis-classification as non-ag areas in 2006, but it is clear that this is not a land use change location.

Figure 6: Errors in Land Use Changes Resulting in Ag to Non-ag to Ag Conversions

3.3) Corn Intensification

The analysis in the last section on corn extensification determined if, potentially driven by the new ethanol plant, non-agricultural land went into new corn production. Conversely, this section looks at corn intensification: whether the new ethanol plant may have influenced crop conversions from non-corn crops to corn.

As shown in Table 6, IRE requires 20,450,000 bushels of corn to produce 55 mgpy of corn ethanol on an annual basis. At the surveyed yield of 196.1 bu/acre the 2007 land requirements totaled 104,284 bushels. However, corn production in the corn draw area went up by 261,574 acres (2.5 times the IRE corn requirements) while soy production went down by 299,365 acres (almost 3 times the acres required for IRE corn production). Clearly, while IRE may have had a small influence on corn intensification, other variables (maybe economics, high export demand) seemed to drive corn intensification.

The current IRE land demand of 104,284 amounts to 7% of the total corn acres within the corn draw circle, a relatively small fraction of corn acres. While 7% of corn acres are diverted to IRE corn ethanol production, yield increases in the corn draw area between 2007/2006 and between 2006/2005 were 5.4% and 11%, respectively. In other words, the corn requirements for IRE were almost met by yield increases in the corn draw area. Counting DDGS produced at IRE as a corn-substitute co-product, IRE's corn supply/co-product balance was likely met by yield increases alone. We recognize that this is a snapshot of past conditions and yields may vary over time.

However, a recent report estimates national yields to reach 289 bu/acre by 2030 (Korves, 2007). If this is the case for the IRE corn draw are, the IRE land requirements would drop from currently 104,284 acres to 70,761. If corn acreage stays the same in the corn draw area, IRE will require only 4.8% of the land for its corn supply.

Table 6: Corn Intensification within the IRE Corn Draw Area

	2007	2006	2005
Corn Yield IRE Grower Survey (bu/acre)	196.1	186.1	167.4
Corn Yield Increase 2007-2006	5.4%		
Corn Yield Increase 2006-2005		11.2%	
IRE Delivered Corn (bu)	20,450,000		
IRE Required Acres	104,284		
IRE Acres as Percent of Corn Draw Area	7.0%		
Corn Acres	1,487,560	1,225,986	1,158,809
	261,574		
Soy Acres	540,975	840,340	851,540
	-299,365		

In summary, we conclude that much larger adjustments in corn vs. soy acres have taken place than could have been prompted by IRE's operation: Corn intensification cannot be attributed to the operation of the ethanol plant.

4) CO_2 Sequestration and N_2O Emissions

Greenhouse gas emissions from most agricultural systems (rice excluded) are primarily driven by the balance between N_2O emissions and carbon sequestration. Emissions and sequestration assessments differ by a large variety of variables (soil type, climate, management practices). Likewise, the employed methods that quantify emissions and sequestration effects differ by the treatment of these variables. The IRE GWI study assessed emissions and sequestration effects for the IRE corn draw area according to several methodologies including those by Mummey et al (1998) and Eve et. al. (2002). Since these assessments depend on crop rotations and since the present study produced more accurate land use change data, we must first reassess crop rotation patterns as well.

4.1) Crop Rotations

Using the vetted land use data detailed in Table 4 a model routine was created to reassess the crop rotations (of each 30 square meter location). In contrast to the above analysis, the model allows a location specific correlation: what was the specific land use of one particular acre in 2005, 2006, and 2007 (as opposed to how did the land use change within a masked area analyzed above). Figure 7 and Figure 8 below show land use rotations are dominated by corn-soy-corn (34%) followed by corn-corn-corn (26%). The diversified category includes primarily rotations of wheat, small grains, and other crops to corn.

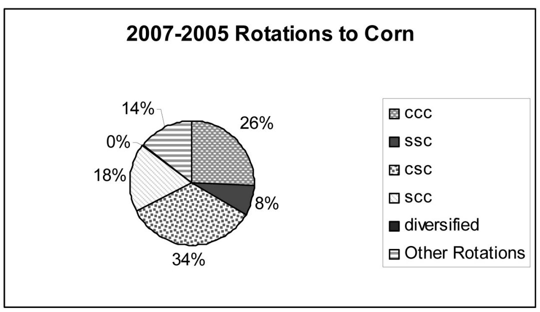


Figure 7: Land Rotations in Percent

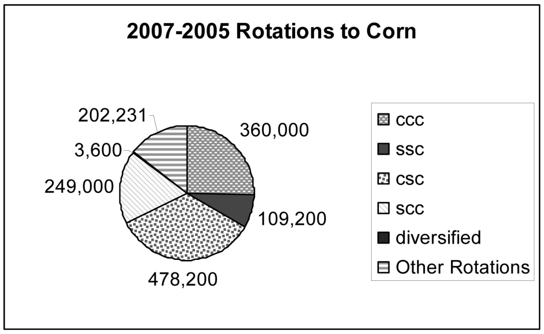


Figure 8: Land Rotations in Acres

4.2) N_2O Emissions and Carbon Sequestration

The N_2O Emissions below are calculated according to several different methodologies. Detailed background on the employed methodologies can be found in the IRE GWI Study.

Using the reassessed crop rotations and the surveyed tillage practices, the N_2O - Emissions based on Mummey et al (informed by Wander) total 15.09 g/bu or 91,403 tonnes CO_2e (from N_2O) for all bushels delivered to IRE (Mummey, 1998).[v,vi,vii] The supporting table is provided in Appendix B. The second methodology followed Argonne's GREET model, which is based on an emissions factor approach. The current GREET default value results in 11.7 g/bu or 70,822 tonnes of CO_2e emissions for IRE's corn demand. Applying the surveyed N-fertilizer inputs (368 g/bu or 0.811 lb of N per bushel) to the GREET emissions factor equation results in 10.6 g/bu or 64,164 tonnes of CO_2e emissions. Finally, several N_2O measurements using measurement chambers at the University of Illinois at Urbana Champaign yielded lower results in the range of 0.94 to 1.41 g/bu of CO_2e emissions (Wander, 1998). The midpoint of 1.2 g/bu resulted in 7,113 tonnes of CO_2e emissions.

While nitrogen inputs of 0.811 lb/bu are already fairly low a potential further reduction in nitrogen inputs could be possible. High fertilizer prices, sophisticated precision agriculture technologies, or government incentives may be potential drivers to reduce N inputs in the future. If we assume an N-input rate of 0.65 lb/bu (294.8 g/bu) close to the theoretical minimum and the GREET emissions factor equation, N_2O emissions drop to 9.1 g N_2O per bushel or 55,085 tonnes for the IRE demand.

CO_2 Sequestration effects were also calculated according to different methodologies. Using the reassessed crop rotations and the surveyed tillage practices, the CO_2 sequestration effects based on Eve et al. (informed by Wander) total 259 g/bu or 5,300 tonnes for all IRE bushels (Eve, 2002).[viii,ix,x] The supporting table is provided in Appendix B. For the Illinois region, the Chicago Climate Exchange (CCX) offers soil

carbon management offsets of 0.6 metric tonnes per acre per year for agricultural land treated with conservation tillage practices. At the surveyed rate of 13% no-till/strip till for IRE acres the CCX rate would result in soil carbon management offsets of 8,134 tonnes per year (assumes 13% of 104,450 acres required for IRE supply or 13,560 acres use conservation tillage). A long term study by the University of Illinois Extension Service (UIES) measured carbon sequestration on fields in no-till since 1967. The study summary data is listed in Appendix C. Over a period of 12 years, the study determined an annual sequestration rate of 1.67 metric tonnes per acre, which, at a 13% no-till/strip till rate would result in 22,645 tonnes per year.[xixii]

There is further room for improvement. Using Eve et al and encouraging 100% no-till (as opposed to the currently practiced 13%) would increase CO_2 sequestration to 30,820 tonnes on IRE supply acres (but it would in turn slightly increase N_2O emissions in the Mummey model). Eve et al and direct measures show that adding winter cover crops could additionally double the carbon sequestration rates to 61,640 tonnes on IRE supply acres. Using the CCX factors, if we assume 100% no till on all IRE supply acres we calculate 62,570 metric tons of carbon management offsets. Using UIES sequestration values and going to 100% no-till would result in 174,432 tonnes of carbon sequestered per year. Also, since the survey showed no-till practices for 13% of acreage around IRE, carbon sequestration values according to CCX for all acres in the corn draw area were calculated. Based on these assumptions 13% of the 1.48 million acres would sequester 116,030 tonnes of CO_2. Using UIES sequestration values would result in 321,308 tonnes.

The Table 7 and Figure 9 below summarize the carbon assessment findings. The left y-axis displays the total carbon emissions/sequestration values on all acres supplying IRE (104,450 acres). The right y-axis displays the carbon emissions/sequestration values per heating content of ethanol produced. In summary, N_2O emissions and carbon sequestration effects could be of the same magnitude. The increased carbon sequestration from no-till and winter cover crops can provide significant reductions to the GWI of corn ethanol. Therefore, ethanol plant operators could encourage these practices in their region. If ethanol plants in addition to their own suppliers could take credit from encouraging no-till in their region, large additional GWI reductions could be possible.

The solid bars on the right represent the carbon emissions/sequestration values assuming 13% no till across the whole draw area and applying the CCX and UIES sequestration values (rather than for the IRE supply acreage only). If IRE was able to take credit for the sequestration associated with these no till efforts in its whole corn draw area, the contributions using CCX and UIES values would amount to 25 gCO_2e/MJ and 69.1 gCO_2e/MJ, respectively. The potential implication from this assessment is the following question: Should or could an ethanol plant be able to take sequestration credits for its product by encouraging no-till among farmers in an ethanol plant's whole draw area?

The IRE GWI Study found that the life cycle global warming impact of corn ethanol produced at the plant totals 54.8 gCO_2e/MJ, which is 21% lower than the current GREET default natural gas dry mill corn ethanol plant and 40% lower than gasoline (see Table 8 and Figure 10). Subtracting the average sequestration numbers for the 13% of IRE supply acres under no-till/strip till (CCX, UIUC, UIES average values for 13% no-till from

Table 7) from the life cycle of IRE corn ethanol of 54.8 gCO_2e/MJ reduces it to 52.2 gCO_2e/MJ. Subtracting the average sequestration numbers for encouraging 100% no-till on IRE supply acres from the life cycle of IRE corn ethanol reduces it to 35.9 gCO_2e/MJ. Since, as a first order estimate, encouraging 100% no-till in this case is likely equivalent to encouraging 50% no-till and 50% winter cover crops these practices would alternatively result in a GWI of 35.9 gCO_2e/MJ at IRE. These values exclude GWI contributions from indirect/international land use changes since, as demonstrated, IRE did not measurably effect land use.

Table 7: N2O Emissions and Sequestration Values

Metric Tons Sequestered on IRE Acres	CO2e for IRE Supply Acres (tonnes/y)	IRE Ethanol GWI Contribution (g/MJ LHV)*
N2O: Mummey Factors	91,403	19.6
N2O: GREET Default	70,822	15.2
N2O: GREET IRE Customized	64,164	13.8
N2O: GREET N-Application Optimized	55,085	11.8
N2O: IL Measured	7,113	1.5
Sequestr.: UIUC Factors, 13% no till	-5,300	-1.1
Sequestr.: CCX CMO, 13% no till	-8,134	-1.7
Sequestr.: UIES, 13% no till	-22,645	-4.9
Sequestr.: UIUC Factors, 100% no till	-30,830	-5.8
Sequestr.: UIUC Factors, 100% no till, Winter Cover	-61640	-11.7
Sequestr.: CCX CMO, 100% no till	-62,570	-13.4
Sequestr.: UIES, 100% no till	-174,432	-37.5
Whole Draw Area: CCX CMO 13% no till	-116,030	-25
Whole Draw Area: UIES 13% no till	-321,308	-69.1

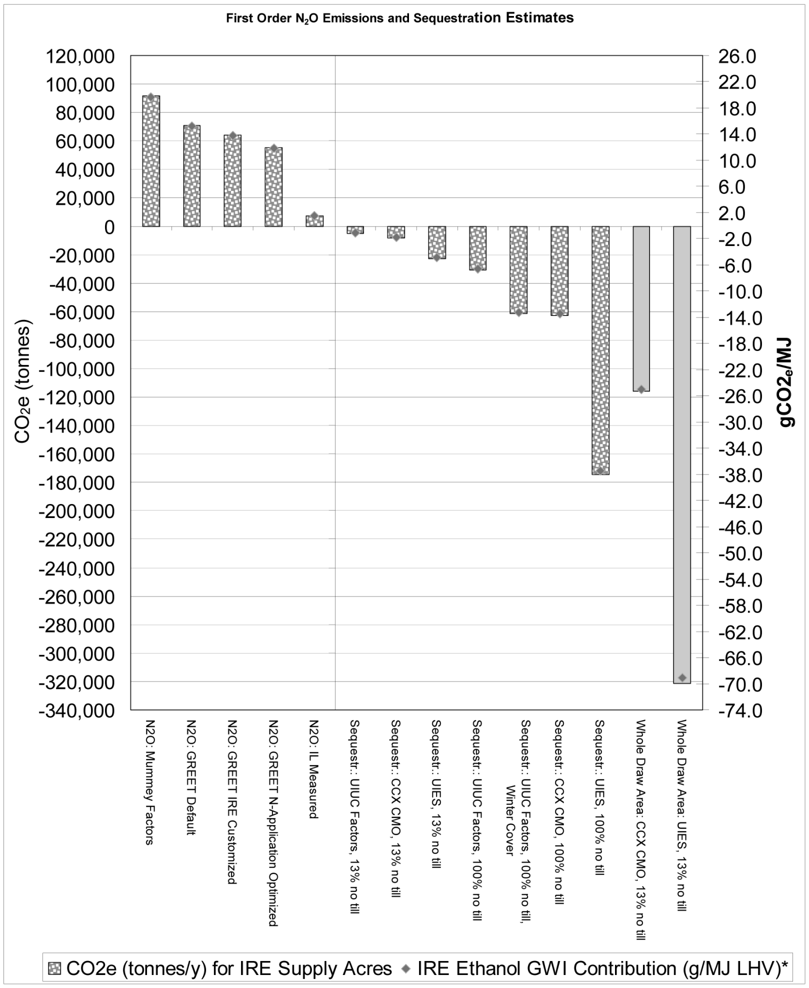


Figure 9: Carbon Assessment Summary

Table 8: GWI of IRE Produced Corn Ethanol

	Gasoline	GREET Default	IRE	IRE & Avg 13% No-Till	IRE & Avg 100% No-Till
N Fertilizer			14.2	14.2	14.2
Other Ag and Distribution			11.9	11.9	11.9
IRE Biorefinery			28.7	28.7	28.7
C-Sequestration			0.0	-2.6	-18.9
Net GWI	92.1	69.1	54.8	52.2	35.9

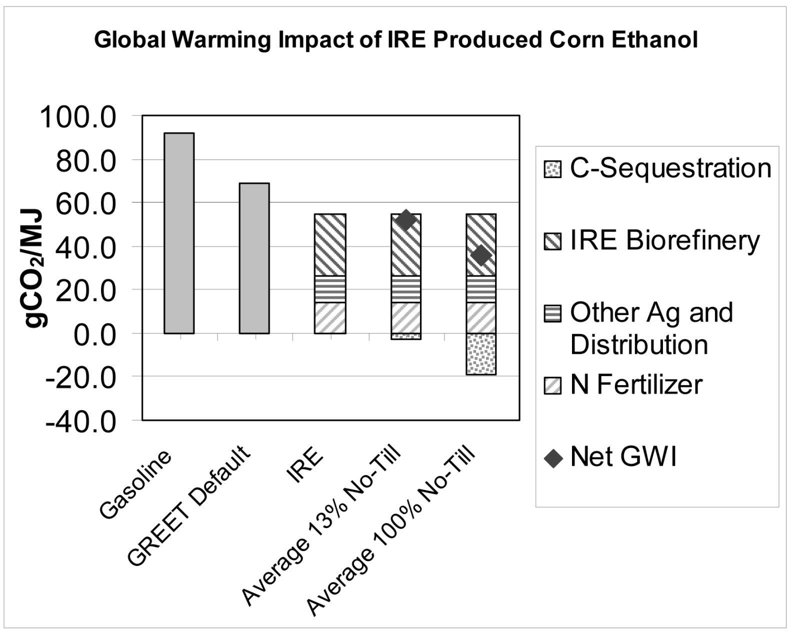


Figure 10: GWI of IRE Produced Corn Ethanol

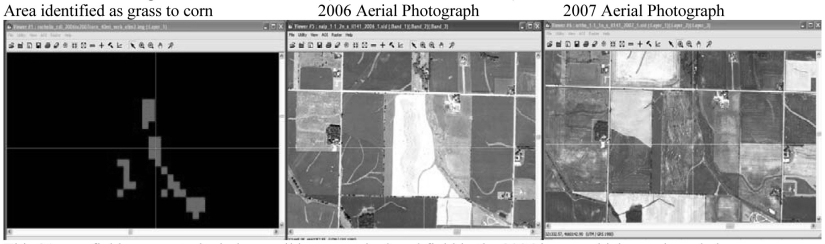
Appendix A: Examples of Errors in Non-Agriculture Land Use Change

Test Samples: The test samples below confirm that the data vetting routines correctly eliminate errors in land use change classifications. The decreases in several categories (woodlands to corn, grass/pasture to corn, grass/clover/wildflowers to corn) reflect the correct classifications.

Area identified as woodlands to corn | 2006 Aerial Photograph | 2007 Aerial Photograph

This six acre area that was classified as woodlands in 2006 and corn in 2007 appears to have been in woodlands both years according to the aerial photography from each year. Again, its narrow east to west dimensions may have led to pixels with a combination of agriculture and forestry being identified as each class in 2006 and 2007.

Grass/Pasture/Non-Ag in 2006 to Corn in 2007 (3,982 acres were estimated)
Area identified as grass to corn | 2006 Aerial Photograph | 2007 Aerial Photograph



This 21 acre field appears to be in bare soil but an agricultural field in the 2006 image which may have led to it's classification as a non-agricultural area in 2006, but in corn production in 2007.

Area identified as grass to corn 2006 Aerial Photograph 2007 Aerial Photograph

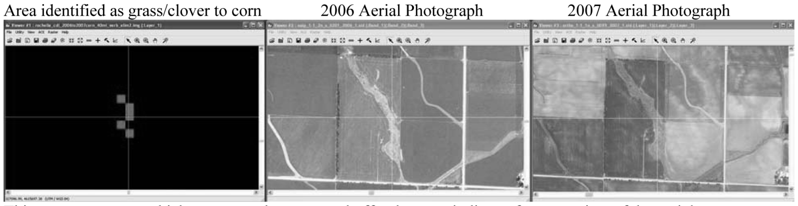
This 6.5 acre area along a roadway was identified as grassland in 2006 and corn in 2007. The aerial photography, however, does not indicate any land use change between these two years.

Areas identified as grass/clover/wildflowers in 2006 and Corn in 2007 (216 acres)

Area identified as grass/clover to corn 2006 Aerial Photograph 2007 Aerial Photograph

This 4.5 acre location identified as grass/clover/wildflowers in 2006 and corn in 2007 appears to be a home site with grass surrounded by agricultural production which probably led to the errors in classification.

Area identified as grass/clover to corn 2006 Aerial Photograph 2007 Aerial Photograph



This seven acre area which appears to be a stream buffer does not indicate, from a review of the aerial photograhy, any land use change associated with a grass/clover/wildflower area being converted to agriculture. The area appears to be grass in both years.

Appendix B: N2O Emissions and Carbon Sequestration Calculations

		CSC,SSC, Other Rot.	SCC/CCC	Other Rotations, Diversified
N-Emissions Factors		kg N2O-N/ha per y	kg N2O-N/ha per y	kg N2O-N/ha per y
Conventional Till		3.7	2.9	4.8
No Till		4.2	3.6	4.6
Surveyed Tillage Practice				
Conventional Till (%)	0.87			
No Till, Strip Till, Minimum Till (%)	0.13			
Blended Emissions Factor (kg N2O/ha per y)		3.765	2.991	4.774
Blended Emissions Factor (kg N2O/acre per y)		1.524	1.210	1.932
Bushels Delivered to IRE	20,450,000			
Average Yield	196			
Corn Acres Needed for IRE Supply	104,337			
What were 2007 IRE Acres in 2005 (%)		42%	43%	14.7%
What were 2007 IRE Acres in 2005 (acres)		43,707	45,314	15,315
Emitted N2O-N (kg/y)		66,596	54,851	29,590
Total Emitted N2O-N on IRE Acres (kg/y)	151,037			
Total Emitted N2O-N of IRE Del. Corn (g/bu)	7.39			
Total Emitted N2O of IRE Del. Corn (g/bu)	11.61			
Indirect Emissions Factor	30%			
Total direct and indirect emissions (g/bu)	15.09			

		CSC,SSC, Other Rot.	SCC/CCC	Other Rotations, Diversified
CO2 Sequestration Factors		tC/acre per year	tC/acre per year	tC/acre per year
Conventional Till		0.01	0.05	-0.15
No Till		0.02	0.2	-0.1
Surveyed Tillage Practice				
Conventional Till (%)	0.87			
No Till, Strip Till, Minimum Till (%)	0.13			
Blended Squestration Factor		0.011	0.070	-0.144
Bushels Delivered to IRE	20,450,000			
Average Yield (bu/acre)	196			0
Corn Acres Needed for IRE Supply	104,337			
What were 2007 IRE Acres in 2005 (%)		42%	43%	15%
What were 2007 IRE Acres in 2005 (acres)		43,707	45,314	15,315
Sequestered Carbon (t/y)		494	3,149	-2,198
Total Sequestered Carbon on IRE Acres (Mt C/y)	1,445			
Total Sequestered Carbon on IRE Acres (MT CO2/y)	5,300			
Total Sequestered Carbon on IRE Acres (MT CO2/acre)	0.05			
Total Sequestered Carbon on IRE Del. Corn (g CO2e/bu)	259			

Appendix C: Carbon Sequestration Using No-till Production in Southern Illinois

Michael Plumer, University of Illinois Extension

The study was conducted at the University of Illinois Extension Ewing Field site near Mt. Vernon, Illinois. Established in 1969 this site has the oldest continuous no-till plot in the Midwest. The plot has been in continuous no-till production since that time and is in a corn soybean rotation. An adjoining plot was in conventional tillage, moldboard plow and disk system until 1992 when it was converted to continuous no-till. This plot is in a corn, corn, soybean, wheat rotation. The soil type is a *Cisne gray prairie claypan silt loam, fine, smectitic, mesic Mollic Albaqualfs*. Both sites started with the same organic matter level of 1%.

Each site has 15 sample points and the data represents the average value for those samples. Sampling has been done in 1" increments to a depth of 8"and in 2" increments to a depth of 14". The A horizon is at a depth of 8"with an acidic subsoil in the range of 4.5 to 5.0 pH. Both plots received a lime application initially and again in 1983. No lime has been added since and soil tests do not require any pH modification.

No-till planting has been done on a timely basis, and as early as soil moisture conditions would allow. All nitrogen was surface applied as 34-0-0 until 1995 when nitrogen was injected as liquid fertilizer 28%. Residue was not disturbed from harvest till spring planting. Fertility was applied based on crop removal. The following table represents the changes in carbon in the soil profile.

	Ewing Field Carbon			
Surface Depth	1992 long no-till carbon (#/a)	2003 long no-till carbon (#/a)	1992 conv.1992 carbon (#/a)	2003 conv. 1992 Carbon (#/a)
0-1	6045.0	6692.7	1727.1	5181.4
1-2	4533.7	6692.7	2374.8	5181.4
2-3	4102.0	6692.7	2158.9	5181.4
3-4	3454.3	6692.7	2158.9	5181.4
4-5	3022.5	6692.7	2158.9	5181.4
5-6	1727.1	6908.5	1727.1	5397.3
6-7	2374.8	6908.5	1079.5	5181.4
7-8	2590.7	6260.9	1079.5	4317.8
8-10	4317.8	12521.7	2158.9	8635.7
10-12	3022.5	10362.8	3886.1	7772.1
12-14	4317.8	7340.3	4749.6	7772.1
Sum	39508.2	83766.1	25259.4	64983.5
	Carbon Increase in Continuous No Till System:		Carbon Increase in Converting Conventional Till to No Till System:	
Difference (#)	44257.9		39724.1	
Difference per Year (#)	3688.2		3310.3	
Difference per Year (Mt)	1.67		1.50	

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Endnotes:

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[i] The US EPA is starting to use satellite based data from Winrock International in their ethanol lifecycle modeling efforts.
[ii] The correlation coefficient between N applied and yield was calculated. At -0.12 the correlation coefficient is weak. The negative sign may indicate that further N application may not increase yield. However, the study design and collected data is likely insufficient to perform a yield response analysis.
[iii] The Proexporter Network (PRX) is a consulting firm specialized in U.S. grain flows, transportation demand, and the impact of these items on cash grain markets. Besides mapping systems for detailed analysis of U.S. grain movements PRX has also developed a geographic tool that assesses the corn draw areas around ethanol plants (the PRX Polygon).
[iv] This data has not been vetted to the above described standards but provides a first estimate of land additional land.
[v] Michelle Wander is the Director of the Agroecology and Sustainable Agriculture Program at the University of Illinois at Urbana-Champaign and Associate Professor of Soil Fertility and Ecology.
[vi] Emissions factors by Mummey et al informed by Wander:

	CSC,SSC, Other Rot.	SCC/CCC	Other Rotations, Diversified
N-Emissions Factors by Mummey et al.	kg N2O-N/ha per y	kg N2O-N/ha per y	kg N2O-N/ha per y
Conventional Till	3.7	2.9	4.8
No Till	4.2	3.6	4.6

[vii] This value is slightly lower than the IRE GWI study due to the adjusted crop rotations. The CO2e emissions in the IRE GWI study were 92,917 tonnes.
[viii] It should be noted that carbon gains generally occur in surface depth (0-30 cm). At deeper depths gains disappear which means that conversions away from carbon storing management practices may have a reversible effect. Furthermore, these are so-called linear rates that are applicable for about 10 years of a particular land use practice.
[ix] CO2 sequestration factors by Eve et al. informed by Wander:

	CSC,SSC, Other Rot.	SCC/CCC	Other Rotations, Diversified
CO2 Sequestration Factors by Eve et al.	tC/acre per year	tC/acre per year	tC/acre per year
Conventional Till	0.01	0.05	-0.15
No Till	0.02	0.2	-0.1

[x] This value is higher than the IRE GWI Study due to the adjusted crop rotations. The value in the IRE GWI Study was 2,160 tonnes
[xi] The 13% no-till/strip till include 3% strip till. The carbon sequestration rates of strip till are probably slightly lower than for no-till (about 10% lower per Michael Plumer, UIES). However, IRE is located in a slightly colder region than the Ewing plots, which should increase carbon sequestration. Therefore, the sequestration value of 1.67 Mt should be close for the assessed tillage practices.
[xii] The soil type from this sequestration study may not be fully reflective of the soil type surrounding IRE. However, the Uof I Extension study was able to document (for the studied conditions) long-term continuous sequestration effects.

ATTACHMENT 3

Use of Remote Sensing to Measure Land Use Change from Biofuels Production

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Abstract

The introduction of remote sensing datasets into the assessment of land use change associated with bio-fuels production seems obvious. Remote sensing offers the opportunity to image the extent of land use change but the errors associated with the classification must be taken into account. The present study assesses the accuracy of both direct and indirect land use changes predicted with different sensors (AWiFS, SPOT-VEGETATION, MODIS) for different regions (Illinois, Brazil) and different ecosystems (forest, cropland, savannah).

We found that direct land use changes for biofuels production can be assessed using higher resolution imagery from sensors such as Landsat Thematic Mapper and AWiFS (30m and 56m, respectively) if the data is further vetted for field and roadway fringes. The accuracy of this process is likely in excess of 95%. In contrast, indirect land use change assessments for biofuels production using imagery from SPOT-VEGETATION or MODIS (1km and 500m spatial resolution, respectively) produce results with high inaccuracies. In fact, the combined error range may exceed the predicted land use change between important ecosystem transitions for biofuels analyses such as the conversion of tropical rainforest to cropland in Brazil.

Regulatory agencies such as the California Air Resources Board and the US EPA, which are in a rule making process to incorporate land use considerations for biofuels production, must consider the limitations of remote sensing for this purpose. We recommend that land cover products based on the resolution of AWiFS imagery or better for transition regions associated with indirect land use change are created.

Introduction
Over the last three years increased biofuels production has frequently been recognized as a means to reduce the United States' dependence on foreign transportation fuels. However, several studies assert that crop demand for biofuels production may prompt conversion of native ecosystems to agriculture. This conversion process of ecosystems may result in carbon releases from native biomass and negatively impact the greenhouse gas (GHG) profile of biofuels (Righelato 2007, Searchinger 2008). Two agencies, the California Air Resources Board and the US Environmental Protection Agency are currently in advanced stages to develop rules on how to quantify and include GHG emissions when comparing the environmental impact between different fuel pathways (California Environmental Protection Agency 2009). The initiating legislation for the rule making process are the California Low Carbon Fuel Standard (LCFS) and the Federal Renewable Portfolio Standard (RPS), which require that the GHG emissions from biofuels have to be assessed on a full life cycle basis including contributions from direct and indirect land use change.

GHG emissions from direct land use change are generally considered to include those emissions associated with the direct supply chain of biorefineries (Plevin 2008). For corn ethanol this includes emissions from land converted to corn crop to meet the incremental demand of an ethanol plant. Economics-based indirect land use change models take market forces into account which act to induce land use change on domestic but mostly foreign land that is not part of the direct supply chain (Kim 2008). For example, one proposition of these model efforts is that increased ethanol production in the US leads to increased planting of corn which reduces available areas for soybean production thus reducing soy export from the US. In turn, other countries, such as Brazil will adjust their agricultural land use and ultimately convert native land to meet the soybean shortfall created by US biofuels production.

The quantification of the GHG impact from this process is captured by models in a two stage process: a) the adjustments in land surface area converted to crop in different countries is quantified for various US biofuels production scenarios (i.e. amount of new hectares in corn, soybeans, etc. in each country), followed by b) an assessment of what types of ecosystems are being converted to crop production (i.e. hectares of rainforest to corn, hectares of savannah to soybeans, etc.). Most datasets that are used to assess the types of ecosystems conversions taking place for biofuels production are based on remotely sensed imagery. However, we are not aware of a sound assessment that determines the accuracy of remote sensing with a focus on land use changes for biofuels production. The hypothesis of this study is that the accuracy of these global remotely sensed information products is insufficient for determining land use changes from biofuels production.

The use of remotely sensed imagery for the determination of land cover is well documented. Since the 1970s, with the launch of the first Landsat satellite by NASA, this imagery has been classified with a good level of success into land cover parcels. From the type of cover, it is usually self-evident what the land use is. For instance, if the land cover is pavement, it is safe to assume the land use would be human development or urban. In addition, when compared from year to year, satellite imagery can identify land use change. If an area is identified as agriculture one year and human development the following year it may be assumed that the area is one of urban encroachment.

Comparison of Spatial Resolutions for Different Sensors

The recent introduction of remote sensing datasets into the assessment of land use change associated with the possible expansion of agriculture to accommodate bio-fuels production seems obvious. Remote sensing offers the opportunity to directly image the extent of land use change but the errors associated with the classification must be taken into account. For instance, if 15% of forested areas are incorrectly identified in year one and 10% are incorrectly identified in year two, the error range totals 25%. Another common problem with land use change is the nature of the occurrence itself. Land use change usually occurs in transition areas between two land cover types such as forestry and agriculture. These transition areas are prone to mis-classification from a mixed pixel effect. A pixel is the minimum area on the ground for which one value associated with the intensity of light reflected from the earth's surface is being recorded. If the area within a pixel consists of more than one land cover type it can be mis-classified, especially from one year to the next. These errors may seem minor but when assessing land use change on a regional scale over millions of hectares, small percentage errors can indicate large, incorrect changes. The higher the number of pixels recorded by a sensor for a given surface area the higher is the spatial resolution of the imaging system.

Figure 1 below shows a 1 km area in Illinois captured with sensors onboard different satellites. Depending on the spatial resolution of the sensor on the satellite the 1 km area is divided into different amounts of pixels. The square on the top left in Figure 1 shows an aerial photograph of the scene with agricultural land, water, urban/buildings and roadways. Buildings and roadways make up a significant part of the scene.

The square on the top right shows the same scene with the 30 m resolution Landsat Thematic Mapper (TM) sensor, which was used by USDA for the NASS Cropland Data Layer from 1999 to 2005. We can see how the USDA NASS Cropland Data Layer classification for 2004 using the Landsat TM captures the waterway, the grass, the forest, and the urban areas. Currently, USDA NASS is using the AWiFS sensor for the Cropland Data Layer with a resolution of 56 m, which is close to Landsat (AWiFS also has a shorter re-visit time of 5 days versus 17 days for TM, which increases accuracy).

The square in the lower left corner of Figure 1 shows the same scene with the 2004 Global Landcover Classification's 500 m resolution from the MODIS sensor. US EPA has stated that their modeling efforts for life cycle analyses of the Renewable Portfolio Standard are relying on MODIS satellite data. We see that with MODIS significant reductions have been made and that one pixel now combines forest, crop and urban areas into one "crop" category.

Lastly, the lower right corner of Figure 1 shows the Illinois scene with a 1km resolution from the SPOT-VEGETATION sensor, which is, for example used for the "New IPCC Tier-1 Global Biomass Carbon Map for the Year 2000" (Ruesch 2008). With this sensor, the complete scene is further reduced and characterized as cropland. Figure 2 provides a similar demonstration for a more homogeneous land cover scene in Illinois. As can be seen the MODIS and SPOT sensors combine the mixed land cover in that scene into one cropland category.

For the present study we chose the best possible sensors to determine the accuracy of modeling direct and indirect land use while acknowledging the tradeoff between resolution and cost (availability). Therefore, direct land use change was modeled using the higher resolution AWiFS sensor whereas indirect land use change was modeled using MODIS since this sensor produces a global land cover product. The region chosen for direct land use was modeled based on the corn supply area for an ethanol plant in Illinois; indirect land use change was modeled for Illinois and Brazil.

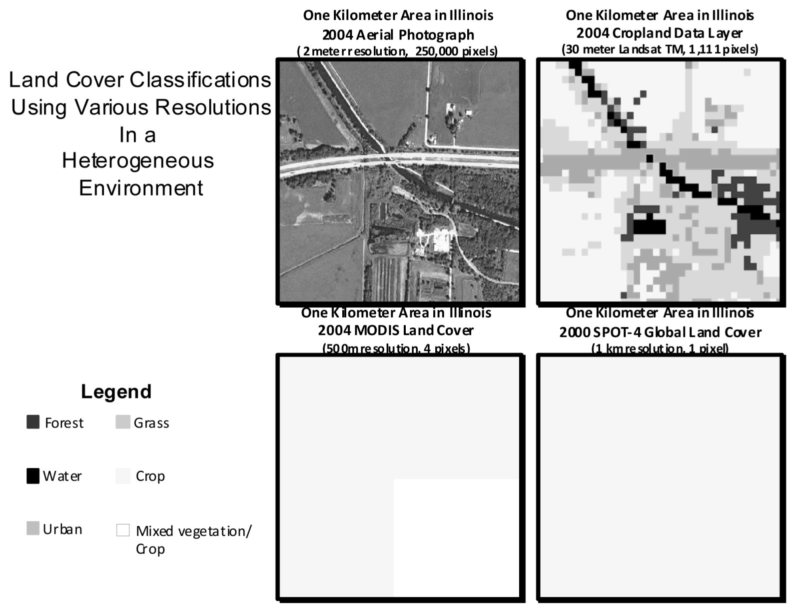


Figure 1: Example Scene 1 in Illinois. Satellite Imagery with Different Resolutions

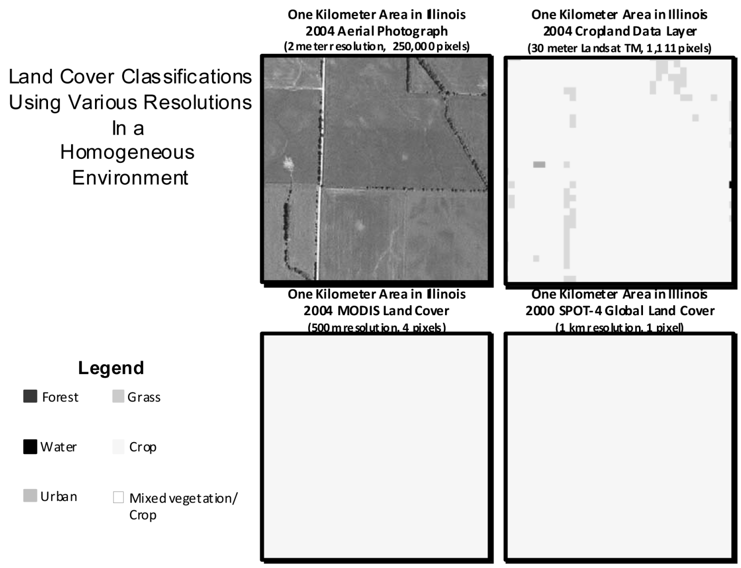


Figure 2: Example Scene 2 in Illinois. Satellite Imagery with Different Resolutions

Direct Land Use Change

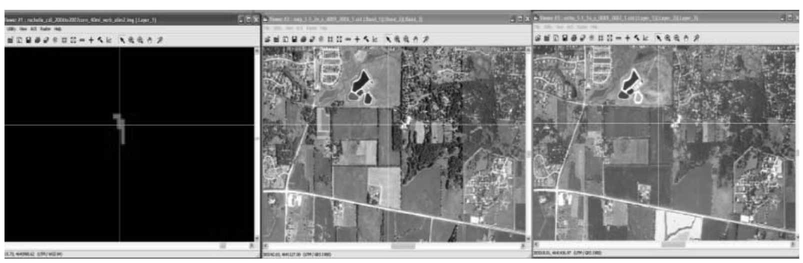
In a previous study we assessed land use change for a 40 mile circle surrounding an ethanol plant in Illinois (Mueller 2008). For the present study we have further analyzed the data since it is representative of the accuracies that can be achieved for direct land use change assessments. The assessment uses the USDA NASS Cropland Data Layers for 2005, 2006 and 2007 (developed by USDA NASS using AWiFS imagery with 56 m resolution and 5-day revisit time for agricultural areas) combined with the 2001 National Land Cover Data (NLCD) set for non-agricultural classifications (which is currently the most recent version with a new version expected in 2010).[1] The overall accuracy of the cropland data for Illinois in 2007 is 97.6 % (cropland data includes agricultural classes only).[2] The error range for land use change between two years, in this case for Illinois, would approximate 2*(1-0.976)=4.8% .

[1]Information on the National Landcover Dataset is available from the website of the Multi-Resolution Land Characteristics Consortium (MRLC) at http://www.mrlc.gov
[2]Accuracies for all USDA NASS Cropland data layers are available at http://www.nass.usda.gov/research/Cropland/metadata/meta.htm

However, the accuracies of the 2001 NLCD are lower and not consistently assessed. No formal accuracy assessment of the NLCD has been performed on a national basis, but overall accuracy assessments have been estimated at 83.9% (Homer et al. 2007). Furthermore, roadways and field fringes introduce further inaccuracies. Therefore, the accuracy assessment of our direct land use parcel employed an additional vetting routine.

The data showed that 39,841 hectare out of the 601,994 hectares in corn during the study year 2007 would have been predicted to change from non-ag use to corn, a predicted change of 7%. However, in a further analysis step, an additional vetting of the data was performed by applying a routine to the masked area that subtracted a 0.3 hectare buffer along the roadways. Subtracting the roadway buffers resulted in a significant drop of the non ag categories from a total of 39,841 hectares to 1,663 hectares or 0.27% of predicted non ag land use change. We took about 50 test samples with areal photography to confirm that these parcels were indeed roadway buffers or field fringes around agricultural land (see Figure 3). The characteristics of roadway buffers and fringes are such that very minor change in vegetation can prompt change in land use classifications. Furthermore, an additional 10,771 hectares which, in the imagery evaluation routine were classified as ag to non-ag to ag conversion (an unlikely scenario) over the three year period 2005-2007 were categorized separately. Test samples again confirmed that ag to non-ag to ag conversions are misclassified as continuous corn rotations.

We conclude that for direct land use change assessments for biofuels production where changes from non agricultural land to agricultural land are the focus, the lower accuracy of the NLCD as well as roadways and field fringes may lead to significant overestimations of land use change (39,841 hectares from non ag use to corn vs. 1,663 hectares). Therefore, additional vetting of the data needs to be performed for the purpose of direct land use assessments. Since the additional vetting affected primarily (non-agricultural) NLCD classifications, it can be asserted that the vetting process raised the lower accuracy associated with the NLCD to cropland data levels (in excess of 95%).



This 2.8 hectare area was classified as woodlands in 2006 and corn in 2007 but appears to have been in agricultural production both years. Trees surrounding the field likely led to the misclassification in 2006.
Figure 3: Field Fringe Test Sample

Land Use	2007 Crop Area in 2006			
	NASS Unvetted Hectares		NASS Vetted Hectares	
Corn	276,370		275,324	
Soybeans	269,417		267,764	
Winter Wheat	5,848		6,081	
Other Small Grains	299		111	
Win. Wht./Soyb. Dbl. Cropped	113		45	
Alfalfa	2,809		1,238	
Other Crops	4,537		3,815	
Fallow/Idle Cropland	2,760		651	
Grass/Pasture/Non-Ag	37,639	39,841 hectares Non-ag to corn	1,611	1,663 hectares Non-ag to corn
Woodland	1,401		49	
Urban/Developed	747		2	
Water	49		0	
Wetlands	4		0	
Ag 2005 to Non-Ag to Ag Land	0		10,771	
Field and Roadway Fringes	0		34,531	
Total Analyzed	601,994		601,994	

Table 1: Unvetted and Vetted AWiFS Crop Data

Indirect Land Use Change

NASA offers a global land cover product which has been developed from the agency's MODIS sensors on-board the Terra and Aqua satellites. As pointed out above the MODIS remote sensing data has been considered for land use change modeling of biofuels for regulatory purposes. Therefore, the accuracy of land use change predicted with MODIS land cover data was selected for further assessment.[1] The MODIS sensor collects images at 250 meter, 500 meter and 1 kilometer resolution pixels over every location on the earth's surface on a daily basis. The MCD12Q1 is processed at the 500 meter resolution. The global land cover product has been developed on an annual basis from 2001 to 2005 by combining cloud free MODIS images throughout the year and analyzing these multi-temporal datasets for land cover based on the reflectance and a detailed network of ground truth information.

The MODIS MCD12Q1 land cover dataset comes with a number of land cover classes identified. The MCD12Q1 actually comes in different land cover classification schemes including one develop by the University of Maryland and another that breaks agriculture into cereal and broadleaf crops. For this analysis, the International Geosphere Biosphere Programme (IGBP) land cover classification land cover types were used but aggregated to facilitate data analysis (see Table 2).

[1] The MODIS dataset, known as MCD12Q1 is available free of charge for download by the general public at ftp://e4ftl01u.ecs.nasa.gov/.

Table 2: Reclassification of IGBP Classes

IGBP Classification Scheme	Classification Scheme Used for This Analysis
Water	Water
Evergreen Needle-leaf forest	Forest
Evergreen Broad-leaf forest	Forest
Deciduous Needle-leaf forest	Forest
Deciduous Broad-leaf forest	Forest
Mixed forest	Forest
Closed shrublands	Shrub
Open shrublands	Shrub
Woody savannas	Savanna
Savannas	Savanna
Grasslands	Grassland
Permanent wetlands	Wetland
Croplands	Crop
Urban and built-up	Urban
Cropland/Natural vegetation mosaic	Mixed
Permanent snow and ice	Other
Barren or sparsely vegetated	Other

An analysis of land cover predicted for Brazil for 2001 and 2004 by the MCD12Q1 dataset does show a decline in the number of hectares in forest and shrub lands and an increase in cropland but it also shows a considerable increase in savanna and a significant decrease in the mixed/crop class (Table 3). These classifications indicate that there is some potential confusion in the amount of natural vegetation that is being converted into cropland.

Table 3: Number of hectares for NASA MCD12Q1 land cover classification dataset

Land Cover	2001	2004	Difference
Forest	393,451,000	382,090,000	-11,361,000
Shrub	5,394,000	2,720,000	-2,674,000
Savanna	272,622,000	312,837,000	40,215,000
Grassland	45,449,000	23,965,000	-21,484,000
Wetland	10,450,000	11,296,000	846,000
Crop	27,869,000	28,110,000	241,000
Urban	3,924,000	3,921,000	-3,000
Mixed/Crop	85,737,000	79,866,000	-5,871,000
Barren/Snow	705,000	225,000	-480,000

The accuracy associated with these MCD12Q1 land cover classifications needs to be taken into consideration when determining the relevance of change measured with these datasets. The NASA land cover team gathered ground truth points from various locations throughout the world and then compared those points to the results from the land cover classification. The current version of the MCD12Q1 is version five. There are no published errors for this land cover version. The most recent published errors are for version three (Boston University 2009). It is unlikely that version five will have obtained a significant increase in accuracy for purposes of this analysis. Therefore, the accuracies associated with version three will be used. Table 4 lists

the confidence value which indicates the probability that each pixel will meet the accuracy of the ground truth used to develop the map.[2]

Table 4: Global Confidence Values by Land Cover Class

	IGBP Land Cover Class	Confidence Value (%)
1.	Evergreen Needleleaf	68.3
2.	Evergreen Broadleaf	89.3
3.	Deciduous Needleleaf	66.7
4.	Deciduous Broadleaf	65.9
5.	Mixed Forest	65.4
6.	Closed Shrubland	60.0
7.	Open Shrubland	75.3
8.	Woody Savanna	64.0
9.	Savanna	67.8
10.	Grasslands	70.6
11.	Permanent Wetlands	52.3
12.	Cropland	76.4
14.	Cropland/Natural Veg	60.7
15.	Snow and Ice	87.2
16.	Barren	90.0
17.	Water	(Not Available)
	Average Value, All Classes	70.7
	Area-Weighted Average	78.3

If a class has a confidence value of 70%, each location in this class has a 30% probability of incorrect classification. When assessing changes in a class from year to year, then, it is necessary to take this error into account. If the amount of change in the class is less than the amount of potential error than there is a legitimate chance that the change may be incorrect. For instance, if a class consists of 1,000,000 hectares in 2001 and 800,000 hectares in 2004 but its accuracy is 70% then that class could be off by up to 300,000 hectares in 2001 and 240,000 hectares in 2004 creating a total error of +/- 540,000 hectares. With the potential error of 540,000 hectares for a 200,000 hectares change it may be difficult to use this change with a high level of confidence.

For this analysis, the potential error for each class was applied to the 2001 and 2004 MODIS datasets. The error was applied to the hectares for each individual class and then combined to ensure accuracy (see Table 5). These errors, when applied to the data, bring into question efforts to calculate change from a number of these classes to or from crop. The combined error range for forested hectares land use change, for instance, could total 90 million hectare. The total amount of land in crops in Brazil is around 28 million hectare each year. Figure 4 illustrates the scale of these values. The combined error range for land use change for savanna is even greater at almost seven times as many hectares in question (192 million) as land in crops (28 million). If the error range far exceeds the predicted change for land use transitions asserted for biofuels production, then these datasets are not suited to support sound analyses in this field. In fact, the

[2] The table is reproduced from http://www-modis.bu.edu/landcover/userguidelc/consistent.htm

Global Landcover Validation Report states that the purpose of the MCD12Q1 datasets are to assess global land cover and should not be used to assess inter-annual change (Strahler 2006).

Table 5: Possible Hectares in Error from MODIS Land Use Change Analysis

Land Cover	Possible Hectares in Error in 2001	Possible Hectares in Error in 2004	Total
Forest	46,910,000	43,070,000	89,980,000
Shrub	1,870,000	980,000	2,850,000
Savanna	89,910,000	102,500,000	192,410,000
Grasslands	13,360,000	7,050,000	20,410,000
Crop	6,580,000	6,630,000	13,210,000

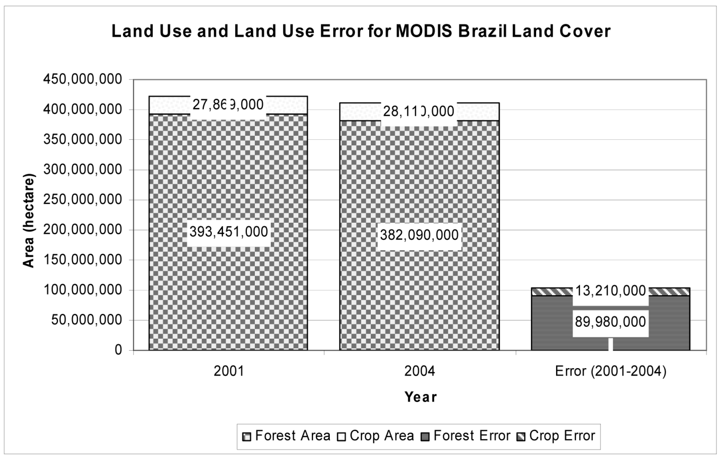
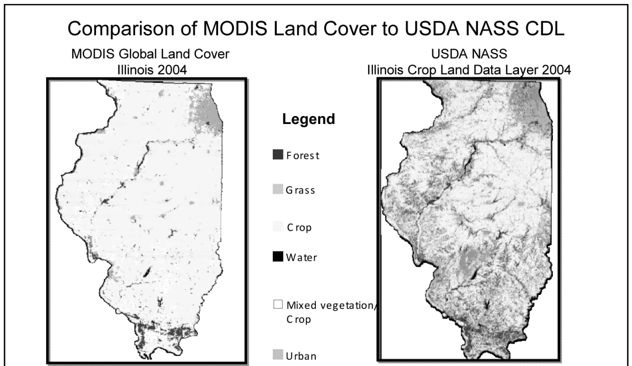


Figure 4: Land Use and Error Determined with MODIS for Brazil

Lastly, we analyzed MODIS imagery for Illinois and compared the results to tabular survey data compiled by the US Forest Service and the USDA NASS. Figure 5 shows that for forest area MODIS under estimates the surface area by 71%, whereas for cropland MODIS over estimates the surface area by 27%. We conclude that the MODIS datasets are fairly inaccurate for predicting land use changes from or to forested areas in Illinois and areas with similar ecosystems (such as other Midwestern states).



Class	MODIS Acres for Illinois in 2004	Tabular Data
Forest	1,127,000	4,423,000
Cropland	26,989,000	23,515,000

Figure 5: MODIS Imagery for Illinois

Conclusions

The accuracy of remote sensing for land use analyses generally varies by the type of land use and the resolution of the sensor. For changes in crop types between two years, for example, Landsat or AWiFs imagery can achieve a combined error range as low as 4.8% (Illinois, 2.4% error for each year), which is sufficiently accurate in combination with survey data for many types of crop land statistics (including the USDA NASS Cropland Data Layer sets).

For the present study we assessed the accuracy of remote sensing for land use changes expected from biofuels production. We looked both at direct and indirect land use changes. We conclude that for direct land use change assessments for biofuels production in the US where changes from non agricultural land to agricultural land are the focus, the lower accuracy of the current National Land Cover Data (NLCD) set as well as roadway and field fringes may lead to significant overestimations of land use change. Without additional vetting we would have predicted land use changes from non ag land to ag land of 39,841 hectares (or 7% of all hectares in corn in a given area) whereas the vetted data showed that likely only 1,663 hectares were converted to agricultural land (or 0.27% of all hectares in corn in a given area). Since the additional vetting affected primarily (non-agricultural) NLCD classifications, it can be asserted that the vetting process raised the lower accuracy associated with the NLCD to cropland data levels (in excess of 95% for land use change assessments).

Looking at indirect land use changes in Brazil, we found that for land use changes such as those potentially prompted from biofuels production (forest to cropland) the combined error range between two years was larger than the predicted change: The combined error range for forested hectares land use change, for instance, could total 90 million hectare, whereas the total amount of

land in crops in Brazil is around 28 million hectare each year. If the potential error far exceeds the predicted change then using these datasets is tenuous at best.

With respect to indirect land use change in Illinois we showed that for forest ecosystems MODIS under estimates the surface area by 71%. For cropland MODIS over estimates the surface area by 27%. We conclude that the MODIS datasets are fairly inaccurate for predicting land use changes from or to forested areas in Illinois and areas with similar ecosystems (such as other Midwestern states).

In summary, direct land use changes for biofuels production can be assessed using higher resolution imagery from sensors such as Landsat and AWiFS (30m and 56m, respectively) if the data is further vetted for field and roadway fringes. The accuracy of this process is likely in excess of 95%. Assessing indirect land use changes for biofuels production using imagery from SPOT-VEGETATION or MODIS produces results with high inaccuracies. In fact, the combined error range may exceed the predicted land use change between important ecosystems such as the conversion of tropical rainforest to cropland in Brazil. Regulatory agencies such as the California Air Resources Board and the US EPA which are in a rule making process to incorporate land use considerations for biofuels production must consider the limitations of remote sensing for this purpose. We recommend that land cover products based on high resolution AWiFS imagery for transition regions associated with indirect land use change are created.

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EXHIBIT 23

American Farm Bureau Federation

March 25, 2009

Hon. ARNOLD SCHWARZENEGGER,
Office of the Governor,
State Capital,
Sacramento, CA

RE: Concerns Regarding Proposed LCFS Regulation

Dear Governor Schwarzenegger,

We are writing with regard to the proposed California Low Carbon Fuel Standard (LCFS). As you may know, the American Farm Bureau Federation (AFBF) is the unified national voice of agriculture, working through our grassroots organization to enhance and strengthen the lives of rural Americans and to build strong, prosperous agricultural communities.

Increasing America's energy resources and protecting national security by reducing our dependence on foreign oil and continuing to grow our domestic renewable fuels industry are among the most important challenges facing our country. As farmers and ranchers we believe that we can play an important role in lessening our dependence on foreign oil. We are concerned, however, about the direction of the current LCFS proposal.

From our understanding, the LCFS was originally intended to allow all eligible fuels to compete on a level, carbon-based playing field. There is widespread agreement in the scientific and research communities that biofuels produced from U.S. farms have significant benefits over petroleum and other fossil fuels like natural gas based on the "cradle to grave" carbon emissions associated with producing and using the fuel. For example, soybean-based biodiesel receives a CA-Greenhouse gasses, Regulated Emissions and Energy use in Transportation GREET carbon intensity score of 26 g/MJ, while corn-based ethanol receives a score of 67 g/MJ. Advanced biofuels like cellulosic ethanol and renewable diesel have even better carbon scores. These numbers are considerably lower than California gasoline and diesel, which CA–GREET scores at 96 g/MJ and 95 g/MJ, respectively.

To be clear, the CA–GREET model accounts for the carbon emissions directly attributable to the full lifecycle of the respective fuel. For biofuels CA–GREET includes the application of fertilizer, and the land directly converted to produce biofuel feedstocks. For petroleum CA–GREET includes major upstream refinery emissions. In both cases, transportation and combustion of the fuel is included.

Unfortunately, the Air Resources Board (ARB) is proposing to enforce an additional carbon penalty against biofuels only, increasing the carbon score of these fuels by 40 percent or more. ARB staff calls the penalty "indirect land use change." The effect is a "market-mediated" or "economic carbon effect" derived by running estimated future biofuel demand through an economic model. The problem with this proposal is two-fold: (1) the science of predicting indirect, economically-derived carbon effects is extremely new and uncertain; and, (2) no level of certainty justifies enforcing economically-derived carbon effects against only one type of fuel.

As to the issue of uncertainty, we note that 111 scientists submitted a letter detailing the state of the science and recommending against premature enforcement of indirect effects. We also point out that AIR, Inc. released a study showing that increasing corn ethanol production in 2015 to the same levels modeled by ARB results in zero indirect land use change based on updated treatment of biorefinery coproducts and crop yields. It is particularly troubling to AFBF that the current model runs for indirect land use change do not include inputs for the use of land enrolled in the Conservation Reserve Program (CRP) and idle cropland. The omission of CRP and idle land is problematic because any farmer looking to produce additional biofuel feedstock is most likely to look first to idle cropland so as not to disrupt current cash flows. A land use assessment without this factor is quite simply not credible or based on real world decision-making.

As to the issue of selectivity, it is clear that all fuels have market-mediated carbon effects. But only biofuel is penalized for indirect effects. As stated in the scientist letter, "[e]nforcing different compliance metrics against different fuels is the equivalent of picking winners and losers, which is in direct conflict with the ambition of the LCFS."

It is important to note that U.S. farming practices continue to advance both in sustainability and productivity. According to the United States Department of Agriculture (USDA), in 2008 American farmers produced the second largest corn crop on record and attained the second highest yield per acre in history with fewer en-

ergy and fertilizer inputs. Also, the distillers grains that are a co-product of ethanol production are playing a major role in providing livestock—in the U.S. and abroad—with high-protein, nutrient rich feed.

The agricultural community is eager to play a central role in the increased use of biofuels. However, if adopted as currently proposed, the LCFS will uniformly dissuade the production and use of all forms of biofuels that utilize land and undercut what is a tremendous opportunity to spur economic growth in agricultural communities and reduce carbon emissions with American farming.

Several different stakeholder groups, including the 111 scientists who submitted a letter to your office on March 2, recommended that ARB adopt an LCFS regulation based only on direct carbon effects, or those emissions directly attributable to the production and use of the particular fuel, while taking the lead on the further assessment of the indirect carbon effects of all fuels. AFBF believes that a regulation based on direct effects will be balanced and represents the "level playing field" your office envisioned at conception of the program.

Thank you for your time and consideration. AFBF appreciates this opportunity to comment on this vitally important program.

Sincerely,

BOB STALLMAN,
President.

EXHIBIT 24

Growth Energy Comments: California's Dangerous Gamble with Indirect Land Use Change

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growth energy™
America's Ethanol Producers

Executive Summary

Growth Energy is committed to the promise of agriculture and growing America's economy through cleaner, greener energy. Growth Energy promotes reducing greenhouse gas emissions, expanding the use of ethanol in gasoline, decreasing our dependence on foreign oil, and creating American jobs at home.

Ethanol is America's best renewable fuel, reliable and affordable now. It is high-tech, home grown, and on the verge of innovative breakthroughs that will make it even cleaner and greener for the long term. Ethanol is vital to achieving greater American energy independence. It is today's only viable and available fuel that can be substituted for gasoline. Unlike oil, ethanol is renewable – it will never run out. As science moves from making ethanol from corn to producing it from corn cobs and other plant materials, ethanol will continue to be a sustainable and effective energy solution for the world. America's dependence on foreign oil causes enormous problems for Americans every day – raising prices on everything from gas to groceries and sending money and jobs overseas. Ethanol is America's green growth energy solution to our foreign oil problem.

For these reasons, Growth Energy is very concerned about the Low Carbon Fuel Standard (LCFS) regulation proposed by the California Air Resources Board (ARB). Our review of the proposed regulation and the staff report raises three major concerns:

(1) *The unequal treatment of the ethanol fuels*, which are subjected to an analysis of "Indirect Land Use Change" (ILUC) effects calculated by a seriously deficient model, as opposed to the other transportation fuels, which are not; and the bare, unsupported finding that there are no discernible indirect effects of *any kind* caused by the use of the other fuels.

Our basic objection here is that this regulation creates an unlevel playing field for transportation fuels by assessing a carbon intensity (CI) penalty on ethanol fuels for ILUC effects predicted by the Global Trade Analysis Project model (GTAP). This penalty, which places ethanol fuels in the same CI category as gasoline, is derived from a general equilibrium model designed to predict the amount of land that would be converted to agricultural use if the U.S. ethanol market experienced a significant increase in demand that, under the model's assumption, would be met entirely by increased production of corn. Such a model leaves out or inadequately accounts for a whole host of economic, political, meteorological and other factors, such as technological innovation, normal declines in other crops, export declines not associated with corn or soybeans, land conversion costs of converting from nonagricultural to agricultural uses, and the discrepancies in emission estimates of stored and released carbon. These deficiencies have provoked wide-spread criticism in the scientific community.

(2) *The Ca-GREET model for Life-Cycle GHG emissions*, which utilizes outdated and inaccurate inputs related to farming and ethanol production, which is insensitive to critical geographic differences in corn and ethanol production that greatly affect the total life-cycle GHG emissions, and which produces a

flawed co-product calculation that substantially underestimates the environmental value of dry distiller's grain with solubles (DDGS).
These errors and limitations serve only to exacerbate the highly discriminatory carbon intensity score for ethanol fuels. They also add further questions about the overall technical rigor of ARB's methodology for such highly sensitive calculations.

(3) *The legal standards applying to the process for adoption of new regulations,* which require a broad assessment of all of the relevant economic effects on business that a regulation may impose; the consideration of all of the evidence in the record relating to the proposed regulation; the avoidance of arbitrary or capricious decision making or any discriminatory or selective enforcement as a result of the regulation, the fair and equal treatment of all economic actors, and require careful consideration of the environmental impacts that the regulation may have.

Growth Energy supports CARB in its groundbreaking efforts to address global climate change and to deal successfully with the enormous challenges posed by such an important undertaking. Because of this, we strongly recommend that staff reconsider its decision to introduce into the program a highly controversial and very premature process for the identification and quantification of indirect environmental effects from the production and use of a transportation fuel. At some point there may be a strong scientific basis for initiating such an investigation, but that time has yet to arrive. But equally important, no such investigation should single out one fuel and ignore the indirect effects of other fuels. As science and methodology move forward, a full and fair-minded investigation may then be warranted. But as for now, this is a public policy disaster in the making. Unfortunately, there is no kinder way to put it.

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Growth Energy Comments: California's Dangerous Gamble with Indirect Land Use Change

Introduction

Reducing carbon emissions in transportation fuel, a subject of recent national debate, is in fact an ambitious and admirable goal for the state of California. It is also a goal fraught with danger. Unless sound, proven science is used to determine carbon emissions, the state and nation could suffer the reverse effect: a transportation system that actually increases emissions.

An issue before California's Air Resources Board (ARB) threatens to cause just that. The theory of Indirect Land Use Change (ILUC) employs no empirical evidence and an unfair notion of justice to single out one industry – ethanol – as the culprit behind poor environmental practices in other countries. The Air Resources Board should reject use of ILUC and prevent bad policy from undermining America's only clean, green alternative to gasoline available today.

In January 2007, Governor Arnold Schwarzenegger signed an Executive Order establishing the first Low Carbon Fuel Standard (LCFS). The goal of the LCFS is to lower the carbon intensity of California's transportation fuels by 10 percent by 2020. Governor Schwarzenegger charged the ARB with developing the regulations that would govern the LCFS, and the agency released a draft rule for public comment with the final rule to be voted on by the ARB on April 23.

One of the most controversial aspects of the ARB's rulemaking has centered on the carbon accounting of biofuels, and more specifically the inclusion of Indirect Land Use Change (ILUC) models in calculating the carbon intensity of biofuels. Currently, the carbon intensity of transportation fuels is determined through "lifecycle analysis." So for corn-based ethanol, its carbon intensity is calculated from the time the crop is planted and farmed until it is harvested, turned into ethanol and burned as an additive in gasoline. According to the most recent data from the University of Nebraska-Lincoln, the ethanol industry currently produces a fuel that is 48 to 59 percent lower in lifecycle greenhouse gas emissions than gasoline.[1]

However, the ARB is now proposing a significant shift in these internationally-recognized standards for lifecycle analysis by including indirect emissions theoretically related to the production and use of biofuels. This theory claims that growing crops for biofuel production displaces other crops, which are then grown in other parts of the world, leading to deforestation. Based on this theory, the ARB would assign an indirect land use change "adder," or penalty, to ethanol in addition to its direct carbon intensity. According to ARB's preliminary work on this issue, it has calculated the carbon intensity of dry-mill corn-based ethanol to be 67.6 (gCO2/MJ), which is not as good as the University of Nebraska's

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[1] http://ianrnews.unl.edu/static/0901220.shtml

findings, but is significantly better than calculation for California Gasoline Blendstock of 96.88 (gCO2/MJ). But, when adding the indirect land use change penalty to ethanol, ethanol's carbon intensity jumps to 97.6 (gCO2/MJ).[2]

The debate over ILUC has become increasingly polarized, with opponents of ILUC models pointing to the scientific problems with its application and proponents saying any number is better than zero, even if there are many unknowns. Often lost in this debate is whether applying ILUC penalties to biofuels will actually accomplish the original goal – reducing carbon emissions.

The theory behind ILUC is not conclusive and it fails to be realized empirically. The adoption of ILUC models could have the opposite intended effect - creating disincentives to decrease a fuel's carbon intensity. It could have dangerous repercussions in the broader policymaking effort to reduce carbon emissions. There are alternatives to ARB's proposal that would promote incentives for biofuels producers to adopt more sustainable practices that are verifiable and would ultimately contribute greatly to California's efforts to reduce its greenhouse gas emissions.

<u>Indirect Land Use Change – How Did We Get Here?</u>

The effort to include ILUC models in lifecycle analysis has been driven by a small group of academics who have relied on a theoretical framework rather than observable data. The first person to promote this theory was Mark Delucchi from the University of California-Davis.[3] In a paper he released in October 2004, Delucchi claims the calculation of GHG emissions for transportation fuels should include a wide array of factors, including policy action, production and consumption of energy and materials, prices, emissions and environmental systems. Instead of citing data, Delucchi provides imagined scenarios on how these factors could impact a fuel's carbon footprint.

Delucchi's theory was then promoted by a group of academics at University of California-Berkeley, Alex Farrell, Richard Plevin, Michael O'Hare, and Daniel Kammen. As part of his Masters in Science degree, Richard Plevin submitted a dissertation calling for California policy to measure the carbon intensity of biofuels by using "market-based" lifecycle tools.[4] It's important to note that while these academics are now firm opponents of corn-based ethanol, they previously supported it in a paper they published in *Science* in January 2006v. Once Governor Schwarzenegger signed the Low Carbon Fuel Standard in 2007, he appointed Alex Farrell to work with the ARB to develop the regulations for the standard and in August 2007, Farrell and his team submitted a policy analysis on how the ARB should establish the rules.[5] In the document, they acknowledge "indirect land use changes associated with biofuel production in the LCFS would be difficult to estimate because it is uncertain how increased biofuel production in one location (for instance California or Iowa) would affect the use of land in another

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[2] http://www.arb.ca.gov/fuels/lcfs/lcfs.htm
[3] http://www.its.ucdavis.edu/publications/2004/UCD-ITS-RR-04-45.pdf
[4] http://plevin.berkeley.edu/docs/Plevin-MS-2006.pdf
[5] http://www.arb.ca.gov/fuels/lcfs/lcfs_uc_p2.pdf

location (for instance prairie land in the Great Plains or rain forests in Malaysia or Brazil). Few economists believe the international computable general equilibrium model could reliably predict such land use changes." Yet they go on to conclude that even though a correct indirect land use change penalty cannot be accurately determined, any number is better than zero. They justify this policy position by writing that it would send a "signal" to biofuels producers.

At that point, it was clear the ARB would move forward in developing a model to calculate an ILUC penalty for biofuels. The theory's proponents scored another victory when ILUC language was inserted in the final version of the Energy Independence & Security Act of 2007 (EISA), which gave the U.S. Environmental Protection Agency authority to use ILUC models to determine the greenhouse gas emissions of biofuels. The ILUC language had to be added to a section in EISA about life cycle analysis precisely because it is outside the accepted practices of life cycle analysis.

Then, in February 2008, the concept of indirect land use change gained enormous publicity when Tim Searchinger, an environmental lawyer with no scientific background, published a study in *Science* claiming that carbon emissions related to ILUC made corn-based ethanol more carbon intensive than gasoline.[6] According to Searchinger, the land diverted for increased corn production used for ethanol would lead to sharp decreases in American grain exports, which in turn would lead to increased land cultivation elsewhere, releasing the carbon stored in that particular region. This paper will address the many flaws of Searchinger's paper in the next section, but it's important to note that immediately after it was released, his research was widely disputed by experts in lifecycle analysis, including Dr. Michael Wang of Argonne National Laboratory[7] and Dr. Bruce Dale of Michigan State University.[8] Unfortunately, the media did not include these critiques in their stories and treated Searchinger's paper as actual "science." More recently, Professors Matthews and Tan of Macquarie University published a thorough review of Searchinger's February 2008 assumptions, methods and motives concluding: "if you wished to put US ethanol production in the worst possible light, assuming the worst possible set of production conditions guaranteed to give the worst possible ILUC effects, then the assumptions chosen would not be far from those actually presented (without argument or discussion of the alternatives in the Searchinger et al paper.[9]

Meanwhile, the ARB continued work on a model to include ILUC in its calculation of the Low Carbon Fuel Standard. In April 2008, Alex Farrell passed away, and now Michael O'Hare is lead advisor to the ARB. In addition, the ARB hired Lifecycle Associates, a company that includes Richard Plevin as part of its staff to conduct the lifecycle analysis for the various transportation fuels. The ARB's findings have all been posted on its Web site.[10]

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[6] http://www.sciencemag.org/cgi/content/abstract/319/5867/1238
[7] http://www.bioenergywiki.net/images/0/0a/Michael_Wang-Letter_to_Science_ANLDOE_03_14_08.pdf
[8] ://www.bioenergywiki.net/images/e/e5/Dale.pdf
[9] http://www.sciencemag.org/cgi/content/abstract/319/5867/1238
[10] http://www.arb.ca.gov/fuels/lcfs/lcfs.htm

Theory vs. Reality

While the environmental impacts of land use changes related to international market effects need to be carefully studied for all land use-related activities, the assumptions behind ILUC models employed by CARB are contradicted by real world data. Further, policies are already in place that address many of the concerns raised by indirect land use change proponents.

It's easy to understand why the media and opponents of biofuels have come to embrace ILUC theory. It's an uncomplicated concept – corn for ethanol displaces other crops, namely soy, and therefore farmers in Brazil cut down the rainforest to grow soy and fill the demand. However, the facts dispute this simple narrative. First, the theory of ILUC is built on the idea that American grain exports will plummet because of corn used for ethanol. In his paper, Searchinger estimates that corn exports will decrease by 62 percent and that soy exports will decline by 28 percent.[11] In fact, nothing could be further from the truth. Even with growing ethanol production, corn production has been able to meet the demands for food, fuel, and exports. In 2007, the U.S. produced a record 13 billion bushels of corn and in 2008; American farmers harvested more than 12 billion bushels of corn, the second largest crop ever produced.[12] Meanwhile, since 1998, corn exports have remained at 1.5-2.5 billion bushels sold abroad each year.[13] These exports have been supplemented by the surge in distiller grains, a key co-product in ethanol production used to feed livestock. According to the U. S. Departmentof Agriculture (USDA), exports of distiller grains increased by 91 percent from 2.36 million metric tons (mmt) in 2007 to 4.51 mmt in 2008.[14] The story is similar for soybeans.

According to the U.S. Soybean Export Council, 2008 was a record year for soy exports, totaling 1.5 billion bushels exported, a 7 percent increase over the previous year.[15] Indeed, according to the 2009 United States Department of Agriculture's Long-Term Projections Report, American exports of corn and soy will grow or remain stable through 2015, showing that Searchinger's dire predictions are baseless.[16]

American farmers have been able to meet the demand for corn because technology has allowed them to grow more on the same amount of land. For example, in 1980, the average corn yield per acre was 91 bushels. In 2008, it was 153.9 bushels.[17] Similarly, ethanol yield has increased from 2.4 gallons per bushel in 1980 to 2.81 in 2007.[18] Had there been no improvements in ethanol and crop yield since 1980, it would have required significantly more land to grow the corn needed for ethanol. As it is, the U.S. planted 84.6 million acres of corn in 1976 and 85 million acres are expected this spring.

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[11] http://www.sciencemag.org/cgi/content/abstract/319/5867/1238
[12] http://www.ncga.com/files/pdf/2009WOC.pdf
[13] http://www.ncga.com/files/pdf/2009WOC.pdf
[14] http://domesticfuel.com/2009/02/18/record-distillers-grains-exports
[15] http://www.ussoyexports.org/news/stories/pr/pr102008.pdf
[16] http://www.ers.usda.gov/Publications/OCE091/OCE091c.pdf
[17] http://www.ers.usda.gov/Data/feedgrains/StandardReports/YBtable1
[18] http://www.cleanfuelsdc.org/pubs/documents/FoodFeedandFuel08.pdf

The second major component of the ILUC theory is that corn for ethanol production leads to increased soybean farming worldwide which then encourages deforestation in places like the Amazon rain forest in Brazil. While deforestation continues to be an environmental challenge, there is no verifiable correlation between deforestation in Brazil and ethanol production. According to the National Institute of Space Research, deforestation in the Amazon has declined sharply just as American biofuels production doubled. In 2004, 10,588 square miles of the Amazon was deforested and in 2008, that number dropped to 4,621 square miles;[19] the peak year for ethanol production.

In addition to government policies that have reduced deforestation in the Amazon, partnerships between the private sector and non-governmental agencies also are also helping to keep the rainforests intact. One such project is the Soybean Moratorium. In July 2006, the Brazilian Vegetable Oils Industry Association (ABIOVE), which includes ADM, Cargill, and Bunge, signed an agreement with Conservation International, World Wildlife Fund, and Greenpeace to implement a voluntary ban on the purchase of soybeans grown on deforested land, destroying the market for soybeans grown in the Amazon. ABIOVE and Greenpeace say the moratorium has been effective at reducing new rainforest clearing for explicit soy production. A joint report released in April 2008 found no new soybean plantations in any of the 193 areas that showed deforestation of 100 hectares (250 acres) or more between August 2006 and August 2007.[20] The moratorium has been extended until 2010.

<u>Endorses Different Standards for Different Types of Energy</u>

It is important to note that land use is only one type of indirect impact that can be accounted for with respect to greenhouse gas emissions. In fact, there are many complex economic, social and political indirect effects that could lead to energy sources being more carbon intensive. Unfortunately, indirect effect penalties are only applied to biofuels. By singling out biofuels for ILUC penalties, the ARB would be applying different standards to different types of transportation fuels and artificially creating winners and losers under the Low Carbon Fuel Standard.

For example, a study presented by Life Cycle Associates at the last ARB meeting found that there are many direct and indirect carbon emitting effects of oil production that are not captured by the board's current lifecycle analysis.[21] Further, it shows that several elements of direct carbon emissions, including oil refining and transport are either not included or not well understood by the current models. And while the ARB has indicated that indirect land use changes may not be applicable to petroleum, there are many indirect effects that are not currently calculated in its lifecycle analysis for gasoline. These include carbon emissions related to refinery co-products, which are often toxic and hazardous waste, macroeconomic effects, the use of military forces and equipment to protect the Middle East oil supply, and the reconstruction of Iraq. Indeed, the increased carbon intensity from the characterization, storage, transport and disposal of oil production waste products could dwarf what the ARB is

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[19] http://www.mongabay.com/brazil.html
[20] http://news.mongabay.com/2008/0623-soy_amazon.html
[21] http://www.arb.ca.gov/fuels/lcfs/013009lca.pdf

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considering as a penalty for ILUC related to biofuels. In a recent publication Liska and Perrin quantified the carbon intensity of the indirect effects associated with petroleum-based military emissions and found that these emissions amount to 98 g CO2e MJ-1 which roughly double the carbon intensity for gasoline.[22]

Creates Disincentives to Innovate

Adoption of ILUC models in GHG measurements could slow advancements in second-generation biofuels and discourage corn-based ethanol producers from investing resources to reduce their carbon footprint. ILUC models lead to decreases in innovation because the models inject uncertainty in the marketplace. Already, it is widely understood that the penalties assigned for ILUC cannot be verified. Therefore, even though the penalty is derived from a model, the result is ultimately an arbitrary figure based on theoretical assumptions that have no basis in reality. With that in mind, why would someone invest in second generation biofuels when the feedstock they are using could be deemed to have indirect land use change effects? Why would corn ethanol producers, who have been making their production process increasingly efficient, continue to invest millions of dollars in new technology to be greener when that reduction in GHG emissions could be wiped out by an ILUC penalty?

Additional Concerns: Absence of Fair Determination and Application of Direct Effects

The California-modified GREET pathway for corn ethanol inaccurately measures carbon intensity values in a variety of significant ways, including use of undocumented assumptions, lack of transparency of analysis and reliance on outdated farming and ethanol production data; underestimating the co-product credit for corn-based ethanol and failing to account for regional differences in corn production inputs.

In order for scientists to understand and recognize conclusions from the GREET model as applied by ARB, parameter values and data sources must be clearly shown according to known protocols such as those described in ISO 14040 and 14044, federal EPA guidelines and guidelines provided by the federal Office of Management and Budget. Cassman and Liska[23] describe five major areas of deficiency in this regard with additional 23 specific deficiencies which render the ARB results from the GREET analysis without merit. For example, the proposed regulation appears to incorporate data about farm input rates from 1995-1999.[24] More recent information is likely available, however, and based on recent improvements in efficiency (including reduced petroleum use, no-tillage and increased corn yield) updated information would result in more accurate and better GHG performance for corn-based ethanol.[25]

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[22] http://www.arb.ca.gov/lists/lcfs09/251-2009_liska_perrin_bbb.pdf
[23] http://www.arb.ca.gov/lists/lcfs09/25-9-03-31_critique_of_transparency_in_carb_lca_methods.pdf
[24] http://www.arb.ca.gov/lists/lcfs09/25-9-03-31_critique_of_transparency_in_carb_lca_methods.pdf
[25] growthenergy.org; http://www.monsanto.com/pdf/investors/2008/06-05-08.pdf

The California-modified GREET proposed pathway also uses outdated data about ethanol production. For example, the regulation appears to incorporate ethanol energy use data from 2001.[26] Ethanol production facilities have made significant advances in energy usage since 2001. Without accounting for this the regulation significantly overestimates the energy used to produce ethanol.[27] With the dramatic increase in state-of-the-art refinery capacity soon to be on line, average industry energy efficiency will improve substantially, and a later baseline year will more accurately represent the industry; earlier years give a large bias towards much higher carbon intensity for corn-ethanol. In order to accurately reflect the current technology used by ethanol producers, the baseline for LCFS evaluation of corn-based ethanol should be 2007 or later. The proposed calculation of the DDGS co-product credit is seriously flawed and substantially underestimates the environmental value of DDGS.[28]

The model fails to account for differences in corn and ethanol production among different states and regions. As noted by Cassman and Liska,[29] "[c]rop inputs per unit of grain yield vary substantially from state to state, with southern states requiring greater nutrient inputs per unit of grain produced, and western states requiring additional fossil fuel use for irrigation." Similarly, "there is substantial variation in the GHG emissions intensity of corn-ethanol due to biorefinery design and location."[30] The failure to adequately account for regional differences in production is more significant than might first appear because production inputs constitute a large part of GHG emissions and production inputs can vary greatly. "Based on state averages for crop yields and management, crop production represents 37 to 65% of total life-cycle GHG emissions..."[31] The model's failure to adequately address these regional differences severely undermines the scientific accuracy of the proposed regulation as applied to corn ethanol.

Proposed Regulation Violates Applicable Legal Standards

The staff report fails to analyze the relevant economic effects the regulation will have on business; the indirect land use change effect analysis is not supported by substantial evidence; the carbon intensity penalty assessed on the ethanol industry improperly discriminates against and burdens interstate commerce; and the environmental impacts from the regulation are inadequately evaluated.

The violations identified in these comments are based on review of the proposed regulation, the staff report and its initial statement of reasons for the proposed regulation, and the comments received from the public. Other violations, legal claims or legal issues may be identified and pursued by Growth Energy after the entire rule-making file and administrative record is made available for review.

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[26] http://www.arb.ca.gov/lists/lcfs09/25-9-03-31_critique_of_transparency_in_carb_lca_methods.pdf).
[27] http://www.arb.ca.gov/lists/lcfs09/25-9-03-31_critique_of_transparency_in_carb_lca_methods.pdf
[28] http://www.arb.ca.gov/lists/lcfs09/25-9-03-31_critique_of_transparency_in_carb_lca_methods.pdf
[29] http://www.arb.ca.gov/lists/lcfs09/25-9-03-31_critique_of_transparency_in_carb_lca_methods.pdf
[30] http://www.arb.ca.gov/lists/lcfs09/25-9-03-31_critique_of_transparency_in_carb_lca_methods.pdf
[31] http://www.arb.ca.gov/lists/lcfs09/25-9-03-31_critique_of_transparency_in_carb_lca_methods.pdf

Relevant economic effects on business from the regulation are not addressed. Gov. Code Section 11346.3 requires a broad assessment of the potential for adverse economic impacts on "business" – not simply California businesses and not simply limited impacts. The staff report limits, without justification, the entire analysis of economic effects to the "cost effectiveness" and "job growth" aspects of the regulation. Despite a series of GTAP "uncertainties" enumerated in the staff report, the application of the model usurps the hard-won economic advantages of the ethanol industry and transfers them to its competitors. None of this is mentioned or discussed in the staff report.

The LCA and ILUC provisions in the proposed regulation applying to the ethanol industry are not supported by substantial evidence. Gov. Code Section11350 adopts the substantial evidence standard for review of legal challenges to ARB's adoption or repeal of its regulations. As set forth in these comments, the calculations from the use of the CA-GREET and GTAP models for determining the direct and indirect carbon emissions emitted and or caused by ethanol production, use, and demand are not supported by substantial evidence.

Additionally, the findings and determinations required by Gov. Code Section 11340 et seq. are not supported by substantial evidence. Consequently, any decision to approve the Proposed Regulation on the basis of the current record would constitute an abuse of discretion and arbitrary and capricious governmental action.

The Proposed Regulation Violates the Commerce Clause. Under the Commerce Clause of the United States Constitution, states may not enact a statute that directly regulates or discriminates against interstate commerce, or favors in-state economic interests over out-of-state interests. Here, because California harvests relatively little of the country's corn, the land use "penalty" for corn-based biofuels under the Proposed Regulation necessarily regulates extra-territorial conduct and effectively favors in-state interests over out-of-state interests. Furthermore, while California has a legitimate interest in protecting its citizens against the effects of global warming, it may not do so in a manner that places an excessive burden on interstate commerce. Including ILUC in the Proposed Regulation will place an excessive burden on interstate commerce by arbitrarily denying the corn ethanol industry access to the nation's largest market of transportation fuels.

The environmental analysis is inadequate and does not comply with the California Environmental Quality Act. As set forth below, approval of the Proposed Regulation on the basis of the current record would violate the California Environmental Quality Act ("CEQA"), Public Resources Code § 21000 et seq., in at least two respects. First, the Proposed Regulation is not within the scope of the ARB's certified regulatory program. Therefore, an environmental impact report ("EIR") is required. Second, the environmental analysis contained in the staff report, which is apparently intended to serve as the "functional equivalent" of an EIR under ARB's certified regulatory program, is inadequate and does not comply with CEQA in numerous respects.

State regulatory programs that meet certain environmental standards and are certified by the Secretary of the California Resources Agency ("Secretary for Resources") are exempt from CEQA's requirements

for preparation of EIRs, negative declarations and initial studies. Environmental review documents prepared pursuant to such certified programs are considered the "functional equivalent" of EIRs or negative declarations and may be used instead of environmental documents that CEQA would otherwise require. However, certified regulatory programs remain subject to other CEQA requirements.

On August 17, 1978, the Secretary for Resources certified a portion of ARB's regulatory program, stating as follows: "I hereby certify that the portion of the regulatory program of the State Air Resources Board involving the adoption or approval of standards, rules, regulations or plans to be used in the regulatory program for the protection and enhancement of the ambient air quality of California meets the requirements for certification in Public Resources Code Section 21090.5. As a result of this certification, this portion of the regulatory program is exempt from the requirement for preparing environmental impact reports under Chapter 3 (commencing with Section 21100 of Division 13 of the Public Resources Code)."

The Proposed Regulation in this case is not intended to protect or enhance the "ambient air quality of California," but rather is intended to address the issue of global climate change by reducing the emissions of greenhouse gases associated with the use of transportation fuels in California. To the extent that the Proposed Regulation has any effect on "ambient air quality in California," such an effect is clearly incidental to the primary purpose of the Proposed Regulation.

Furthermore, in deciding whether or not to certify ARB's regulatory program under CEQA, the Secretary of Resources was required to consider, among other things, whether the enabling legislation of the regulatory program contains, "authority for the administering agency to adopt rules and regulations for the protection of the environment, guided by standards set forth in the enabling legislation." Pub. Res. Code § 21080.5. In this case, the staff report identifies a variety of "legislative and policy" directives that "support" the LCFS, beginning with the adoption of Assembly Bill 32 in 2006 and continuing through the AB 32 Scoping Plan adopted by ARB in December 2008. Importantly, none of these legislative and policy directives existed at the time ARB's regulatory program was certified in 1978. In fact, there were no legislative or policy directives relative to global climate change at that time, as the connection between greenhouse gas emissions and global climate change was not generally understood or recognized as scientific fact until many years later.

In its 1978 decision to certify a portion of ARB's regulatory program, the Secretary for Resources cites various reasons to support the certification. These reasons focus on ARB's authority to establish and achieve certain ambient air quality standards within designated air basins and to protect the public health. Not surprisingly, none of the current policy concerns associated with global climate change - severe droughts, melting ice caps, rising sea levels, increased risk of wild fires and impacts on plant and animal life - are remotely covered by the Secretary of Resources' 1978 certification decision.

Finally, it should be noted that the Secretary for Resources' 1978 certification decision extends only to that portion of ARB's regulatory program that is designed to enhance the ambient air quality of California. The Proposed Regulation, on the other hand, is obviously intended to address the global

problem of man-made climate change. Indeed, the staff report states on page ES-4 that an "important goal of the LCFS is to establish a durable fuel carbon regulatory framework that is capable of being exported to other jurisdictions." Thus, the Proposed Regulation is clearly not limited to enhancing California's ambient air quality, and has far-reaching implications that go well beyond the scope of the program that was certified by the Secretary of Resources over 30 years ago.

Because the Proposed Regulation falls outside of the scope of that portion of ARB's regulatory program that has been certified by the Secretary of Resources, ARB is required to prepare an EIR in accordance with the requirements of CEQA. Moreover, even if the Proposed Regulation was within the certified portion of ARB's regulatory program, the Proposed Regulation may not be approved at this time because the environmental analysis contained in the staff report is wholly inadequate and does not meet the applicable legal standards.

In the case of a certified program, an environmental document used as a substitute for an EIR must include "[a]lternatives to the activity and mitigation measures to avoid or reduce any significant or potentially significant effects that the project might have on the environment ..." 14 CCR § 15252. This requirement is reflected in ARB's own regulations, which provide: "All staff reports shall contain a description of the proposed action, an assessment of anticipated significant long or short term adverse and beneficial environmental impacts associated with the proposed action and a succinct analysis of those impacts. The analysis shall address feasible mitigation measures and feasible alternatives to the proposed action which would substantially reduce any significant adverse impact identified." 17 CCR § 60005.

Here, the staff report acknowledges or indicates that the Proposed Regulation may have adverse effects in the areas of energy consumption (see page VII-12, which states that for "cellulosic ethanol facilities, the energy requirements are typically greater than that for convention ethanol facilities based on the conversion of corn starch"), air quality (see page VII-20, which states that that "there may still be localized diesel PM impacts and localized facility emissions impacts"), water quality (see page VII-24, which states that "[e]thanol and biodiesel blends release to surface water may increase the likelihood and degree of fish kills compared to CARB gasoline and petroleum diesel because they deplete oxygen more rapidly"), biological resources (see page VII-27, which notes that the refining, marketing and distribution of petroleum fuels - which are given favorable treatment over corn-based ethanol under the Proposed Regulations - may "adversely impact important habitat, or interfere with critical life-cycles of native species," due to the potential for leaks, spills and wastewater discharges into water resources), and hazardous materials (see page VII-29, stating that the operation of new biofuel facilities "will involve the transportation of hazardous materials that could be released on roadways"). Nonetheless, the staff report fails to evaluate any alternative to the Proposed Regulation that may avoid or lessen any of these potential impacts. For example, the staff report fails to evaluate an alternative to the Proposed Regulation that would establish a "level playing field" by eliminating the indirect land use "penalty" for crop-based ethanol fuels. By eliminating the "advantage" given to traditional petroleum-based fuels under the Proposed Regulations, such an alternative could lessen the potential impacts associated with the continued use of such fuels. Such an alternative could also eliminate the need for some of the

estimated 30 new biofuel facilities that are assumed in the staff report, thereby further reducing the potential impacts of the Proposed Regulation.

The environmental analysis contained in the staff report also fails to identify feasible mitigation measures for some potential impacts and improperly defers the formulation of mitigation measures for other potential impacts. For example, the staff report acknowledges on page ES-29 that the LCFS is designed to stimulate the production of lower-carbon, non-crop-based fuels. After noting that the energy requirements for cellulosic ethanol facilities are greater than conventional ethanol facilities based on the conversion of corn starch, the staff report states, on page VII-12, as follows: "To provide additional information for local districts and to inform the CEQA process, ARB staff is committed to developing a guidance document to provide information on the best practices available to reduce emissions from these types of facilities. This effort will commence immediately; ARB staff plans to have a draft available by the end of December 2009."

Other examples of ill-defined and/or improperly deferred mitigation measures can be found throughout the staff report. See page VII-12 ("ARB staff recommends that the emissions associated with production of low carbon fuels be fully mitigated consistent with local district and CEQA requirements"); page VII-26 ("Any impacts associated with aesthetics, siting and construction of facilities supporting the LCFS would be assessed on a location and project-specific basis"); page VII-27 ("If siting of facilities results in the conversion of agricultural land, this would be subject to the CEQA process and approved by the city or county on a project-by-project basis"); and page VII-31 ("During construction of facilities, traffic impacts can be mitigated through ingress and egress controls to mitigate for congestions, and facility design should include appropriate traffic controls such as turn lanes, traffic lights, and reduced speed zones to ensure safety").

The environmental analysis contained in the staff report is also inadequate in each of the following respects:

The environmental analysis, which focuses almost exclusively on the presumed decrease in greenhouse gas emissions and the potential impacts associated with the construction of the estimated 30 new biofuel production facilities, is impermissibly narrow. Among other things, by not applying the indirect land use impact "penalty" to petroleum -based fuels, the LCFS indirectly encourages the use of such fuels over crop-based ethanol fuels. Yet the environmental analysis fails to consider any of the potential environmental effects associated with the production, transportation, or use of petroleum-based fuels. As stated above, these potential impacts include, but are not limited to, the carbon emissions related to refinery co-products, which are often toxic and hazardous waste, the use of military forces and equipment to protect Middle East oil supplies and the storage, transport and disposal of oil production waste products.

The environmental analysis is also based on highly-speculative assumptions. For example, the staff report indicates that in order to meet the proposed LCFS, approximately 30 new biofuel production facilities will need to be built in California, including 18 new cellulosic ethanol facilities and 6 new

biodiesel facilities, by 2020. However, the staff report acknowledges (on page ES-24 and elsewhere) that biofuel production on a commercial scale will require development of new technologies. What will happen if these "new technologies" are not developed as hoped? Would the proposed regulation have the unintended effect of promoting the use of petroleum-based fuels? If so, what are the potential impacts on the environment? The environmental analysis contained in the staff report fails to address these questions.

Finally, as indicated elsewhere in these comments, the staff report is replete with conclusions that are based on faulty or incomplete data, derived from highly-flawed models, or otherwise not supported by substantial evidence. Many of these conclusions relate directly to the potential environmental impacts of the Proposed Regulation. For example, as stated above, the CA-GREET and GTAP models used for determining the direct and indirect carbon emissions allegedly attributable to ethanol production, use and demand are seriously flawed, thereby unfairly skewing the environmental analysis against crop-based ethanol fuels. These flaws, coupled with persistent questions concerning the feasibility of commercial-scale development of non-corn-based ethanol fuels, will likely result in the continued use of environmentally-damaging petroleum-based fuels well into the future.

The foregoing comments raise significant environmental issues relative to the proposed regulation. Therefore, pursuant to applicable regulations, ARB staff must summarize and respond to the comments either orally or in a supplemental written report. 17 CCR § 60007. Additionally, prior to taking final action on the Proposed Regulation, ARB must approve a written response to each environmental issue raised in this letter.

The Current Ethanol Market

The ethanol market – already challenged by the economic downturn – will be crippled by the LCFS if, as proposed, it selectively enforces indirect effects only against ethanol. The ethanol market is critical to environmental and energy security goals set by government and as evidenced by federal and state mandates exist for the use of ethanol. According to the Congressional Budget Office, overall U.S. consumption of ethanol hit a record high in 2008, exceeding 9 billion gallons. The California market currently consumes approximately 950 million gallons of ethanol per year.

The federal Energy Independence and Security Act of 2007 set a goal of 36 billion gallons of renewable fuels for 2022, which requires 15 billion gallons of corn ethanol, 16 billion gallons of cellulosic ethanol and 5 billion gallons of advanced biofuels. California has advanced a number of programs for increasing the usage of renewable transportation fuel, including goals to produce a minimum of 20% of its own biofuels, including ethanol, by 2010, 40% by 2020, and 75% by 2050.

The ethanol market in California, including infrastructure, represents approximately $500 million in capital investment and a production capacity of 220 million gallons per year (citation). Though currently idle, five ethanol production plants exist and have operated in California, representing sufficient ethanol production capacity to meet the 2010 target. Additional capacity will be needed to meet the 2020

target. SR-II-3. Additionally, the 2007 State Alternative Fuels Plan (ARB/CEC) calls for 30 to 60 new ethanol plants in California using imported corn feedstock, initially, and transitioning ultimately to agricultural waste products. Ethanol is a crucial market for security and environmental reasons for both California and the nation. In view of this, it is inexplicable that ARB would single out this market for a crippling blow by putting ethanol at a comparative disadvantage against the petroleum industry. Yet this is exactly what the inclusion of ILUC would do.

Conclusion

As the world's efforts to reduce greenhouse gas emissions continue, carbon accounting will be an increasingly important factor in identifying the best solutions to our climate challenges. For this reason the best available science must be employed, and the standards for such measurements need to be the same across the board. But as we have seen, current Indirect Land Use Change models fail to accurately account for carbon emissions and are used selectively. As a result, the inclusion of ILUC models to determine the carbon intensity of biofuels should be rejected by California's Air Resources Board.

Not only is the foundation for the theory flawed, it creates different standards for lifecycle analysis, and would ultimately damage any amount of innovation that would help decrease GHG emissions further. California should take the opportunity afforded by the LCFS to create a level playing field for all fuels and by studying indirect effects using the best available science using a peer review process through an objective organization like the National Academy of Sciences.

The members of the Growth Energy take great pride in the environmental benefits of their product and desire to work with states like California and the environmental community to ensure that renewable fuels like ethanol are as clean and green as possible. In order to ensure that happens, policy decisions need to be based on science and observable data, not rigid ideology or speculative models.

EXHIBIT 25

Renewable Fuels Association

April 17, 2009

MARY D. NICHOLS,
Chairwoman,
California Air Resources Board,
Headquarters Building
1001 "I" Street,
Sacramento, CA.

Dear Chairwoman Nichols,

The Renewable Fuels Association (RFA) respectfully submits the attached comments on the California Air Resources Board's (CARB) Proposed Regulation to Implement the Low Carbon Fuels Standard (LCFS).

As the national trade association for the U.S. ethanol industry, RFA appreciates the opportunity to comment on the information presented in the documentation published March 5, 2009. As you will see in the attached comments, we have prepared detailed remarks about the land use modeling framework, key assumptions, and fundamental approach CARB is using for its current lifecycle analysis of ethanol. We also offer comments on other aspects of the regulation, such as the decision to include corn ethanol in the baseline gasoline formulation.

In general, we continue to believe CARB's analysis of indirect land use change is insufficient. Ongoing scientific discourse and research clearly suggest we are not currently able to estimate indirect land use changes (particularly international land conversions) with an acceptable degree of certainty. Additionally, we continue to believe the Global Trade Analysis Project (GTAP) model employed by CARB for this analysis requires significant refinement and validation before it can be reasonably used in the development of a policy framework such as the LCFS. Our attached comments are quite detailed in this regard, as we have been independently experimenting with the GTAP model and interacting with other GTAP modelers for much of the last year.

Among the major concerns we have with the GTAP modeling used to produce the results presented in the Initial Statement of Reasons are: inconsistency of projected average grain yields and the period of the "shock"; underestimation of the significant land use "credit" provided by distillers grains (the feed co-product of grain ethanol); and assumptions on carbon emissions from converted forest. Several other concerns are discussed as well.

Our attached comments show that GTAP modeling runs with reasonable adjustments to certain assumptions performed by Air Improvement Resource, Inc. results in corn ethanol ILUC emissions in the range of 8 g CO_2-eq./MJ. This is significantly lower than CARB's current estimate of 30 g CO_2-eq./MJ.

We sincerely appreciate CARB's consideration of these comments and look forward to further interaction with the agency as it continues development of the LCFS regulation. We welcome further dialog and look forward to responses to any of the comments offered in the attached documentation. We will continue to analyze the GTAP model, review the information provided by CARB, and respond with comments as appropriate.

Sincerely,

BOB DINNEEN,
President & CEO,
Renewable Fuels Association.

ATTACHMENT

Review of
CARB's Low Carbon Fuel Standard Proposal

April 17, 2009

Prepared for:

RFA
Renewable Fuels Association

Prepared by:

Air Improvement Resource, Inc.
47298 Sunnybrook Lane
Novi, Michigan 48374

Table of Contents

Review of Low Carbon Fuel Standard
Initial Statement of Reasons (ISOR)

1.0 Summary and Recommendations

The ISOR develops carbon intensity (CI) values for corn ethanol and other biofuels that are the sum of direct emissions and indirect emissions. The direct emissions for corn range from 50 to 69 g CO2 eq/MJ, and the indirect (land use) emissions are estimated at 30 g/MJ. The ISOR also contains a brief analysis of the food versus fuel issue.

Our comments and recommendations focus on four areas: land use change analysis, direct emissions analysis, food versus fuel analysis, and the LCFS baseline. These are further described below.

Land Use Change Analysis

In developing the indirect land use change (ILUC) emissions values, CARB claims to have followed a "fair and balanced process." We concur that CARB followed a fair and balanced process by holding workshops, developing draft materials and encouraging stakeholder input. However, we do not think CARB has arrived at a fair and balanced result; we think the 30 g/MJ is too high based on a number of factors. The following are our overall comments on the corn ethanol ILUC value:

- GTAP is not a mature model for estimating land use changes
- The land use values estimated by CARB do not appear to include a carbon "storage derating factor"
- The biofuels "shock" implemented in GTAP is inconsistent with USDA projected crop yields
- The method used to estimate effects of exogenous yield trends overestimates land use changes
- GTAP co-product land use credits result in overestimation of land use changes
- Other GHG benefits of co-products are ignored (or "still being evaluated")
- Missing land sets in the GTAP database result in extra forest land being converted
- The analysis does not consider relative costs of converting different land types, resulting in overestimation of forest land converted
- Key GTAP model elasticities were "guessed," and are not supported by empirical data
- There is no narrative explanation provided of how the Woods Hole emissions factors are applied to converted lands
- The accounting methods applied to timing of emissions are flawed
- Existing pasture intensification in other countries could further reduce land conversion

We examined factors that would both raise and lower the ILUC value from CARB's estimate. We considered10 factors, that if included (or included at more reasonable levels), would lower overall ILUC emissions. Only two factors (if included) could increase the emissions.

To develop alternative estimates of ILUC emissions, we incorporated the effects of four of these 10 factors that would lower emissions:

- Increased yield elasticity with respect to area expansion
- Improved GTAP U.S. land database analysis
- Improved distillers grain land use credit
- Improved exogenous yield adjustment

The first factor was incorporated by including the change in the GTAP model. The yield elasticity with respect to area expansion range was increased from CARB's assumption of 0.5-0.75 to 0.7- 0.9, based on an analysis by the agricultural economics firm Informa Economics, LLC on area expansion in Latin America that indicated that the elasticity was close to 1.0 in the period from 1988-90 to 2006-2008.

For the improved U.S. land use database, we assumed that only grasslands were converted in the U.S. The current GTAP model used by CARB omits Conservation Reserve Program (CRP) land, idle land, and cropland pasture. If these land types were included in the model, the amount of forest converted would be much lower. CARB included this additional land case in their June 30 workshop results, but it was omitted without explanation from the ISOR.

In our analysis, the improved distillers grain credit was included as an external adjustment. We examined two increases in this credit from the CARB assumption of 33% to 55% and 70%. The 55% is based on 1 lb. of distillers grains replacing 1 lb. of feed where the feed consists of 27% soybean meal and 63% corn (weighted average across all animal types). The sensitivity case using the 70% credit assumes 1 lb. of distillers grains replaces 1.24 lbs. of animal feed. A review of CARB's distillers grain land use credit by Prof. Gerald Shurson from the University of Minnesota, an independent animal science expert, indicates that a displacement ratio of 1 lb. of DG replacing 1.24 lbs. of feed (leading to the 70% credit) is most appropriate.

Finally, for the improved exogenous yield adjustment, we made the adjustment consistent with the year of the ethanol shock used for GTAP (2015). CARB assumed in the ISOR that corn yields in the U.S. were unchanged between 2006-08 and 2015 at about 152 bushels/acre. The USDA projects that corn yields will improve to about 169 bushels/acre by 2015.

Results of this analysis (based on the adjustments explained above) show corn ethanol ILUC emissions of between 4 and 18 g/MJ, with a mean of about 8.2 g/MJ, significantly lower than CARB's 30 g/MJ. Notably, we did not include all of the factors that would reduce ILUC emissions from corn.

Economists from National Economic Research Associates (NERA) also examined CARB's time accounting for ILUC emissions. They determined that the Fuel Warming Potential approaches were arbitrary, and should not be used by CARB. In addition, they recommended that the time accounting for ILUC emissions should include the increasing social cost of carbon, which was omitted from the CARB analysis of time accounting.

Our recommendations on the ILUC issue is to refine the analysis assuming a more balanced and less pessimistic set of assumptions influencing the overall ILUC emissions.

Direct Emissions

We also have concerns with CARB's determination of some of the direct emissions for corn ethanol, and have research programs that are starting to address some of these issues. However, one overarching concern here is that the direct emissions are typically based on agricultural and ethanol production data collected in the 2001-2006 timeframe. CARB selected the baseline year for the LCFS as 2010, and it is very likely many of these inputs will change dramatically from the levels assumed in the CA-GREET model. This will have a significant effect on the direct emissions. Thus, we believe CARB must update the direct emissions analysis to 2010 to be consistent with its chosen baseline year.

Food vs. Fuel

CARB's food versus fuel analysis entirely omitted the significant contribution of distillers grains co-products from ethanol plants. These co-products greatly reduce the land use and food demand impact of corn ethanol. For example, CARB estimates that it takes 110,000 acres of corn to support a 100 million gallon per year ethanol plant. However, on a net basis, after subtracting the land use credit of distillers grain fed to animals, we estimate that impact is closer to 33,000 acres. At 15 billion gallons per year, we estimate the area impact on U.S. cropland at about 4%. This number is likely to go lower with time as yields improve even beyond 2015 due to advancements in seed technology. CARB's food vs. fuel analysis should be updated to account for the contribution of feed co-products and the impact of yield improvements.

LCFS Baseline

The LCFS gasoline baseline includes corn ethanol as well as CaRFG gasoline. As a result, corn ethanol must compete with itself for GHG reductions, as well as with fuels from other feedstocks. CARB should revise the baseline so that corn ethanol is competing fairly with other ethanol feedstocks. This is similar to what CARB has done with biodiesel (i.e. there is no biodiesel in the diesel fuel baseline).

2.0 Introduction

On March 16, CARB released its Initial Statement of Reasons (ISOR) for its proposal for the Low Carbon Fuel Standard. This proposal is scheduled to be considered at a CARB Hearing on April 23-24, 2009. The proposal contains regulations that purport to lower the carbon content of the state's motor fuel (both gasoline and diesel) by 10% in calendar year 2020.

Ethanol made from corn is currently supplying about 4% of the state's car and light truck energy needs (on a BTU basis), and by 2010 , this will expand to about 7%, when it is expected that most fuel providers will provide reformulated gasoline meeting CARB's specifications that contains 10% ethanol by volume.

The LCFS includes estimates of direct greenhouse gas emissions (GHG), and also estimates of indirect land use change emissions for a number of biofuel feedstocks, including corn, sugarcane, cellulose, and soybeans. CARB evaluated four compliance scenarios for 2020. These compliance scenarios rely heavily on the development of ethanol production facilities using forest residue and cellulose. These facilities are yet to be built. In the four compliance scenarios, ethanol from corn represents about 10% of the total ethanol in 2020. In other words, the corn feedstock share of ethanol in California would be expected to decline from 100% in 2010 to 10% in 2020. If the direct emissions of corn ethanol are improved, then this percentage could be higher (however, direct emissions from other feedstocks could also be lowered). But the estimated ILUC GHG emissions from corn ethanol are estimated by CARB to be approximately 33% of the total lifecycle emissions, so even if the direct emissions are reduced significantly, there still remains a significant emissions penalty from the ILUC estimate.

Estimating the impact of biofuels on land use changes is a science in the early stages of development. The author has reviewed the few studies available on this topic in the last year, and has obtained and used Purdue's Global Trade and Analysis Project (GTAP) model, which CARB used to make its land use estimates. The land use numbers can vary widely depending on many highly sensitive input assumptions.

The purpose of this paper is to provide our comments and recommendations on the CARB LCFS proposal. The majority of these comments pertain to corn ethanol. This is because much of CARB's work on ILUC has focused on corn ethanol. Further, corn is the feedstock for more than 95% of U.S.-produced ethanol. However, some of our comments focus on CARB's limited analysis of other biofuel feedstocks.

Our comments are divided into the following sections:

- Background
- Indirect Emissions from Indirect Land Use Change
- CA-GREET Model Values for Corn Ethanol (Direct Emissions)
- Food vs. Fuel
- LCFS Baseline

The first topic presents background information that provides a contextual setting for our comments and recommendations. The second topic is the LCFS baseline. The proposal has corn ethanol in the baseline, which disadvantages corn ethanol more so than other feedstocks since it must compete with itself. In other words, the proposal is not "fuel

neutral" as was intended. The section provides numerical examples of the dilemma created by including corn ethanol in the LCFS gasoline baseline, and contains recommendations for a change to the baseline for gasoline only.

The next section contains a discussion of land use issues, which affect the indirect emissions from corn ethanol. The third section covers issues with the direct emissions for corn ethanol from the CA-GREET model. The last section provides our recommendations for modifying the LCFS proposal.

There are four appendices:

Appendix A: RFA's Comments on January 30 ARB LCFS Workshop
Appendix B: Informa's Review of the Exogenous Yield Adjustment
Appendix C: Dr. Gerald Shurson's Distillers Grain Review
Appendix D: NERA's Review of Time Accounting Methods

3.0 Background

3.1 Overview

Through this proposal, CARB has established carbon intensities (CI) for various fuels. The carbon intensities are summarized in Table 1. We have shown the ILUC emissions values separately from the direct emissions. The units for all values in Table 1 are grams of CO2 equivalent (or GHG) per mega-joule (MJ) of fuel (CO2eq/MJ).

Table 1. Carbon Intensity Values for Various Fuels (g CO2eq/MJ)

Fuel	Direct Emissions	Land Use Emissions	Total Emissions
CARBOB gasoline	95.9	0	95.9
Midwestern corn ethanol	69.4	30	99.4
California Low CI ethanol	50.7	30	80.7
CaRFG Baseline fuel	95.9	–	95.9
Cellulosic ethanol	2.4	18	20.4
Forest residue ethanol	22.2	0	22.2
Sugarcane ethanol	27.4	46	73.4
Electricity	34.9	0	34.9
Hydrogen	33.1	0	33.1
Diesel fuel	94.7	0	94.7
Biodiesel-soybeans	26.9	42	68.9
Biodiesel-waste derived	15	0	15
CNG	75.6	0	75.6
Electricity	38.8	0	38.8

There are several items to note. First, the ILUC emissions estimates range from 18 g/MJ (cellulosic ethanol) to 46 g/MJ (sugarcane ethanol) [1]. Second, the direct emissions of the biofuels are lower than gasoline and diesel, but when the land use values are added in, the emissions are much higher. The lowest overall emissions are for cellulosic and forest residue ethanol (20-22 g/MJ) and waste-derived biodiesel (15 g/MJ), but CARB's estimates for these are considered "preliminary" in the ISOR.

The CaRFG baseline fuel is a mixture of CARBOB and 10% corn ethanol, with the ethanol being 80% from the Midwest and 20% from California. In order to meet the 2020 requirement of a 10% reduction, fuel marketers must provide fuel with a 10% reduction from the baseline value of 95.9 g/MJ, which is a CI value in 2020 of 86.3 g/MJ.

It is clear from the above table that one cannot meet the LCFS for gasoline by blending in Midwest corn ethanol with a CI of 99.4 g/MJ. Only by blending in prodigious amounts of cellulosic and forest waste residue ethanol, along with the use of some electricity for plug-in hybrids and/or hydrogen, can the 10% reduction be met for gasoline. The major

[1] In this report, wherever we indicate g/MJ, it is understood to mean g CO2eq/MJ.

reason why corn ethanol cannot be used is the ILUC emissions value (30 g/MJ). Of course, if corn ethanol plants can reduce their direct emissions from the 69 g/MJ level, then some corn ethanol could be used. But ethanol plants have little to no control over the ILUC number that they are assigned. [2]

Even if direct emissions were cut in half to approximately 35 g/MJ, the total would still be 65 g/MJ with the land use change effect. Therefore, not much corn ethanol can be used to help meet the 2020 LCFS standard. This is the reason why determining the proper land use change emissions values are so critical, and this is a major focus of our comments.

3.2 Further Analysis of Corn Ethanol Land Use Change Emissions

The indirect land use change (ILUC) emissions proposed by CARB are 30 g/MJ. There were seven sensitivity scenarios with different inputs that were used to estimate this value, and the ILUC emissions ranged from 18.3 g/MJ to 44.3 g/MJ. Total land converted ranged from 2.68 million hectares (mha) to 5.48 mha. [3] The U.S. land converted ranged from 1.16 mha to 2.03 mha. For the world, the average (for the seven scenarios) forest converted was 0.86 mha and pasture converted was 3.03 mha. Thus, forest converted was 22% of total land converted and pasture was 78%. However, emissions from forest accounted for (on average) 64% of emissions, and pasture 36% of emissions. It is clear, therefore, that the ILUCs are driven largely by estimated forest converted, even though this represents one-fifth of the estimated converted land by volume.

[2] As discussed later, CARB is considering allowing yield improvement adjustments to the land use values if they can be demonstrated. But due to flaws in the accounting method, the impact of yield increases is lower than it should be.

[3] There are approximately 2.5 acres in one hectare

4.0 Indirect Land Use Change

4.1 Overview

Estimating GHG emissions related to indirect land use changes has been one of the most difficult parts of this proposal. The reasons for this are that the models used to estimate these changes are still in the early stages of development. The model used by CARB to estimate these changes is the Global Trade and Analysis Project (GTAP) model, developed by Purdue University with input from many others. The U.S. EPA is using a different modeling system for its analysis of ILUC pursuant to the rulemaking process for the Renewable Fuels Standard.

Because the modeling systems are still in the early stages of development for estimating the land use effects of biofuels, AIR conducted a "top-down" study of the potential land use changes associated with 15 billion gallons per year of corn ethanol in 2015.[4] This was done to provide another "reality check" on the modeling efforts. The report was released on February 25, 2009, and is available at www.ethanolrfa.org. This report concludes that the land use requirements for 15 bgy of ethanol from corn in 2015 can be met without converting pasture and forest to crops. The reasons for this are (1) significant yield increases between 2001 and 2015, (2) the U.S. has, maintained exports to other nations of major grains and is expected to continue to do so, (3) the distillers grains produced from ethanol plants are a high quality animal feed (actually, higher quality than the animal feed going into the plant) that replaces much of the land used to produce corn used in the ethanol plants, and (4) the availability of other cropland such as land used previously for cotton and wheat.

The first part of this section discusses many concerns with CARB's GTAP modeling (4.2). The second part estimates new ILUC emissions for corn ethanol based on modified GTAP modeling. The third part contains our recommendations at this time on indirect land use emissions for corn ethanol.

The work in this section also references additional research performed by three other entities. Dr. Gerald Shurson from the University of Minnesota, a leading animal science expert, reviewed information in the ISOR on the use of distillers grains from ethanol plants. Informa Economics, LLC, reviewed CARB's exogenous yield improvement methodology and elasticity of yield with respect to area expansion. Finally, National Economic Research Associates (NERA) reviewed CARB's methods for time accounting of emissions.

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[4] A "top- down" study is a study that looks at overall aggregates of land demand and land supply to determine the necessity of land conversion. A "bottom-up" study estimates land demand and supply from (hopefully) detailed data and equations and interactions between different variables affecting demand and supply. When the two methods don't agree, one is wrong. When they do approximately agree, there is greater confidence in the result. For example, CARB's on-road emission model EMFAC has predicted continued reductions in light duty carbon monoxide for the past 20-30 years. This prediction has been validated by trends in ambient carbon monoxide concentrations. The downward trend in ambient CO is a top-down confirmation of the bottom-up trend estimated by EMFAC model.

4.2 Summary of CARB's GTAP Modeling of Land Use for Corn

CARB's indirect land use emissions for corn ethanol are shown in Table 2, which come directly from Table IV-10 in the CARB ISOR (Volume 1). These results were generated by the Global Trade and Analysis Model (GTAP).

TABLE 2. CARB's Table IV-10 from ISOR – LUCs for Corn Ethanol

Scenario	A	B	C	D	E	F	G	Mean
Economic Inputs								
ETOH prod increase	13.25	13.25	13.25	13.25	13.25	13.25	13.25	
Elasticity of crop yields wrt area expansion	0.5	0.75	0.5	0.5	0.5	0.66	0.75	0.59
Crop yield elasticity	0.4	0.4	0.2	0.4	0.4	0.25	0.2	0.32
Elasticity of land transformation	0.2	0.2	0.2	0.3	0.1	0.2	0.2	0.2
Elasticity of harvested acreage response	0.5							0.5
Model Results								
Total land converted	4.03	2.68	5.48	4.56	3.01	3.83	3.66	3.89
Forest land	1.04	0.37	1.46	0.89	1.00	0.73	0.55	0.86
Pasture land	3.00	2.32	4.02	3.65	2.01	3.10	3.10	3.03
US land converted	1.74	1.16	2.01	2.12	1.14	1.46	1.32	1.56
Forest land	0.7	0.36	0.82	0.81	0.48	0.46	0.40	0.58
Pasture land	1.04	0.79	1.19	1.31	0.66	1.00	0.92	0.99
LUC carbon intensity (g CO2 eq/MJ)	**33.6**	**18.3**	**44.3**	**35.3**	**27.1**	**27.4**	**24.1**	**30**

The results, shown in the bottom line, show a wide range of effects from 18.3 g/MJ (Scenario B) to 44.3 g/MJ (Scenario C), with an average of 30 g/MJ. ARB explains that:

> "The 30-year annualized value for carbon intensity (30 gCO2e/MJ) differs from the value previously reported by ARB in October (35 gCO2e/MJ). As discussed previously, our current analysis removes the results obtained from the most improbable combinations of input elasticity values by establishing "most reasonable" ranges for these elasticity values. As reflected in the sensitivity analysis, GTAP model output is most sensitive to the *elasticity of crop yields with respect to area expansion*. A major concern expressed about our October result was that the range chosen for this parameter (0.25 to 0.75) extended too low. ARB agreed with this opinion and has excluded all modeling runs for which this elasticity was less than 0.5. Application of these new elasticity criteria reduces the carbon intensity from 35 to 32.9 gCO2e/MJ. The carbon intensity value is further reduced to 30 gCO2e/MJ by applying the external adjustment for increase in corn yield."

Thus, the above estimates are corrected from the January 30 estimates in two ways – the removal of the low elasticity with respect to area expansion values, and for the exogenous yield improvements.

The ISOR goes on to list the acreage requirements for U.S. corn ethanol in its Table IV-19, which is reproduced below in Table 3.

TABLE 3. ISOR Table IV-19			
Year	Gallons of Ethanol Produced	Acres of Agriculture Land Required (millions)	Percentage of 2008 Planted Corn Acres
2006	5	11.8	13.8%
2009	10	22.6	26.3%
2015	15	31.8	37.0%

This table assumes 2.8 gal/bushel yield for ethanol, and the implied corn yields are 156.7 bu/acre for 2009 and 168.5 bu/acre for 2015.[5] Unfortunately, the ISOR fails to point out that these are gross acreage requirements, not net requirements after subtracting for a distillers grain land use credit which is included in CARB's GTAP modeling. So the numbers shown above are not very useful for anything other than to communicate the mistaken impression that corn used for ethanol is requiring prodigious amounts of land. We will say more about this later in section 4.2.4.

The ISOR goes on to say that CARB is performing ongoing analyses on corn ethanol, including:

- "The possible inclusion of Conservation Reserve Program Land in the analysis
- The use of improved emission factors, as they become available
- The evaluation and possible use of data and analyses provided by the stakeholders, and
- Characterization in greater detail of the land use types that are subject to conversion by the GTAP model (forest, grassland, idle and fallow croplands, etc.)"

We are pleased that CARB is still open to input from stakeholders, because we have many concerns with CARB's land use analysis, which are discussed in section 4.2.2 through 4.2.13 below. Following this section, we discuss in Section 4.3 modifications we would make to GTAP input and output, and how this would affect CARB's land use results. In Section 4.4, we discuss factors that could increase ILUC emissions. Finally, in Section 4.5 we discuss or recommendations.

The concerns we have are as follows:

- GTAP is not a mature model for estimating land use changes
- The land use values estimated by CARB do not appear to include a carbon "storage derating factor"
- The biofuels "shock" implemented in GTAP is inconsistent with USDA projected crop yields
- The method used to estimate effects of exogenous yield trends overestimates land use changes

[5] The 2015 yield that CARB uses for this table (168.5 bu/acre) is higher than the value used by CARB to correct the land use results for exogenous yield increases (~155). bu/acre). CARB should use the 168.5 bu/acre for both estimates, which would increase the exogenous yield effect. For further discussion on this, see sections 4.2.3 and 4.2.4.

- GTAP co-product land use credits result in overestimation of land use changes
- Other GHG benefits of co-products are ignored (or "still being evaluated")
- Missing land sets in the GTAP database result in too much forest land being converted
- The analysis does not consider relative costs of converting different land types, resulting in overestimation of forest land converted
- Key GTAP model elasticities were "guessed," and are not supported by empirical data
- There is no narrative explanation provided of how the Woods Hole emissions factors are applied to converted lands
- The accounting methods applied to timing of emissions are flawed
- Existing pasture intensification in other countries could further reduce land conversion

4.2.1 GTAP is not a mature model for estimating land use changes

CARB chose GTAP for several reasons, but indicated in the ISOR that it was a relatively mature model with a "long history." This is indicated by CARB in the passage from the ISOR below:

> "The GTAP has a global scope, is publicly available, and has a long history of use in modeling complex international economic effects. Therefore, CARB staff determined that the GTAP is the most suitable model for estimating the land use change impacts of the crop based biofuels that will be regulated under the LCFS. The GTAP is relatively mature, having been frequently tested on large-scale economic and policy issues. It has been used to assess the impacts of a variety of international economic initiatives, dating back to the Uruguay and Doha Rounds of the World Trade Organization's General Agreement on Tariffs and Trade. More recently, it has been used to examine the expansion of the European Union, regional trade agreements, and multi-national climate change accords."

We would not take issue at all with the assertion that the GTAP model has been used repeatedly over a period of years for examining trade agreements between nations. However, its use for estimating the land use impacts of biofuels – the subject for which it is being used in the LCFS – is very young, so CARB's statement here is misleading. For example, the model did not have a distillers grains land use credit until June of 2008. This is a basic factor that is tremendously important to ILUC modeling. And the distillers grain land use credit that was incorporated into the model is based on outdated information; namely, that DGs are only fed to beef cattle (even with this incorrect assumption, the DG credit still reduced the land use impact of corn ethanol by 33%). Second, another issue raised by stakeholders is the fact that the model does not include exogenous crop yield improvements. This was not addressed by GTAP modelers until January of 2009. Many other items are still missing, for example, the model does not include approximately 35 million acres of Conservation Resource Protection (CRP) Land, and 24.9 million acres of "idle" land. Until these major land areas in the U.S. are included in the model, its predictions of land use change are highly suspect. Other issues that are of concern will be discussed below.

Our primary point is that the GTAP model is still very much in the early stages of development when it comes to assessing land use impacts of biofuels policies, quite the contrary to CARB's claims. CARB seems to be very determined to set the LUCs from

GTAP at this time while the model is still being developed for this purpose, which means that the numbers proposed by CARB could change significantly over the next few years as additional development work is conducted.

4.2.2 ILUC values do not appear to include “storage derating factor”

Initially, CARB was assuming that all above-ground carbon mass on lands converted from forest or grassland was converted to CO2. RFA and others pointed out that much of the above-ground mass was for trees. Because GTAP assumes conversion of commercial forests, it is logical that much of this wood mass would be used in consumer and other products. These products would eventually find their way into landfills, where carbon conversion to CO2 is very slow or nonexistent. In response to this, CARB indicated in the ISOR that “our current modeling assumes 90 percent conversion of the above-ground carbon is released to the atmosphere.” (This is the same thing as saying that 10% of the carbon from converted forest is stored indefinitely in landfills.) Yet, there is no evidence that this assumption was truly integrated into the modeling, because the overall corn ethanol ILUC value of 30 g/MJ was unchanged from earlier when CARB was assuming 100 percent of above-ground carbon is released.

RFA presented published evidence in previous comments that approximately 25% of above-ground mass from forests would be stored in landfills, so the 10% value being assumed by CARB is much lower than 25%. [6] As a reason for not including a higher value, CARB indicated “ARB staff also notes that decay of biomass in landfills will more likely lead to release of methane (a more potent GHG) rather than carbon dioxide. This would have to be considered if a non-trivial percentage of biomass from converted lands is placed in landfills.” While we acknowledge that methane needs to be considered in this, it is also true and verifiable that growing numbers of landfills are using methane to generate power. Since 64% of CARB’s ILUC emissions value for corn ethanol is due to forest conversion, a difference between 10% and 25% is 3 g/MJ, or 10% of the CARB ILUC value. As explained in later sections, we think there is little if any forest converted to crops for 15 bgy of corn ethanol in 2015. If this is the case, this is not an important issue. But if CARB thinks that forest is being converted, then we recommend that CARB make a priority of further research into this area since it does have a significant impact on the ILUC emissions value, not just for corn, but for every feedstock grown on land to make ethanol (cellulose, corn, and sugar).

While CARB’s new assumption that 10% of above-ground carbon is stored (and not attributable to biofuels) is certainly an improved estimate over 0%, we cannot find evidence that this adjustment was actually made to CARB’s estimates for corn ethanol ILUC emissions in Table IV-10 of the ISOR. We were able to replicate CARB’s scenario A-G values with our own GTAP modeling to within 0.1 g/CO2 eq/MJ for each scenario, when the only adjustment we made was for exogenous yields, and before we had updated our modeling with the latest emission factors from CARB that are contained in an Excel file called “ef_tables.xls.” This comparison is shown in the first two rows of the Table 1 below.

The 10% adjustment is included in the Excel file “ef_tables.xls,” available on the CARB website. CARB multiplies the forest above-ground emissions by a “storage derating factor” of 90% (which is the opposite of the 10% credit we refer to, but accomplishes the

[6] See Appendix A, the RFA Comments on the ARB January 30 workshop

same thing).[7] However, when we compare the emission factors in this spreadsheet with the emissions in our GTAP model, which was used to create the first two rows in Table 4, we find that the emissions in our GTAP model for forests are higher. When we use all of the emissions in the spreadsheet, which presumably are the latest data used in CARB's model, we obtain the results in the third row of Table 4 below. These results are, on average, 1.7-1.8 g/MJ lower than the first two rows (all rows are corrected for the 8.7% exogenous yield improvement). *Therefore, we do not think Table IV-10 of the ISOR was updated for the CARB storage derating factor of 90%.*

Table 4. Corn Ethanol Land Use Values With and Without Storage Derating Factor

	A	B	C	D	E	F	G	Mean
ARB ISOR Table IV-10	33.6	18.3	44.3	35.3	27.1	27.4	24.1	30.0
GTAP (AIR run)	33.6	18.2	44.4	35.4	27.1	27.5	24.2	30.1
GTAP with EFs from ef_tables.xls	31.6	17.2	41.7	33.2	25.4	25.9	22.9	28.3

These modifications need to be made to the CARB values for corn, since they were already apparently intended by CARB to be included.

4.2.3 The biofuels "shock" implemented in GTAP is inconsistent with USDA projected crop yields

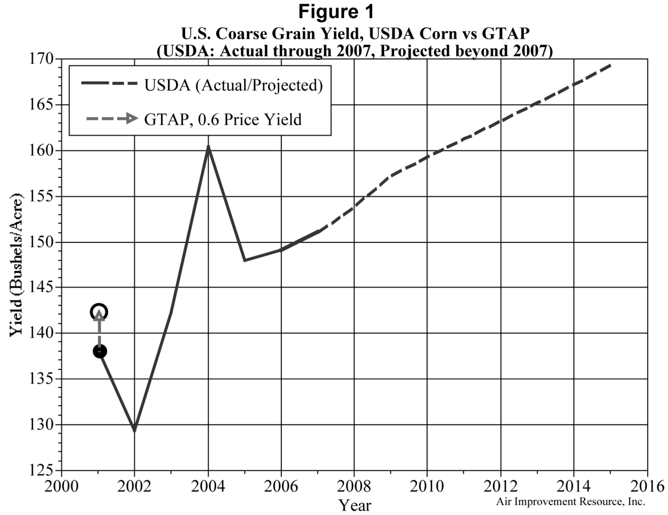
This section discusses general yield trends for corn, and the next section discusses CARB's approach for modifying GTAP output for changes in yields over time. Improvements in crop yields significantly relieve the pressure for land use change by allowing more production on the same acres. Generally, corn yields are much lower outside the U.S. as compared to the U.S., but even non-U.S. yields are improving with time.

The GTAP model includes a price-yield relationship that is governed by the price-yield elasticity. When the model is "shocked" with the 13.25 bgy ethanol increase, prices increase, and yields increase with prices. This is an endogenous response. But this price-yield response does not account for long-term changes in yields that are the result of technology improvements such as improved seed (so-called exogenous effects). This is particularly important because GTAP starts with a 2001 database, and is straining to try to adequately predict the situation in 2015 when corn ethanol reaches 15 bgy. The effect of the shock on endogenous yields (utilizing a 0.6 price yield elasticity, much higher than the elasticity used in the final GTAP modeling) is shown in Figure 1 at the left hand side of the figure. Yields increase only marginally on the shock.

Also shown in Figure 1 are actual average yields for 2001-2007 with USDA projections through 2015. Yields start at about 138 bu/acre in 2001 and are expected to increase to 170 bu/acre by 2015. This is an increase in yields of 23.9% over this period.

[7] CARB's "storage derating factor is actually an emissions derating factor, because it is not carbon storage that is being "derated" it is actually being improved. It is the emissions release that is being derated.

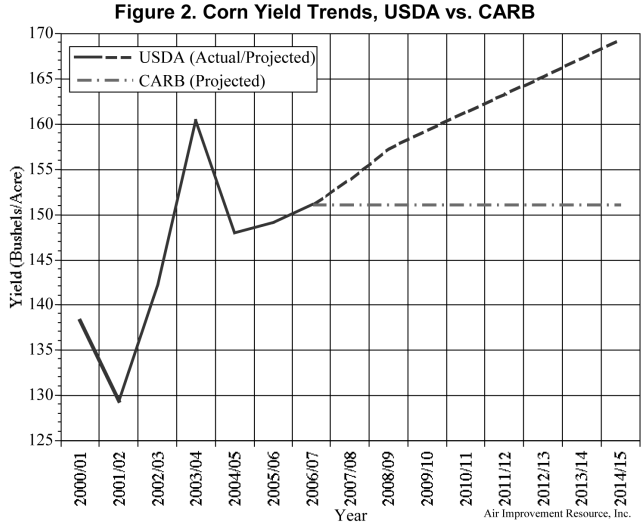
Figure 1



In taking this factor into account, GTAP modelers devised a way to correct the model results outside of the model. This procedure and its limitations are discussed in the next section. The procedure requires knowing the percent improvement in yields over a specified period of time, estimating the percent impacts on land use, and multiplying that by the land converted.

In applying this correction, CARB estimated the yield improvement only from 2001 to the average yield of the period from 2006-2008, even though the ethanol shock being applied to the model is to calendar year 2015. Therefore, CARB is currently ignoring the expected yield improvements between 2006-2008 and 2015. In other words, CARB is assuming that technological improvements will “stand still” for the next 7-8 years. This assumption significantly increases the ILUC impact of corn. This is shown in Figure 2.

Figure 2. Corn Yield Trends, USDA vs. CARB



Initial yield increases for corn (which began in earnest in the 1940s) were due to a variety of improvements in fertilization, seed breeding, improved herbicides, better mechanization, better information on planting decisions, etc. More recently in the U.S., however, increased yields are driven by biotechnology-derived improvements in seed, such as "triple stack" hybrid seeds that are resistant to three different types of pest infestations. This is very clearly described in a recent paper by Edgerton. [8] The penetration of these hybrid seeds is accelerating in the U.S. quickly. This is the technology that CARB appears to be discounting. We think CARB ought to, at a minimum, use the USDA projections between the 2006-2008 time period and 2015 to estimate its land use impacts for corn ethanol. This would also be consistent with the approach taken by CARB to estimate Table IV-19 of the ISOR, which uses a yield very close to 169 bu/acre in 2015.

Detractors of the positive effects of yield improvements frequently assume that the reason for yield improvements in the U.S. is "increased intensification," which means more fertilizer, insecticides, herbicides, and water. This assertion is clearly answered in the Edgerton paper, which shows that much of the projected improvement in the U.S. in the future is not due to increased intensification, but due to greatly improved seed with higher productivity and enhanced stress tolerance. Further evidence of this is shown in trends in fertilization rates in Figure 3 below, which are trending *down* on a per bushel basis, and have been for some time. [9]

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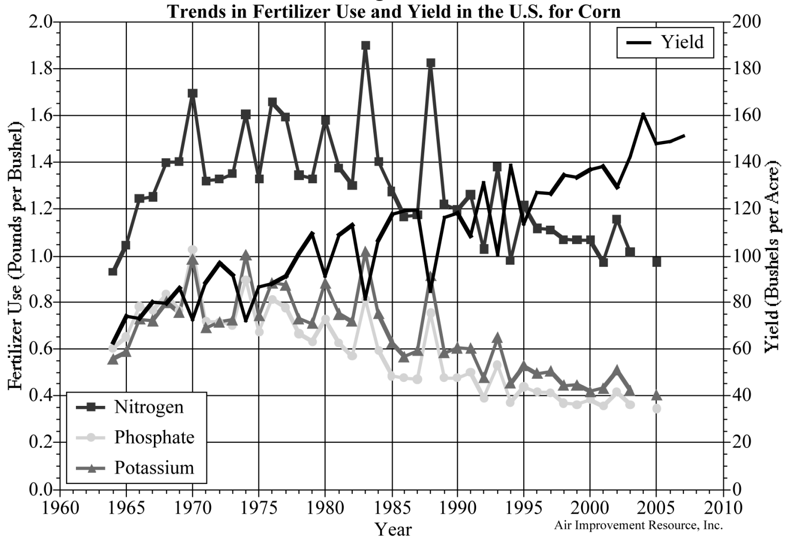
[8] Edgerton, "Increasing Crop Productivity to Meet Global Needs for feed Food, and Fuel", Plant Physiology, January 2009, Vol. 149, pp 7-13.

[9] In two years, 1983 and 1988, fertilizer use appeared to spike. But this was because yields dropped in those two years due to weather shocks, not because fertilizer use increased.

Figure 3

Trends in Fertilizer Use and Yield in the U.S. for Corn



4.2.4 CARB's method of correcting for exogenous yield trends overestimates land use changes

CARB proposes to estimate the exogenous yield increase (as in the previous section), and estimate the percent reduction in land converted directly from this exogenous yield increase, and apply the percent reduction to the land use change emissions. For example, CARB estimates the increase in yield from 2001 to 2006-08 at 9.5%. The reduction in land use and emissions is therefore 1/1.095 = 0.913 which corresponds to an 8.7% decrease (1-0.913 = 0.087). ARB estimates that 3.9 mha in the world will be converted from either forest or grass to crops because of the ethanol increase to 15 bgy. The new land use change volume after the exogenous yield adjustment would be 3.9 * 0.913 = 3.57 mha. The reduction in land converted based on this yield increase is therefore 3.9-3.57 = 0.33 mha.

Informa Economics LLC, reviewed this methodology for RFA, and their complete analysis is contained in Appendix C (see point 1 in the Informa memo). Basically, the CARB method assumes that crop yield growth is the same in the rest of the world as in the U.S. Informa shows that the yield growth for corn in the ROW is 30% greater than in the U.S. (partly because yields start at a much lower level in the ROW for many crops), and this leads to an over-estimate of land converted. A second point is that the external adjustment method does not incorporate cross-crop interactions like the GTAP model does (see point 3 in the Informa analysis). Both of these factors can lead to significant errors in this adjustment.

4.2.5 GTAP co-product land use credits result in overestimation of land use changes

Our previous comments detailed the problems with CARB's current land use credit for distillers grains, a coproduct of a dry mill ethanol plant.[10] Basically, CARB is assuming that 1 lb of DGs replaces 1 lb of corn only in livestock and poultry feed rations. This results in a 33% land use credit for corn ethanol. At this level, it has a very significant land use impact. For example, in Table IV-9 CARB estimated that ethanol would require 31.8 m acres, or 37% of the corn land. But this estimate did not account for the land use credit for distillers grains. Not including the co-product credit when discussing ethanol's land use impact is akin to a person saying they paid $400 for a television when, if they had received a 33% discount, they actually only paid $268 for it. So, if the 33% land use credit is included in the values in Table IV-9, the land use impact is 21.3 m acres, which is 25% of the corn land, not 37%.

But there is ample evidence to suggest the land use impact of feed co-products may be greater than 33%. The latest research from Argonne National Laboratory shows that 1 lb of DGs from an ethanol plant replaces 1.28 lbs of base feed for beef, dairy cattle, swine, which consists of both corn and soy meal. Thus, we have raw corn going into an ethanol plant, and a higher-quality processed animal feed *and* ethanol coming out of the plant. This was covered in detail in our previous comments. CARB rejected this analysis, and chose to remain with the 1 lb of DGs replaces 1 lb of corn assumption. Their rationale for this was described in Appendix C11. However, CARB indicated that:

> "Clearly, studies such as those cited by Michael Wang and others support the suitability of DDGS as a replacement for both corn feed and soy meal."

Later, CARB indicates:

> "In fact, DDGS appears to face significant barriers to widespread adoption as a replacement for corn and soybean meal. For this reason, staff feels that providing a co-product credit equating 1 lb of DDGS to 1 lb of feed corn is generous."

In other words, DG could clearly replace corn and soy, but would not (in the judgment of CARB) because of "significant barriers."

To address this issue in more detail, RFA contracted with Dr. Gerald Shurson from the University of Minnesota to (1) provide an independent review of the Argonne analysis, and (2) review the ISOR Appendix C11 rationale for utilizing the 1 lb of DG for 1 lb of corn meal assumption. [11] Dr. Shurson performed his own independent analysis of both sources, and found that the Argonne analysis is basically correct; that is, DGs are replacing more than 1 lb of the base feed (he found it replaced 1.22 lbs of base feed vs. Argonne's 1.28), and that it replaced more soybean meal than Argonne estimated. The reasons for the increased share of soybean meal replacement are that Dr. Shurson expanded the analysis to include poultry, where Argonne did not include poultry. Dr. Shurson also had slightly different numbers for beef cattle, dairy cattle, and swine. Dr. Shurson also completely disagreed fundamentally with CARB's assessment of DG applicability in Appendix C11 of the ISOR. Additionally, if there are "significant barriers"

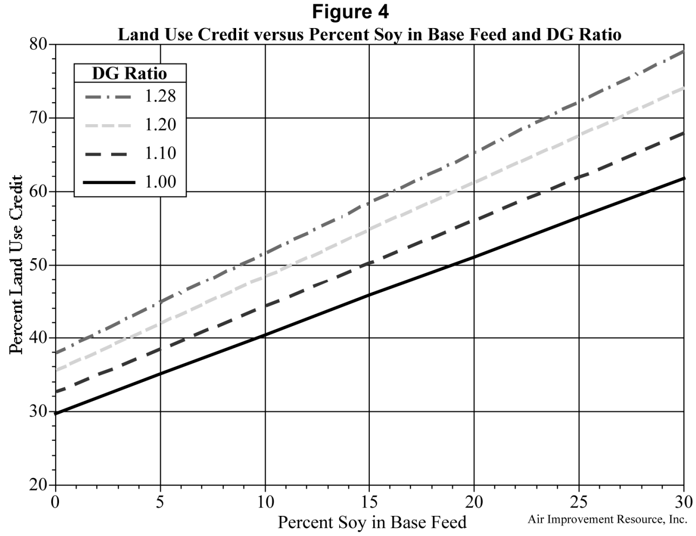
[10] With a dry mill ethanol plant, there is animal feed going into the plant, and animal feed and ethanol coming out of the plant.

[11] See Appendix B for Dr. Shurson's report.

to the use of DGs, it is logical that enormous excess supplies of DG would be accumulating as ethanol production increases. Obviously, this has not happened. Domestic use of DGs has expanded rapidly with ethanol production capacity because it is becoming much more recognized that DGs are an excellent supplement or replacement for the base feed for many animals. Further, DG exports to a number of countries have expanded rapidly as well.

These differences in DG feed replacement have a very significant effect on the land use credit for corn ethanol. The primary reason for this is that the yield for soybeans is much lower than the yield for corn. This is shown in the Figure 4 below, which was presented by RFA at the January 30 CARB workshop (see Appendix A), and is also shown and explained in detail in the AIR Land Use Report.

Figure 4



The “DG Ratio” in this chart is the ratio of the mass of DGs to mass of feed replaced. So, if 1 lb of DGs replaces 1.28 lbs of feed (as supported by the Argonne report), that would be found on the upper (red) line. We show the percent land use credit on the vertical axis and the percent soybean meal replaced in the base feed on the horizontal axis.

At 0% soybean meal replaced in the base feed, and a DG ratio of 1.0 (CARB and GTAP assumption), we see that the land use credit is about 30%. As the percent of soybean meal is increased that DGs replace, the land use credit increases rapidly. This is because the land use credit for soybean meal is higher than the land use credit for corn (because the soybean yield is lower than the corn yield). If we use the values in the Argonne report (1.28 DG ratio and 24% soybean meal replacement), we obtain a land use credit of 71%. If we use the values developed by Shurson, we obtain a land use credit of 74%. The land use credits by CARB, Argonne, and Shurson are compared in Table 5. The figure also shows that if we assume a 1.0 DG ratio (CARB assumption),

and that 20% of the meal being replaced is soy, the land use credit would be 50%, well above ARBs 30-33%.

Table 5. Comparison of DG Land Use Credits			
Source	% Soybean Meal Replaced (remainder is corn)	DG Mass Replacement Ratio (DG:Base Feed)	Land Use Credit
CARB, GTAP	0%	1.00	30%
Argonne	24%	1.28	71%
Shurson	25%	1.25	74%

The implications of these differences are the largest item affecting land use of corn base ethanol. At a land use credit of about 33%, according to CARB, on a net basis 21 million acres are used to make 15 bgy of corn ethanol, which is 25% of the corn land. But if the land use credit is 70%, then only 11 million net acres are used to make ethanol, or about 13% of the corn land, and only 4% of the U.S. farmland. The 13% of corn acreage figure is about 1/3 of the land that ARB said would be needed for corn ethanol in Table IV-19 of the ISOR.

Clearly, this factor, along with the assumed GTAP elasticity of crop yields with respect to area expansion, are the two largest factors impacting CARB's land use estimate for corn (the elasticity discussion is in section 4.2.9).

4.2.6 Other GHG benefits of co-products are ignored

There are other GHG benefits associated with the DG co-product. One is that it reduces methane emissions from enteric fermentation in ruminant animals by shortening the animals' lifecycles. This benefit was developed in the Argonne report, and the previous RFA comments (Appendix A) quantified this effect as a GHG reduction credit of 4-5 g/MJ. CARB indicates in the ISOR that they are still studying this issue. A second benefit from DGs is that it helps animals digest phosphorous, an essential nutrient, thus, the animals need less synthetic phosphorous added to their diets. This displaces some GHGs used to produce phosphorous supplements for animal diets. We have not yet quantified this effect.

4.2.7 Missing land sets in the GTAP database result in too much forest land being converted

The GTAP model used to develop the land use impacts contains three types of land – crop land, pasture, and forest. Forest in this case is commercial forest, and does not include state and national forest land.

The GTAP land database does not include Conservation Reserve Program (CRP) lands. Also, as a part of developing the indirect land use change emissions values for cellulosic ethanol, Purdue identified two new land categories that are not in the GTAP inventory – cropland pasture and idle land. [12] The exclusion of these lands from the GTAP model, and the possible impacts of the exclusion of these lands, is discussed in turn below.

4.2.7.1 CRP Land

Since June 30, 2008, CARB and Purdue have indicated that they were working on incorporating CRP land into the GTAP model. In the ISOR, CARB states:

> "The GTAP model does not include Conservation Reserve Program land in the pool of available land in the US for agricultural expansion. ARB staff and GTAP modelers are updating the GTAP to include CRP land, *as appropriate.* (emphasis added) We will then analyze the effect that this change has on the estimate for amount and location of land converted within the U.S."

CARB further says this about the expansion of corn due to ethanol:

> "The GTAP brings new land into agricultural production from forest and grassland areas. It isn't specific about exactly where that land will come from. Some could come from the Conservation Reserve Program (CRP). Most CRP lands are in the arid far west and could support soybean production but not corn. Although the penalties for breaking CRP contracts are steep enough to prevent CRP lands from being used before their contracts expire, contracts are currently expiring on two million acres due to provisions contained in the recent Farm Bill. The USDA has the authority to make additional CRP lands available. If sufficient CRP land is not available to indirectly support an expansion of corn acreage, a large supply of non-CRP pasture land that was formerly in crops could be brought back into production. It is the availability of this non-CRP former crop land that is behind the GTAP's projection that about 40 percent of the land converted worldwide in response to the increased demand for corn ethanol biofuel will occur in the U.S.

The GTAP modelers assumed that no CRP land would be converted in response to increased biofuel demand. Although some CRP land has been released for cultivation, an abundance of previously farmed pastureland is also available. These pasture lands are generally more productive than the lands released from the CRP system. Before it becomes economical to convert the least productive domestic land areas, land use change tended to shift overseas. The staff is continuing to analyze the effects of including CRP land in the land pool used by the GTAP model.

[12] Tyner, W., et al, "Preliminary Analysis of Land Use Impacts of Cellulosic Biofuels", Purdue University, February 2009.

CARB indicates that GTAP is not specific about where the land will come from, and admits that some could come from the CRP.[13] But then CARB states that most CRP lands are in the far west, and could support soybean production but not corn. We examined the FY2007 CRP program statistics. [14] While much of the CRP land is indeed in the West, we also determined that there are 10 million acres of CRP grasslands in the top 10 producing corn states, as shown in Table 6 below.

Table 6. CRP Enrollment By Practice Category, All General and Continuous Sign-Ups, FY 2007

	Water Quality Buffers	Wellhead Protection Areas	Wetland Practices	Grass Plantings	Tree Plantings	Other Practices
Top-10 Corn producing states	1,122,076	124,954	1,090,288	9,984,347	324,082	1,398,425
All states	1,901,658	170,273	2,063,851	28,496,992	2,275,215	2,032.320

Top-10 corn producing states in 2004 were: Illinois, Indiana, Iowa, Kansas, Minnesota, Missouri, Nebraska, Ohio, South Dakota, and Wisconsin (USDA Production Figures).

Grasslands represent 78% of CRP plantings, and trees represent 6% (the remainder are water quality buffers, wellhead protection areas, etc.). Renormalizing for grassland and trees, 93% are grassland and 7% are trees. Therefore, if some land owners decided not to renew their land enrolled in the CRP, it does appear that there is substantial CRP grassland in areas that would support both corn and soybeans, and it would not have to be acquired from the more sensitive categories.

CARB further states that contracts are currently expiring on 2 million acres of CRP land. We examined the CRP contracts expiring in the FY2007 CRP program. Contracts were due to expire on 2.5 million acres in 2007, 1.3 million acres in 2008, 3.8 million acres in 2009, 4.4 million acres in 2010, 4.4 million acres in 2011, 5.5 million acres in 2012, and between 1.7 and 3.3 million in each of the years between 2012 and 2015. Clearly, there is much more land for which contracts are expiring over the period of simulated ethanol expansion than CARB states.

Next, CARB indicates that there is an abundance of previous farmed pasture land that is available that would be more productive than CRP land. We don't know where CARB obtained this information about the difference in productivity, but we do not disagree with the fact that there is an abundance of pastureland available for conversion, in addition to some CRP land.

If GTAP were to include CRP land (and also idle land and cropland pasture as indicated below), there would have to be an elasticity of land transformation assigned to the land

[13] CARB assumes that no CRP land would be converted as a result of the 15 bgy, but admits that "some CRP land has been released for cultivation." The facts clearly contradict the assumption.
[14] "Conservation Reserve Program, Summary and Enrollment Statistics", FY2007, April 2008.

in GTAP (just like there is for pasture and forest), and the model would convert some CRP land to crops, along with pasture and forest. But the key factor here is the net change would be *less conversion of forest with the CRP land added in (in the U.S.) than without. And since forest conversion largely drives the corn ethanol ILUC emissions, less forest conversion means a lower ILUC emissions value.*

Anytime one introduces a new land type into GTAP that is not forested, it will result in some conversion of that new land type that has the net result of subtracting from overall forest converted. Thus, we still believe CRP land should be included in GTAP (as we did in June 2008, at which time CARB indicated it was contemplating this addition), since it is a significant land inventory that is available to farmers if they want to expand production.

Another factor is that in the June 2008 workshop, CARB performed a CRP sensitivity case where it assumed all the converted land resulting from the biofuels shock in the U.S. was grassland. The emissions of this case were much lower than the others, as expected. However, CARB left this case out of the ISOR, without explaining why.

4.2.7.2 Omission of Idle Land and Cropland Pasture

In addition to omitting CRP land, the GTAP model also does not include idle land and cropland pasture. As a part of its assessment of cellulosic land use impacts, Purdue University examined these land sources as possible land for cellulosic feedstocks.

These land sources are very significant. Purdue estimates there are 14.7 mha of idle land and 22.7 mha of cropland pasture. Together, this is more than twice as much land as in the current CRP (about 14.9 mha). Perhaps not all of these lands would support crops, but a significant portion of them probably would. If these land sources were added to GTAP, the amount of forest converted would be even less than if just the CRP land were added to GTAP.

4.2.8 The analysis does not consider relative costs of converting different land types, resulting in overestimation of forest land converted

GTAP also does not incorporate the costs to convert land in deciding how much forest and how much grassland to convert. GTAP simply maximizes total rents in each Agricultural Ecological Zone (AEZ), as if the cost to convert grassland and forest would be the same. However, GTAP does have an elasticity of substitution that is different for forest than for grassland. This introduces some additional “friction” in the equations for converting forest as opposed to converting grassland. It is not clear if this adequately represents the costs of converting forests.

4.2.9 Key GTAP model elasticities were “guessed,” and are not supported by empirical data

One of the key elasticities that influences the amount of land converted is the “elasticity of yield with respect to area expansion.” As indicated in the ISOR:

> “As discussed in the results section, model output is moderately to highly sensitive to the crop yield elasticity; elasticity of land transformation across cropland,

> pasture, and forest land; and elasticity of crop yields with respect to area expansion (relative productivity of marginal land). In calculating a value for land conversion, ARB staff and GTAP modelers have determined what we believe to be the most reasonable ranges for these elasticity values. These ranges are derived from appropriate research results, unless no such results are available. In the absence of research findings, the best professional judgment of experts has been relied upon. In particular, model outputs are highly sensitive to the value assigned to the relative productivity of marginal land. The land conversion predicted by the model is inversely proportional to the relative productivity assumed for marginal land. A range from 0.25 to 0.75 was originally assigned to this elasticity (e.g. marginal land is 25 to 75 percent as productive as land currently used for agriculture). Based on feedback from stakeholders, ARB staff and GTAP modelers decided that 0.50 to 0.75 was a more appropriate range for this elasticity value which resulted in a lower estimate for land conversion. We will continue to analyze available evidence for this key input parameter."

Further, at a January 26, 2009, GTAP workshop at Purdue University, in regard to this elasticity, an author of the GTAP model stated there is "little empirical evidence" to guide the use of this elasticity and that "more work needs to be done."

Clearly, CARB and GTAP modelers are speculating (another word for "best professional judgment") on the elasticity of crop yields with respect to area expansion, and this is the elasticity with the greatest impact on land use. There has been little to no land converted in the U.S. as a result of biofuels increases (most of the land has come from cross-crop conversions and yield improvements; and DGs from ethanol plants have nearly eliminated the need for additional land), so the U.S. is not necessarily a good place to look for these data.

To examine this issue further, Informa Economics examined the increase in soybean production, which doubled in the world from 1989-1991 to 2006-2008, with much of the increase coming in Latin America (see point 2 in the Informa analysis in Appendix C). If the elasticity of crop yield with respect to area expansion was low, then we should expect to see yields drop significantly. Informa's analysis indicated:

> "…the combination of substantial soybean area growth and increasing yields in Brazil and Argentina demonstrated that it is mathematically unlikely that the assignment (based on judgment) of a value of 0.5 to the elasticity of crop yields with respect to area expansion is correct….it cannot be determined that yields on new area have been meaningfully different than yields on area previously planted to crops (i.e., that the elasticity is less than 1.0)."

There may be areas of the world where if crops are expanded, yields would drop significantly, but these may be areas where crops are not likely to expand. These data indicate that the CARB and GTAP assumption on this elasticity is overly pessimistic, and it should be increased from the 0.5 to 0.75 range to a somewhat higher range. In the next section (4.3) we will use an elasticity of yield with respect to area expansion of 0.7 to 0.9, which is significantly less than 1.0, to determine the land use impacts utilizing this range.

4.2.10 There is no narrative explanation provided in the ISOR of how the Woods Hole emissions factors are applied to converted lands

CARB provided no technical appendix discussing the emissions from forest and grasslands that are converted around the world. CARB did provide a spreadsheet that listed all the emission factors and included some notes on why certain emission rates were used, but this was not adequate to allow a thorough review of the emissions from forests and grasslands. The emissions from these areas are critical inputs for reviewing the ILUCs for all feedstocks.

Regarding grassland, a recent study by Follett, et al. indicates that when CRP-type grasslands are re-commissioned using no-till farming techniques, that there is no release of soil carbon. [15] Release of soil carbon (i.e., below-ground carbon) accounts for most of the carbon release from grasslands, and the ISOR analysis assumes 25% of below-ground soil carbon is released. Thus, if CRP grasslands are re-commissioned, the question is what is the percent of no-till farming used? This issue needs to be examined further by CARB.

4.2.11 The accounting methods applied to timing of emissions are flawed

CARB estimated its primary case for the land use change emissions from a 30-year averaging (annualized) approach. CARB also developed emissions estimates using three other accounting methods, which included:

- Net Present Value (NPV) method
- Fuel Warming Potential (FWP)
- Economic Fuel Warming Potential (FWPe)

For corn ethanol, the annualized approach results in ILUC emissions of 30 g/MJ, the NPV approach results in a value of 37 g/MJ, and the FWP approach results in a value of 37-48 g/MJ. So, the alternative approaches all yield higher emissions than the annualized approach, because these approaches give more weight to the early emission releases more than the later releases.

To evaluate these methods, RFA contracted with National Economic Research Associates (NERA) to review the time accounting of emissions in the ISOR. NERA's report is included as Appendix D, and shows two major findings. One is that the two fuel warming approaches (FWP and FWPe) are arbitrary and should not be used to provide carbon intensity comparisons. The second is that the calculations of carbon intensity should account for the well-established projection that the social cost of carbon (SCC) will increase over time. NERA utilized an SCC value from IPCC of 2.4%. Results comparing the different approaches are summarized in Table 7.

[15] "No-Till Corn after Bromegrass: Effect on Soil Carbon and Soil Aggregates" Ronald F. Follett,* Gary E. Varvel, John M. Kimble, and Kenneth P. Vogel, Agronomy Journal • Volume 101, Issue 2 • 2009

Table 7. Corn Ethanol LUCs Derived by NERA with Different Accounting Methods	
Approach	Corn ethanol LUC (g/MJ)
Annualized (no discount) – CARB proposed	30
NPV with 2%	36.9
FWPe-30, 2%	52.2
Value-Adjusted, 2% (NERA approach that takes into account the social cost of carbon)	28.7

The value-adjusted approach, which takes into account the increasing social cost of carbon with a 2% discount rate, results in ILUC emissions of about 29 g/MJ.

4.2.12 Pasture intensification may be occurring in other countries that would further reduce LUC emissions

UNICA is developing data that may show that as crops expand onto pasture, stocking rates are increasing and pasture is being used more efficiently, rather than pasture expanding into forest. This would also reduce the ILUC impact of corn ethanol.

4.3 Adjusted GTAP ILUC Emissions for Corn Ethanol

Section 4.2 discussed many of the problems with the current CARB estimates of LUC for corn ethanol (and other feedstocks). This section modifies some of the inputs, and estimates new ILUCs with these modified inputs.

There are a number of factors we wish to take into account, as follows:

- Increased yield elasticity with respect to area expansion
- Improved U.S. land database analysis
- Improved distillers grain land use credit
- Improved exogenous yield adjustment

The reader should know we are not including all the items that would lower ILUC emissions, such as (1) a correction to CARB's method for incorporating exogenous yield adjustment, (2) other credits for DGs such as reduced enteric fermentation, and (3) an increased credit for the storage derating factor (25% instead of 10%). Also, emissions would be 4% lower for including the increasing social cost of carbon, utilizing a 2% discount rate, as indicated in the NERA analysis. We think these are justified adjustments to make to emission rates, but have not included all of these in the interest of arriving at a "fair and balanced" estimate.

For the improved yield elasticity with respect to area expansion, we use a value of 0.7 to 0.9, in place of CARB's assumption of 0.5 to 0.7. The value is probably closer to 1.0 (or higher than 1.0, as demonstrated by the Brazil soybean case outlined in Appendix C), but we are using 0.7 to 0.9 to account for a few areas where it may be slightly less than 0.9. This change is made to the GTAP model inputs. We retain all of CARB's other GTAP elasticities. The updated area expansion elasticities are shown in Table 8.

Table 8. Scenario Modifications			
		But with "Elasticity of crop yields wrt area expansion" changed:	
AIR Scenario	Same as CARB Scenario:	From	To
A1	A	0.5	0.7
B3	B	0.75	0.9
C1	C	0.5	0.7
D1	D	0.5	0.7
E1	E	0.5	0.7
F1	F	0.66	0.8
G1	G	0.75	0.9

Regarding the U.S. land database, we propose to estimate the effects of an improved U.S. database by assuming that the land converted would be grassland, either from the CRP or from land that has been idled. The method of making this change is to output the land use changes (forest and grassland) by region of the world, and substitute the grassland emissions for the U.S. for the forest emissions. This is similar to the CARB analysis that was conducted in June of 2008 but omitted from the ISOR. The results of the above two adjustments are illustrated in Table 9. The first two columns (USA, World) are the results assuming both forest and grassland are converted in the U.S. and ROW. The second two columns assume only grassland is converted in the U.S. and ROW. The last two columns scenario assumes only grass or pasture is converted in the U.S. and both forest and grass are converted in the ROW. These results also include the 8.7% CARB exogenous yield improvement adjustment for 2001 to 2006-08. The mean of the scenarios is shown at the bottom.

For the GTAP case, where both forest and grass (In Table 6 “Livestock”= Grass) is converted, the mean emissions are 18.3 g/MJ. The only change from the ARB mean of 30 g/MJ for this case is the change in the expansion elasticity from the CARB range (0.5 to 0.75) to less pessimistic values (0.7 to 0.9). For the scenario where only grass is converted in the U.S. and ROW, the emissions are 10 g/MJ. Finally, for the scenario where forest and grass are converted in the ROW, but only grass is converted in the U.S., the emissions are 11.2 g/MJ.

Table 9. Emissions and LUC for AIR Scenarios							
		Emissions (Million Grams) and LUC					
		Grass, forest converted		Only grass converted		Grass, forest converted in ROW, grass converted in U.S.	
Scenario	Cover	USA	World	USA	World	USA	World
A1	Forestry	316.05	-373.55	-44.25	-62.74	-44.25	-101.75
	Livestock	87.82	-254.10	-87.82	-254.10	-87.82	-254.10
	gCO2/MJ	12.36	-19.21	-4.04	-9.70	-4.04	-10.89
B3	Forestry	195.61	-181.91	-27.38	-23.94	-27.38	-13.69
	Livestock	75.19	-222.26	-75.19	-222.26	-75.19	-222.26
	gCO2/MJ	8.29	-12.37	-3.14	-7.54	-3.14	-7.22
C1	Forestry	344.92	-490.55	-48.29	-93.11	-48.29	-193.92
	Livestock	102.69	-343.72	-102.69	-343.72	-102.69	-343.72
	gCO2/MJ	13.70	-25.54	-4.62	-13.37	-4.62	-16.46
D1	Forestry	352.76	-304.52	-49.39	-36.58	-49.39	-1.15
	Livestock	111.14	-319.56	-111.14	-319.56	-111.14	-319.56
	gCO2/MJ	14.20	-19.10	-4.91	-10.90	-4.91	-9.82
E1	Forestry	223.85	-379.25	-31.34	-78.09	-31.34	-186.74
	Livestock	55.12	-158.23	-55.12	-158.23	-55.12	-158.23
	gCO2/MJ	8.54	-16.45	-2.65	-7.23	-2.65	-10.56
F1	Forestry	263.10	-325.22	-36.83	-56.23	-36.83	-98.95
	Livestock	90.62	-293.93	-90.62	-293.93	-90.62	-293.93
	gCO2/MJ	10.83	-18.95	-3.90	-10.72	-3.90	-12.03
G1	Forestry	207.79	-241.65	-29.09	-39.64	-29.09	-62.95
	Livestock	88.15	-299.76	-88.15	-299.76	-88.15	-299.76
	gCO2/MJ	9.06	-16.57	-3.59	-10.39	-3.59	-11.10
Mean	Forestry	272.01	-328.10	-38.08	-55.76	-38.08	-94.16
	Livestock	87.25	-270.22	-87.25	-270.22	-87.25	-270.22
	gCO2/MJ	11.00	**-18.31**	-3.84	**-9.98**	-3.84	**-11.15**

For the improved distillers grain land use credit, we estimate the effects of a 56% credit (this assumes a 1 lb. for 1 lb. replacement, with 27% being soy meal) credit and 70% credit (1 lb. of DG replaces 1.27 lbs. of base feed, with 27% being soy meal). The method used to implement this change is to divide the CARB assumed 33% land use credit emissions by 0.67 (1-0.33) to estimate the emissions without the land use credit, and then reduce these emissions by either 56% or 70%.

For the improved exogenous yield adjustment, we assume the USDA's projection of yields to 2015, instead of CARB's assumption of only correcting to 2006-2008. The CARB estimated effect of this adjustment to 2006-08 is an 8.7% reduction in area converted. Extending this to 2015 results in a 15.4% reduction instead of an 8.7% reduction.

Table 10 shows the impacts of these two adjustments on the LUCs for corn ethanol. In Table 10, we carry across the means from Table 9 for three cases in Table 8.

Table 10. ILUC Emissions Adjusted for Improved DG Credit and Exogenous Yield Adjustment (uses 30-year averaging)				
	Case	Grass, forest converted in U.S. and ROW	Only grass converted, U.S. and ROW	Grass, forest converted in ROW, only grass converted in U.S.
Line 1	Mean LUCs From Table 9 (uses DG credit of 33%)	18.3	10.0	11.2
Line 2	55% DG credit	12.3	6.7	7.5
Line 3	70% DG credit	8.2	4.5	5.0
Line 4	55% DG credit, yield adjustment to 2015	10.9	6.0	6.7
Line 5	70% DG credit, yield adjustment to 2015	7.3	4.0	4.4

Again, the values in Line 1 of Table 10 are based on changing only the elasticity of expansion to 0.7-0.9. The values in Lines 2-5 are calculated off of the values in Line 1 and account for various assumptions on the DG credit and exogenous yield adjustment. For the case where both grass and forest are converted in the U.S. and ROW, the ILUC emissions range from 7.3 to 18.3 g/MJ. For the case with only grass converted, the emissions range from 4 to 10 g/MJ. For the case where grass and forest is converted in the ROW, and only grass is converted in the U.S., the range is 4.4 to 11.2 g/MJ. The mean of all these values is 8.2 g/MJ.

Based on these very appropriate adjustments, our view is that the land use change emissions from corn ethanol using GTAP modeling are likely in the range of 4-7.3 g/MJ. It is notable that these values are close to the results of the AIR "top down" analysis that concluded the ILUC emissions are close to 0 g/MJ. A more pessimistic view would be to use the mean of all these values, which is 8.2 g/MJ. The most pessimistic view would be to estimate the emissions as the average of Line 1, or 13.2 g/MJ. It should be recalled that there are several other items that would lower these emissions further which we have not included here.

4.4 Factors that could increase emissions

In the ISOR, CARB mentioned several items that could increase the overall carbon intensity value for corn ethanol, as follows:

- Time accounting methods for LUCs
- Uncertainties associated with the nitrogen cycle affecting direct emissions

In addition, a comment was submitted by Michael O'Hare that if a 20-year project time horizon were used for corn ethanol, the ILUC emissions would roughly double. One particular concern with the project time horizon is that it appears O'Hare and others are using the "project horizon" to characterize the full useful life of a particular production facility or technology type (e.g. corn ethanol). However, in the context of emissions from

land use change, the project horizon should apply to the land itself—not to the technology type of facility.

NERA's study answers the questions on the time accounting for LUC. When CARB incorporates increased damages (social cost of carbon) with time – which it should – this does not increase ILUC emissions; rather, it reduces them.

Regarding O'Hare's suggestion about the 20-year project horizon for corn ethanol, we do not agree that 20 years is an appropriate project horizon to use for corn ethanol, but if the 20-year horizon is used with the value-adjusted approach (which takes into account the social cost of carbon) the emissions are 45% higher than the 30-year project horizon, not double. If we use our central value of 8.2 g/MJ, a 45% increase is 11.9 g/MJ.

Regarding uncertainties with the nitrogen cycle, CARB is using the IPCC's recommendation for emissions from fertilizer (conversion of N2O from fertilizer). Of course, the LUC emissions for corn should not be made unnecessarily high just to account for some perceived uncertainty in emissions from the nitrogen cycle.

4.5 Recommendations

CARB characterizes its ILUC analysis of corn ethanol in the ISOR as generally "fair and balanced":

> "Although one may argue that there is no scientific consensus as to the precise magnitude of land use change emissions and that the methodologies to estimate these emissions are still being developed, scientists generally agree that the impact is real and significant. Our analyses support this conclusion. We believe that we have conducted a fair and balanced process for determining reasonable values for land use change carbon intensity and we will continue to investigate many of the issues presented above through discussion with stakeholders and analysis of current and new scientific data"

We concur that CARB has conducted a fair and balanced overall process in that it has encouraged input from stakeholders, held a number of workshops, released draft materials for comment, and so on. However, we would differentiate between holding a fair and balanced "process" and attempting to achieve a fair and balanced "result." CARB has not arrived at a fair and balanced result, as evidenced by the information in Table 8.

The table shows most of the sources of uncertainty that are raised in the ISOR, and whether they increase or decrease the ILUC emissions from corn ethanol from CARB's ISOR estimate. [16] An asterisk indicates an affirmative answer to the question stated at the top of the table, and an increased number of stars indicate a relatively larger effect. As the table shows, nearly all of the omissions would reduce the ILUC emissions; very few would increase the emissions.

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[16] We did not include the albedo issue or neglecting to account for converting grassland into forest as a cap and trade measure to offset emissions in this list. We are not sure of the direction of the albedo issue, but converting grassland into forest is a GHG mitigation strategy that would reduce any land use emissions.

Table 11. Summary of Directional Impacts of Un-quantified Items in CARB's ILUC for Corn Ethanol		
Factor	Correction would lower LUC emissions?	Correction would increase emissions?
Storage derating factor (CARB including this, although not included yet)	*	
Yield trends not consistent with biofuels shock	*	
Exogenous yield method overestimates emissions	**	
Coproduct land use credit	***	
Other coproduct benefits ignored	*	
Missing land in GTAP	**	
Land expansion elasticity	***	
No inclusion of land conversion costs	**	
Increased yields lead to increased intensification?	*	*
Include social cost of carbon in time accounting?	*	
Pasture intensification in other countries?	*	
20-year project horizon using value adjusted approach		**

As indicated above, CARB's analysis of corn ethanol ILUC emissions appears considerably biased on the high side, so some corrections should be made to achieve a fair and balanced result.

5.0 GREET Factors for Corn Ethanol

There are several areas where we are still evaluating the CARB GREET model estimates for corn ethanol direct emissions, as follows:

- GREET should not attribute the energy to produce silage to the ethanol plant, since it is used as animal feed and fodder
- There may be issues with CARB's lime application rates. RFA is conducting additional research in this area
- CARB should use an allocation approach instead of a displacement approach with respect to energy allocation for corn ethanol so that it is consistent with what CARB is doing for biodiesel and its co-products
- GREET does not properly reflect agricultural practices that will be in place in 2010, the base year for the LCFS

5.1 CARB GREET should subtract energy to produce silage

A significant amount of stover and silage is produced from corn grown to produce ethanol, and these products are often fed to animals. A portion of the total energy used to produce the corn should be attributed to the stover or silage and not to the ethanol plant. RFA is conducting additional research to determine how much energy this should be, to help inform CARB's decision making.

5.2 Energy assumed for lime is too high

We still have concerns with the lime application rates and the assumed lime types (whether it is applied as limestone or CaCO), and are reviewing these assumptions as well. Since GREET assumes all of the carbon in lime eventually reacts to form CO2, this is an important area.

5.3 CARB should use allocation method for coproducts instead of displacement method

We are concerned with the allocation treatment of distillers grains for corn ethanol in California GREET 1.8B. There are two issues with how CA-GREET1.8B estimates the energy credit of distillers grains. First, the CA-GREET 1.8b model assumes that DGs replace only corn. This has been shown to be faulty assumption based on the detailed research by Argonne referenced earlier in these comments.

Further, this parameter varies from the default Argonne GREET 1.8b assumptions. DGs replace both corn and soybean meal. Second, CARB is utilizing the displacement approach for allocating energy to ethanol and DGs. However, CARB should use the BTU-based allocation method instead, and for two reasons: 1. CARB is using the BTU-based method for the soybean meal co-product produced at a biodiesel plant. 2. DGs produced at an ethanol plant have higher energy content than the corn used in the plant to produce ethanol. This is clearly shown in Table 2 of the Argonne report, and demonstrated by the fact that 1 lb of DGs replaces 1.28 lbs of feed. Therefore, some of the energy used in the plant to produce both ethanol and DGs, which is now all being allocated only to ethanol, should be allocated to DGs as well. And, the best method of doing this is to utilize the BTU-based allocation method.

The impacts of utilizing the BTU-based approach are significant. With the current displacement method, the GHGs associated with ethanol production from a natural gas dry mill are 69 g CO2eq/MJ (excluding land use change emissions). With the BTU-based approach, where the energy used in farming and at the plant is allocated to the products on the basis of their final energy content (consistent with the CARB biodiesel approach), the GHGs associated with ethanol production from the same plant are 47 g CO2eq/MJ, according to our modeling with CA-GREET1.8B. This represents a 32% decrease from the carbon intensity value derived from using the displacement method.

5.4 CARB GREET does not reflect agriculture practices that affect direct GHGs for baseline year of 2010

According to the CARB GREET model, about 35% of the energy used in corn farming is for diesel fuel used to operate equipment during farming operations, and farming GHG represents 14% of total direct GHGs from corn ethanol [17] Thus, the use of diesel fuel for farming operations represents 5% of total direct GHGs.

An increasing trend in corn farming is no-till or low-till practices. This would significantly reduce diesel fuel consumption. It is unclear from the report what level of no-till practices are assumed in the direct CI values, and whether those are representative of no-till farming practices in the base year for the LCFS, which is 2010. This area should be examined.

Also, agriculture chemical production and use account for 41.2% of total direct GHGs from corn ethanol, and N2O emissions from nitrogen fertilizer accounts for half of this 41%, or about 20%. The use of cover crops almost completely offsets N2O emissions from fertilizer, according to recent research from Kim and Dale. [18] The California GREET model for ethanol may assume no use of cover crops, so N2O emissions could be overestimated in GREET based on this factor. RFA is conducting additional research in this area.

CARB has selected the baseline year for the LCFS as 2010. The GREET model CI for corn ethanol is based in large part on farm survey data conducted in the 2001-06 timeframe. The use of old survey data should not carry-over into 2010, without adequate validation. CARB must update the direct CI values for corn ethanol for the year 2010 to be consistent with the baseline year for the LCFS.

6.0 LCFS Baseline

6.1 Corn Ethanol in Baseline

As noted in the Background section, Midwest corn ethanol is in the baseline fuel for gasoline. Originally, the baseline gasoline discussed by CARB was E6, because this was the fuel in use in 2006 when the LCFS Executive Order was signed. Later, when it became possible that the land use change emissions values could have resulted in the CI of gasoline/ethanol mixture increasing from 2006 to 2010 as marketers used more ethanol to meet the 2010 Predictive Model requirements, the baseline was changed to

[17] Table 1.02 of CARB Ethanol GREET report.

[18] "Biofuels, Land Use Change and Greenhouse Gas Emissions: Some Unexplored Variables", Kim, Kim, and Dale, Environmental Science and Technology.

E10 and 2010. The diesel baseline has always been based on 100% diesel fuel. The problem with having corn ethanol in the baseline is that the fuel must effectively compete with itself. If it is determined, as we have done in these comments, that there is little or no land use change for corn ethanol and the CI value of corn ethanol is lower than gasoline, then no credit is given for the GHG reductions for E10 in 2010, or even the expansion from E6 in 2006 to E10 in 2010. If the CI of ethanol is higher than gasoline, then including it in the baseline raises the overall CI, and marketers could lower their CI by removing corn ethanol altogether from the gasoline. If it is nearly equivalent to gasoline, which it is as shown in Table 1 (Background), then marketers have no incentive to remove it or use more (because it does not provide any GHG reductions).

The following table presents an analysis of the sensitivity of the LCFS percent reductions to the baseline fuel and land use assumptions. For baseline fuel, we are estimating reductions from CaRFG with ethanol, and from CARBOB. The current CARB proposal is to estimate reductions only from CaRFG with (corn) ethanol. RFA thinks this may disadvantage corn ethanol, by including corn ethanol in the baseline. As a point of reference, the baseline for diesel fuel is 100% diesel, and includes no biodiesel. In this analysis, we use the CARB Compliance Model to perform the estimates of AFCI. The analysis is summarized in Table 12. Values in bold italics are from the ARB Compliance Model using the inputs shown

In the top row of the table, we are estimating LCFS emission reductions assuming two different levels of California Low CI corn ethanol: 10.75%, which is the percent used in Scenario 1, and 30% California corn ethanol. We also examine the LCFS percent reductions for two levels of ILUC emissions: 0 g/MJ, and 30 g/MJ (the current CARB assumption). Zero is used to show a lower value for ILUC for example purposes.

The baseline AFCI values are shown in the second and third rows. The values that are not in italics are taken directly from the ISOR, the values for CaRFG must be estimated from the CARB Compliance Model, since the ILUC value has been removed. The next set of four rows shows the percent of corn, cellulose, advanced, and sugar making up the ethanol mix. These values must add to 100%.

The next row shows the resultant AFCI from the compliance model for each case. We assume the MSCD recommended levels of plug-in hybrids, BEVs, and FCVs in this analysis. The next two rows show the difference in the LCFS AFCIs and the two baseline AFCIs. The bottom two rows show the percent reductions from the baseline values.

Table 12. Analysis of Percent Reductions and Sensitivity to Baseline Fuel Composition and LUC Values				
	Ca Corn Ethanol = 10.75%		Ca Corn Ethanol = 30%	
	ILUC = 30	ILUC = 0	ILUC = 30	ILUC = 0
CARBOB Baseline AFCI	95.86	95.86	95.86	95.86
CaRFG Baseline AFCI	95.85	***92.62***	95.85	***92.62***
% Ca Corn	10.75	10.75	30	30
% Cellulose	39.25	39.25	29.62	29.62
% Advanced	39.25	39.25	29.62	29.62
% Sugar	10.75	10.75	10.75	10.75
AFCI	***85.07***	***84.63***	***86.61***	***85.39***
Difference, CARBOB Baseline	10.79	11.23	9.25	10.47
Difference, CaRFG Baseline	10.78	7.99	9.26	7.23
% Reduction, CARBOB base	11.2	11.7	9.6	10.9
% Reduction, CaRFG base	11.2	8.6	9.6	7.8

6.2 Analysis

For ILUCs=30 g/MJ, or the CARB current values, the percent reductions from both baselines is the same, because the CaRFG AFCI baseline is the same as CARBOB, and the LCFS reduction is the same. But for LUC=0, the LCFS reductions are much less when compared to CaRFG with ethanol baseline than when compared to CARBOB baseline. Note that the 30% California ethanol fuel passes when compared to CARBOB, but does not when compared to baseline CaRFG. This is because the baseline has dropped much more significantly than the controlled LCFS level. The percent reductions of a 10.75% California ethanol or 30% California ethanol fuel would be lower when compared to a CaRFG baseline than to a CARBOB baseline *at any level of LUC less than 30 g/MJ*.

6.2 Ethanol Plant Mix Type in Baseline

Another baseline issue concerns the percentages of wet and dry mill plants, and the percentages of wet and dry distillers grains. This issue is not relevant if CARB modifies the baseline to be CARBOB, as recommended above.

This issue was covered in our February 13, 2009 comments. CARB assumes that for dry mills, the percent of dried distillers grains is 95% and wet distillers grains is 5%. The latest data indicate that this should be 63% dried distillers grains and 37% wet distillers grains. In addition, CARB assumes 20% of current ethanol production comes from wet mills, and 80% from dry mills, where the latest data indicate 12% comes from wet mills and 88% from dry mills. Both of these incorrect assumptions by CARB make the CI of

Midwest corn higher than it should be. With CARB's assumptions, the CI of Midwest corn ethanol is 98.41 g/MJ, but with the updated assumptions, the CI of Midwest corn ethanol is 96.49 g/MJ, or 2% lower.

6.3 Recommendations

Our overall recommendation is that CARB change the baseline to the CI of CARBOB. This would take care of the first issue.

Regarding the issue of ethanol plant type in the baseline, as indicated in Section 5, CARB has selected a 2010 base year for estimating the 10% LCFS reduction. So, what matters is the mix of plant types in 2010, not some other year like 2008 or 2006. For this reason, we believe that CARB must estimate the plant types providing ethanol in 2010 to properly determine the starting CI of ethanol for the LCFS reduction. The values that are currently being used will be out-of-date and inappropriate by 2010

7.0 Food Versus Fuel Analysis

7.1 CARB's Analysis

The ISOR poorly presents a food versus fuel analysis where the costs and benefits of a 50 million gallon ethanol plant operating in California are summarized. However, the analysis omits the benefits of the feed co-products, which greatly affects the land needed. It also affects the land converted, the release in GHG emissions due to land conversion, and the net GHG benefits. Also, to the extent CARB's land conversion estimates are too high, it also overstates the land converted.

Table 13 below compares the CARB food versus fuel analysis with and without co-products. When including co-products, we have shown two cases – a 55% co-product land use credit, and a 70% co-product land use credit. In addition, we show land converted assuming a yield elasticity with respect to area expansion of 0.9, instead of CARB's average modeling value of about 0.59.

Table 13. Benefits and Costs of a 50 Million Gallon Corn Ethanol Plant

Factor	CARB Analysis No co-product credit assumed in analysis, GTAP with expansion elasticity of ~0.59	With 55% Co-product land use credit, GTAP with expansion elasticity of 0.9	With 70% Co-product land use credit, GTAP with expansion elasticity of 0.9
E85 vehicles fueled	85,000	85,000	85,000
Petroleum displaced (gal)	34 million	34 million	34 million
Non-domestic petroleum displaced (gal) – (assumes 60% imports)	Not included in CARB's estimate	20 million	20 million
Direct GHG reduced (mmt)	0.19	0.19	0.19
Corn input required bu/year	18 million	18 million	18 million
Distillers grain output to animals (tons)	Not included in CARB's estimate	162,000	162,000
Land required to produce feedstock acres (160 bu/acre)	110,000	49,500*	33,000*
Indirect land conversion	36,000	16,200 (7% commercial forestry, 93% pasture)**	10,900 (6% commercial forestry, 94% pasture)**
GHG release from land conversion (mmt)	3.6	<1.6***	<1.1***
Payback period (yrs)	19	<9***	<6***

* On net basis, after subtracting DG land use credit
** Would be less forest if other missing land sources included in GTAP model
*** Would be even less if ARB modified its direct emissions methodology for co-products to be consistent with biodiesel, and also subtracted energy to produce silage, as covered in Section 6

A 50 million gallon per year ethanol plant produces 162,000 tons per year of high quality animal feed used for beef, dairy, swine, and poultry. As shown in the table above, the net land required to produce the feedstock, and the indirect land conversion are 55% to 70% lower than CARB's estimates. The GHG emission releases from converted land are much less, and the payback times much shorter.

7.2 Influence of CARB's LCFS Policy on ROW yield trend growth

One of the keys to adequate food supplies in the future is yield growth in the rest of the world (ROW). Yields for many crops are much lower outside of the U.S. and western Europe. As covered in Section 5 in the discussion of Informa's comments, yields for some crops in the ROW are growing faster than in the U.S., but much of this is because they are starting at much lower levels.

CARB assumes that if corn ethanol is eventually discontinued due to high direct and indirect emissions, that there will be increased land available in the U.S. for food exports. These increased exports may result in less land conversion in the ROW in the short term, and a downward pressure on commodity prices. For example, in the ISOR, CARB states:

> "…the conversion of agricultural land to the production of biofuel feedstocks has the potential to increase the price for food, increase food price volatility, and increase pressure on water supplies…"

If the conversion of agriculture land to the production of biofuel feedstocks has the potential to increase the price of food (commodities), then the reversion of that land has the potential to reduce food prices. This is usually thought of as being "good." However, one issue not examined by CARB is whether the reversion of this land would really lead to increased U.S. exports, which would drive down prices of commodities, lowering farm income in the ROW and thereby slowing the rate of yield growth on crops in the ROW (ROW farmers will have less income to improve yields), thereby canceling out any perceived GHG benefit, and exacerbating food and land use problems.

7.3 Recommendations

CARB should update its food versus fuel analysis to show the significant influences of distillers grains co-products on the results.

8.0 Conclusion

As these comments have explained, there is a significant amount of uncertainty associated with the lifecycle and land use change analyses performed by CARB. The results of CARB's analysis are highly sensitive to a number of key assumptions and model inputs. As we have shown, even slight adjustments to certain assumptions would radically alter the final modeling outcomes. We have provided significant support for making adjustments to several of these key assumptions.

Our general recommendations are that:

- CARB should refine the ILUC analysis assuming a more balanced and less pessimistic set of assumptions.

- CARB must update the direct emissions (CA-GREET) analysis to 2010 to be consistent with its chosen baseline year.

- CARB's food vs. fuel analysis should be updated to account for the contribution of feed co-products and the impact of yield improvements.

- CARB should revise the baseline so that corn ethanol is competing fairly with other ethanol feedstocks.

Appendix A

RFA's Comments on January 30 CARB Workshop

Comments by the Renewable Fuels Association (RFA) on ARB's
January 30, 2009 Workshop on the Low Carbon Fuel Standard
February 19, 2009

On January 30, 2009, the California Air Resources Board (ARB) held a workshop on the Low Carbon Fuel Standard (LCFS), and asked for comments on the information presented at the workshop by February 13, 2009. RFA presented initial oral comments at the workshop, which have been posted on ARB's website. This document expands on those comments, and provides additional detail and references.

Most of these comments are concerning the ARB staff presentation entitled "Indirect Land Use: Technical Considerations." The subjects addressed in these comments are:

- Effect of Increase in Coarse Grain Yields
- Distillers Grain Land Use Credit
- Emissions from the Conversion of Forest
- Effects of Reduced Enteric Fermentation
- Summary of Effects
- CA-GREET
- ARB's LCFS Baseline Change

I. Effect of Increase in Coarse Grain Yields

At the Jan. 30 workshop, ARB explained that stakeholder comments indicated concerns that exogenous yield improvements were not included in ARB's estimate of land use change impacts. In responding to this concern, ARB estimated that yields have improved by 9.5% between 2000/2001 and 2006-08, so that land use change emissions are reduced by 8.7%. ARB is therefore reducing the land use change emissions attributed to corn ethanol by 8.7% to account for exogenous yield improvements.

We have three concerns with this adjustment: (1) the adjustment is not made with respect to the same year as the ethanol increase, which is 2015; (2) the yield improvement between 2001 and 2006-2008 was greater than estimated by ARB; and (3) there is a logical flaw in the method used to make the adjustment. These are discussed further below.

Inconsistency of Years

The 13.25 bgy ethanol shock applied to the GTAP model to estimate land use effects simulates the ethanol volume from 2000/01 to 2015/16. Over this period, the USDA indicates yields will increase 23.4%, from 136.9 bu/acre in 2000/2001 to 169 bu/acre in 2015/16.[1] In making the exogenous yield adjustment, ARB is going only from 2001 to a 2006-2008 average yield. This is inconsistent with the years of the ethanol shock. This also suggests ARB's best estimate of average corn grain yields in 2015 is that they will be unchanged from 2006-08. What are the specific reasons for the belief that yields will not continue to increase after 2006-08? What are the impacts on the land use changes if yields

[1] USDA Agricultural Long-term Projections to 2018. http://www.usda.gov/oce/commodity/ag_baseline.htm

go significantly higher, as indicated by the recent USDA projections? At a minimum, ARB should perform a sensitivity analysis of the land use impacts to this assumption.

2006-2008 Yield Improvement from 2000/01

ARB estimated a 9.5% yield improvement from USDA data. The yield data from the USDA website which ARB referenced is shown in Table 1 below.

Table 1. USDA Corn Yield Data by Crop Year	
Crop Year	Corn Yield
2000/01	136.9
2005/06	147.9
2006/07	149.1
2007/08	151.1
2008/09	153.9
2005/06-2007/08 average	149.4
2006/07-2008/09 average	151.4
% Improvement of 2005/06-2007/08 average	9.1%
% Improvement of 2006/07-2008/09 average	10.6%

As indicated above, the percent improvement from the 2000/01 crop year (which starts in September 2000 and extends through August 2001) to the three-year average of 20005/06-2007/08 is 9.1% and to 2006/07-2008/09 is 10.6%. We are not sure how ARB arrived at 9.5% (even if the average yield for 2006/07-2008/09 is weighted based on acres harvested and total production for each respective year, the weighted average is still 151.3 bu/acre—a 10.5% increase over 2000/01). In any case, this is not critically important because we believe ARB should use the USDA projection of a 23.4% increase from 2000/01 to 2015/16 to be consistent with the ethanol shock implemented in GTAP.

We assume that the 30 g CO2eq./MJ land use change emissions estimate that ARB presented on January 30 utilizes the exogenous yield adjustment. Therefore, the base level that ARB started with in the absence of the exogenous yield adjustment is 32.8 g/MJ (30/0.913). A 23.4% improvement in yield would reduce the LUC by 19%, so a 19% reduction of 32.8 is 6.2 g/MJ. ***Thus, accounting for 2015 projected yields would reduce corn ethanol LUC emissions by 6.2 to 26.6 g/MJ.***

Exogenous Yield Adjustment Based on Faulty Logic

ARB proposes to estimate the exogenous yield increase (as in the previous section), and estimate the percent reduction in land converted directly from this exogenous yield increase, and apply the percent reduction to the land use change emissions. For example, ARB estimates the increase in yield from 2001 to 2006-08 at 9.5%. The reduction in land use emissions is therefore 1/1.095 = 0.913 which corresponds to an 8.7% decrease (1-0.913 = 0.087). ARB estimates that, without an exogenous yield improvement, 3.9 mha in the world will be converted from either forest or grass to crops because of the ethanol increase to 15 bgy. The new land use change total after the exogenous yield adjustment would be 3.57 mha (3.9 * 0.913). The reduction in land converted is therefore .33 mha (3.9-3.57 mha).

There are major problems with this adjustment, which is conducted external to the model. One is that the yield adjustment is only applied to the area of converted land, and not to all land growing corn. There are implicit assumptions in the method that the increase in exogenous yield on the current land (worldwide) is balancing demand, and that the rate of increase in yield outside the U.S. is the same as the rate of increase in within the U.S. All of these are untested assumptions.

Related to this, the ARB adjustment method breaks down severely at significantly higher yield levels. And, if it breaks down at higher yields, then it is also inappropriate at lower yield increase levels. To illustrate this, suppose hypothetically that a technological breakthrough allowed corn yields worldwide to double overnight. The USDA estimates that worldwide, corn production in 2007/08 was 786 million metric tons of corn. So, a doubling of yields and the use of the same amount of land worldwide would produce twice as much corn, or 1,572 million metric tons of corn. Approximately 131 million metric tons of corn will be needed to produce 15 bgy of ethanol in 2015, so the amount needed for 15 bgy is much less than the amount that the doubling of yields would produce (131 mmt is roughly 17% of 786 mmt). Certainly, this additional supply would be more than enough to take care of any increase in demand for corn for non-fuel needs and for the 15 bgy in the U.S., so there would be no need to convert any new land to crops for the 15 bgy. *However, using the ARB yield adjustment method, the reduction in land use change resulting from a doubling of yield is only 50%, from 3.9 mha to 1.95 mha, for the 15 bgy scenario.* This exercise demonstrates the pratfalls associated with this yield adjustment method.

II. <u>Distillers Grain Land Use Credit</u>

The GTAP model used to estimate land use changes has a land use credit of about 33% for distillers grains (DG). This is based on an assumption that DGs replace only corn meal, and that they replace corn meal only on a pound-for-pound basis. The ARB presentation reflects this assumption as well. However, carefully conducted research has recently indicated that these assumptions are far from correct. Because DGs have a much higher protein and fat content, they are currently substituted for the base feed on greater than a pound for pound basis. In addition, the base feed that DGs are replacing includes some soy meal as well as corn meal. Since soy yields are lower per acre than corn yields, any soy meal that DGs replace has a greater land use credit than the corn meal it replaces.

DGs are a co-product of producing ethanol from corn. DGs are a protein- and fat-rich feed source that is used to feed livestock and poultry. In the corn ethanol lifecycle, production of DGs fulfills two purposes. First, the energy of these co-products can be subtracted from the total energy used to produce ethanol, resulting in a lifecycle "energy credit." Second, they significantly reduce the land-use impact of ethanol made from corn by displacing some of the corn and other feed ingredients in livestock diets.

The GREET model uses the displacement method to estimate the DG energy credit. The energy credit is estimated as the energy required to produce a product that would be a suitable substitute for the DGs.

DGs can be provided from the ethanol plant in the "wet" or "dry" form. If they are dried, then the ethanol plant uses more energy (typically natural gas to fuel dryers). Conversely, energy use by the ethanol plant is much lower if DGs can be provided in the wet form.

However, in the wet form they must be fed to livestock relatively quickly before they degrade.

With regard to land use, DGs are important in reducing the land requirement of ethanol from corn. Most corn in the U.S. is used to feed livestock, so when DGs from an ethanol plant are used to feed livestock, they supplant some raw corn products. As a result, somewhat less corn needs to be planted to feed livestock, and less land is used than if DGs were not fed to livestock. In addition, the U.S. exports a significant amount of DGs (approximately 4.5 million metric tons in 2008). This displaces some amount of demand for corn and soybean meal exports for animal feed.

The amount of land credit applied to DGs is a function of two factors. One is the mass ratio of raw corn and soy products that DGs replaces in the livestock diet. Recent research by Argonne National Laboratory indicates that 1 pound of DGs replaces about 1.28 pounds of conventional corn- and soy-based feed in aggregated rations. [2] This greater-than-one-to-one replacement ratio is due to the fact that DGs are generally higher in protein and fat than the diet they are replacing. The second item that affects the land use credit is the amount of soy meal in the base diet that is being replaced. Because the yield on soybeans per hectare is much lower than corn on a volume basis, the more soybean meal in the base diet that DGs are replacing, the greater the land-use credit. The recent Argonne analysis found that 24% of the 1.28 lbs of base diet (or 0.303 lbs) replaced by 1 lb of DGs was soybean meal. The following paragraphs summarize the Argonne research as it pertains to land use credits.

Argonne estimates displacement ratios for DGs, which are used to estimate the energy used to produce alternatives to DGs, and these energy values are credited to ethanol production. The displacement ratios are mass ratio of displaced product per pound of co-product. For example, previous analysis by Argonne indicated that 1 lb of DGs replaced 1.077 lbs of corn meal and 0.823 lbs of soybean meal. Thus, the displacement ratio of corn was 1.077 and for soybean meal was 0.823.

DGs have a much higher protein and fat content than corn grain, as shown in Table 2, taken from the Argonne study.

Table 2. Major Components of Corn and DDGS

Item	Corn grain	DDGs
Dry matter (%)	85.5	89.3
Crude protein (%)	8.3	30.8
Fat (%)	3.9	11.1

As shown in the table, the crude protein levels in DDGS are more than three times the protein levels in corn grain, and nearly three times the fat content.

Argonne goes on to estimate the percent of DGs used by animal type. Dairy cattle consume 44.2%, beef cattle consume 44.2%, and swine consume 11.6% of the DDGs, The estimated inclusion rates were 20% for beef cattle, 10% for dairy cattle, and 10% for swine. For WDGS

[2] "Update of Distillers Grains Displacement Ratios for Corn Ethanol Life-Cycle Analysis", Arora, Wu, and Wang, Argonne National Laboratory, September 2008.

(wet distillers grains), a 40% inclusion rate was estimated for beef cattle, and 10% for dairy cattle.

The base feed for beef cattle contains little or no soybean meal, but the base feed for dairy cattle contains a significant amount of soybean meal. For example, for 10% DDGS replacement over a dairy cow's lifetime, the cow consumes 1864 kg of DDGS, and this replaces 1266 lbs of corn and 1152 kg of soybean meal. The displacement ratios for the different animal types and different meal types are shown in Table 3.

Table 3. Displacement Ratios by Animal Type and Feed Component Type (kg/kg of DGs)

Parameter	Beef Cattle	Dairy Cattle	Swine
Corn Displacement	1.196	0.731	0.890
SBM Displacement	-	0.633	0.095
Urea Displacement	0.056	-	-

The table shows that for each kg of distillers grains consumed by dairy cattle, this replaces 0.731 kg of corn and 0.633 kg of soybean meal. When the results from Table 3 are multiplied by the market shares of DGs supplied to the three animal groups, the overall displacement ratios are 0.955 kg/kg DGs for corn, 0.291 kg/kg DGs for soybean meal, and 0.025 kg/kg DGs for urea. Argonne also estimated the impacts of the 2007 Energy independence and Security Act on the volume of DDGs and these ratios. Argonne found with the 2007 EISA volume of 15 bgy ethanol, the displacement ratios would be as follows:

Corn:	0.947 kg/kg DGs
Soybean meal:	0.303 kg/kg DGs
Urea:	0.025 kg/kg DGs
Total:	1.275 kg/kg DGs

These ratios are only slightly different than the current ratios of 0.955, 0.291, and 0.025.

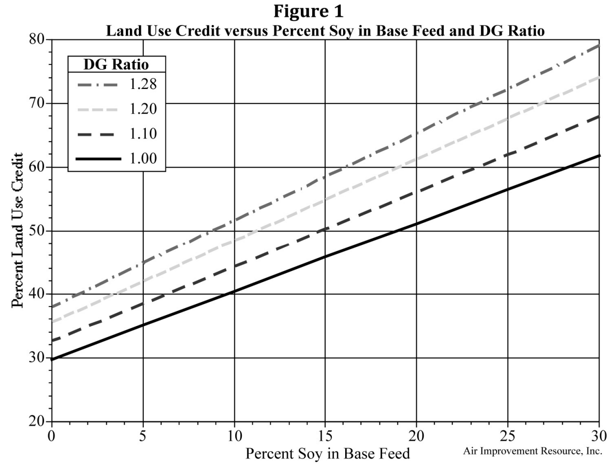
We estimated the impacts of the Argonne work on land use changes using inputs from the California GREET report for corn ethanol, and information from USDA. [3] The California GREET report for corn ethanol indicates that the DG yield per gallon of anhydrous ethanol is 6.4 lbs. Assuming 151 bu/acre (USDA value for 2007), and 2.6 gal/bu (GREET input) this results in 2513 lbs DGs per acre. The Argonne co-products report indicates that this will replace 3217 lbs of feed, consisting of 2445 lbs of corn meal and 772 lbs of soy meal. Again using USDA's corn and soy yields for 2007 of 8456 lbs/acre (151 bu/acre * 56 lbs/bu) and 2502 lbs per acre (42 bu/acre and 60 lbs/bu), the corn acres replaced are 0.29 acres, and the soy acres replaced are 0.42 acres, for a total of 0.71 acres replaced by the DGs produced from making ethanol. [4] Thus, 71% of the acres devoted to corn ethanol are replaced by DGs resulting from the corn ethanol production process.

[3] "Detailed California-Modified GREET Pathway for Denatured Corn Ethanol", Stationary Sources Division, ARB, April 21, 2008, and "Agriculture Statistics 2007", U.S. Department of Agriculture.

[4] Note that in this estimate, we have estimated that 100% of the corn is converted to corn meal, but 73% of the soybean bushel of 60 lbs is converted to soy meal because 26% of the mass has been extracted in the form of soy oil. (Source: CBOT Soybean Crush Reference Guide). Also, the ethanol yield of 2.6 gal/bu may be low – two recent studies of ethanol plants indicate that the yield may be between 2.7 and 2.8 gal/bushel. This would increase the DG land credit from 71% to 77%. (Sources: "Analysis of the Efficiency

The sensitivity of the DG land use credit to assumptions on mass replacement of base feed and percent of soy meal replaced is further illustrated in Figure 1, where we have plotted the land use credit in percent vs. the soy percent in base feed replaced by DGs, and also the DG total replacement ratio (i.e., the 1.275 kg/kg DGs above).

Figure 1



The percent of soy in the base feed based on the Argonne research is 24% (0.303/1.275). The total replacement ratio is 1.28/1. Thus, the figure shows that at 25%, and on the line of 1.28, the land use credit is near 71-72%, and not 33% as us being utilized in GTAP and by ARB. This figure can be used if different total replacement ratios, or percent of soy in base feed values are determined. If DGs are assumed to replace only corn, the DG ratio in Figure 1 would be 1.00. This equates to a DG land use credit of 30%. Of course, slightly different estimates of yields of corn and soybeans per unit area could result in slightly different estimates than the above.

Another conclusion from the above is that as corn and soy yields increase in the future, the DG land use credit increases. The above values were based on 2007 yields. In 2015, if corn yields increase by 23.4% and soy yields increase by 4%, then the land use credit would be 78% for the 1.28 total replacement ratio line. Thus, the land use credit increases as yields increase, due to increased production of DGs on the same area.

Some critics of this displacement ratio approach for estimating land use credits of DGs have pointed out that the use of DGs fluctuates with its price relative to corn meal, and therefore, at different times, feedlots may utilize different levels of DGs with the base feed. While this may be true, it does not detract at all from the basic validity of the displacement ratio

of the U.S. Ethanol Industry in 2007", May Wu, Argonne, March 27, 2008, and "U.S. Ethanol Industry Efficiency Improvements, 2004 through 2007", Christianson and Associates, August 5, 2008)

approach, because in the end, *all DGs are consumed by livestock*. The only relevant question, then, is what the composition of the feed is that they are replacing.

If we take the 26.6 g/MJ developed from the 23.4% yield improvement developed in the previous section, and back out the 33% land use credit for DGs assumed by GTAP, we obtain 26.6/0.67 = 39.7 g/MJ. If we then apply the 71% updated DG credit, we obtain 11.5 g/MJ. ***Thus, accounting for both the 2015 yield and the 71% DG credit brings us to 11.5 g/MJ.***

III. Emissions from the Conversion of Forest

The January 30 CARB presentation shows that CARB currently estimates 0.9 mha of forest will be converted to cropland around the world as a result of a 15 bgy U.S. corn ethanol volume. CARB also estimates that 0.6 mha, or 66% of the forest, is in the U.S.

In estimating the CO2 emissions from the conversion of this forest, ARB assumes that all of the above-ground mass and 25% of the below-ground root mass is immediately converted to CO2. This is the same as assuming that all of the above-ground mass and 25% of the below ground mass of every tree on the 0.9 mha of converted forest is burned, releasing all of the CO2 to the atmosphere. The argument has been made by researchers from UC Berkeley that any wood products used in building, paper, or other products have a relatively short life (less than 100 years?), and that therefore, assuming all the mass is released as CO2 is a reasonable assumption. However, no sources have been cited by ARB or other researchers involved in estimating land use emissions for ARB in utilizing this assumption.

It is important to keep in mind that the forestland in GTAP is primarily commercial forestland that is harvested for lumber, paper, and fuel for producing electricity, as well as many other products. Thus, if commercial forest is converted to cropland, then it stands to reason that it would be harvested first to take advantage of its existing value. The questions of relevance are then:

1. What is the allocation of above-ground mass to various products, such as wood for building, paper, and so on?

2. What are the estimated lives of these products before they are decomposed, and what are the mechanisms of this decomposition?

3. Ultimately, how much of the above ground mass that is harvested and used for products remains as stored carbon in a landfill for a long time, and is not converted to CO2?

None of these significant questions have been addressed by either ARB or their researchers to date, and the answers to these questions are of critical importance, because it is the conversion of forest to CO2 that drives the land use emission estimates that ARB has proposed using. For example, in its October 2008 estimate of 35 g CO2 eq/MJ for land use conversion, 71%, or 25 g of the emission estimate, is from conversion of forest.[5] We do not

[5] This was determined by AIR by running Scenario A from October 16 with GTAPBIO-AEZ. Scenario A has an LUC of 37 g CO2 eq/MJ.

know how much of the current 30 g CO2 eq/MJ estimate is from forest, but assuming the same ratio as in the October 2008 workshop, the estimate would be 21 g CO2 eq/MJ. Thus, determining some reasonable answers to the questions above could have a very large potential impact on the land use emissions attributed to ethanol. At least two reports are of relevance to this issue, and there are likely others.

A paper by Skog and Nicholson estimates carbon sequestration in wood and paper products in the U.S. [6] The authors find that both wood and paper spend a long time in landfills without decaying:

> "The length of time wood, as opposed to paper, remains in end uses may have only a minor effect on the net amount of carbon sequestered in the long run. If, when taken out of use, products are disposed of in a modern landfill, the literature indicates that they will stay there almost indefinitely with almost no decay (Micales and Skog, 1997)."

A study by Fabiano Ximenes regarding the fate of carbon in Radiata Pine trees shows that in the above-ground mass, 37% of the carbon is in harvest residues (limbs, etc.) and 63% is used in sawlogs. [7] Further, of the 67% of carbon in sawlogs, 24% is used in dressed timber products, 5% in composite building products, and 2.5% in paper. All of this 31.5% of carbon in these products is assumed to eventually end up in a landfill, although when they enter a landfill can vary greatly. The remaining 33% of carbon is divided between horticulture products (13%) and energy (20% - wood used in boilers to produce electricity). This information is summarized in Attachment 1, which was from the Ximines report. We would expect these allocations to vary somewhat depending on the types of trees that are being harvested. Overall, in the Ximines report, 32% of the carbon above ground mass is estimated to be eventually stored in landfills.

If we conservatively estimate that 25% of the carbon of the above-ground mass of trees is used in products for a time and eventually ends up in landfills, where little or no decay takes place, then we can estimate what effect this has on the 11.5 g/MJ estimated after correcting for exogenous yields and updated DGs. If 71% of the 11.5 is from conversion of forest, that is 8.2 g/MJ. According to an ARB spreadsheet used to generate the October 16 results, in the U.S. approximately 18% of the total carbon mass assumed by ARB to convert to CO2 is contained in the roots (the total mass is estimated as all of the above ground mass and 25% of the root mass). [8] Thus, 1.5 g/MJ is in the roots, and would not be sequestered in landfills. That leaves 8.2 - 1.5 = 6.7 g/MJ above ground. Applying the 25% figure (% carbon in above-ground mass that is used productively) to 6.7 results in 1.8 g/MJ.

So, if we account for the mass of carbon that is stored in landfills in the U.S. and does not react to form CO2, then we obtain 11.5 - 1.8 = 9.7 g CO2eq./MJ for total corn ethanol LUC emissions. Of course, if CARB does not make the previous two adjustments (yield and DG credit) and does for this factor, this adjustment has a greater impact.

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[6] "Carbon Sequestration in Wood and Paper Products", Skog (USDA Forest Service) and Nicholson (Maryland Energy Administration), USDA Forest Service General Technical Report, RMRS-GTR-59.2000

[7] "Carbon Storage in Forest Products", Fabiano Ximines, New South Wales Department of Primary Industries.

[8] See ARB spreadsheet "draft_luc_ucb.xls", provided to T. Darlington by M.O'Hare.

Our recommendation is to reduce the LUC of corn ethanol using this method, until more detailed work on this issue can be performed. We note that Purdue has also reduced forest carbon by 25% to account for storage in products and landfills in preliminary work performed for Argonne National Laboratory. [9]

IV. Effects of Reduced Enteric Fermentation

The Argonne National Laboratory report on distillers grains also indicates that the use of DGs as livestock feed reduces enteric fermentation from livestock, because of shorter life cycles. [10] Table 16 of the report shows the GHG savings due to reduced enteric fermentation by type of livestock. Over the 3 types of livestock, the average savings is 3,381 g/million BTU of ethanol. This converts to 3.2 g/MJ ethanol.

This can be subtracted directly from the 9.7 g/MJ established in the previous section, to obtain 6.5 g/MJ for total LUC emissions for corn ethanol.

V. Summary of Effects

The effects of the four adjustments discussed in these comments on CARB's LUC estimate of 30 g/MJ are shown in Table 4 below. Taking into account the four factors, LUC emissions for corn ethanol are reduced from 32.8 g/MJ (before any exogenous yield improvement) to 6.5 g/MJ.

Table 4. Summary of the Effects of Four Adjustments on LUC for Corn Ethanol

Adjustment	Amount of Adjustment (g CO2eq/MJ)	Cumulative (starting point 32.8 g/CO2 eq/MJ)
Consistent Yields	6.2	26.6
Updated DG Credit	15.1	11.5
Carbon in Landfills	1.8	9.7
Reduced enteric fermentation	3.2	**6.5**

VI. CA-GREET Model Issues

In addition to the CA-GREET concerns outlined in the letter submitted by RFA to CARB on Feb. 13, 2009, we would like to raise the issues outlined below. Our primary concern is that CARB is being inconsistent in its allocation approach for ethanol and biodiesel co-products.

DG Allocation Approach

We are concerned with the allocation treatment of distillers grains for corn ethanol in California GREET 1.8B. There are two issues with how CA-GREET1.8B estimates the energy credit of distillers grains. First, the CA-GREET 1.8b model assumes that DGs replace only corn. This has been shown to be faulty assumption based on the detailed research by Argonne referenced earlier in these comments. Further, this parameter varies from the

[9] "Land Use Change Carbon Emissions die to US Ethanol Production", Tyner, Taheripour and Baldos, Purdue University, Revision 3 Draft, January 2009.

[10] See reference 1

default Argonne GREET 1.8b assumptions. DGs replace both corn and soybean meal. Second, CARB is utilizing the displacement approach for allocating energy to ethanol and DGs. However, CARB should use the BTU-based allocation method instead, and for two reasons:

1. CARB is using the BTU-based method for the soybean meal co-product produced at a biodiesel plant.

2. DGs produced at an ethanol plant have higher energy content than the corn used in the plant to produce ethanol. This is clearly shown in Table 2 of the Argonne report, and demonstrated by the fact that 1 lb of DGs replaces 1.28 lbs of feed. Therefore, some of the energy used in the plant to produce both ethanol and DGs, which is now all being allocated only to ethanol, should be allocated to DGs as well. And, the best method of doing this is to utilize the BTU-based allocation method.

The impacts of utilizing the BTU-based approach are significant. With the current displacement method, the GHGs associated with ethanol production from a natural gas dry mill are 69 g CO2eq/MJ (excluding land use change emissions). With the BTU-based approach, where the energy used in farming and at the plant is allocated to the products on the basis of their final energy content (consistent with the CARB biodiesel approach), the GHGs associated with ethanol production from the same plant are 47 g CO2eq/MJ, according to our modeling with CA-GREET1.8B. This represents a 32% decrease from the carbon intensity value derived from using the displacement method.

Lime Application Rates
In our previous comments on CA-GREET (dated June 27, 2008), we noted that the lime application rate assumed in the model of 1202 g/bu/year is far too high, and a better estimate of lime application rates was about 87.4 g/bu/year, based on the recent work by Kim and Dale. The latest CA-GREET model still assumes 1202 g/bu. What is the basis for maintaining this assumption when better data exists to guide the parameter?

VII. <u>ARB's Baseline Gasoline Change</u>

We believe ARB should make the LUC emission and CA-GREET adjustments discussed above. When these adjustments are made, corn ethanol will have a significantly lower overall carbon intensity value than baseline gasoline. Because of this, we encourage ARB to revisit its decision to use 2010 E10 as the baseline gasoline. Inclusion of 10% corn ethanol in the baseline gasoline formulation forces corn ethanol to compete against itself, rather than petroleum fuels with higher carbon intensity.

Several months ago, when ARB anticipated that the LUC emissions value for corn ethanol could be very high, it changed baseline gasoline (from which the 10% LCFS carbon intensity reduction is estimated) from 2006 (with 5.7% ethanol) to 2010 (with 10% corn ethanol). We assume the purpose behind this change in the baseline year and gasoline formulation was to prevent penalizing oil companies for the possibility of increasing carbon intensity values between 2006 to 2010 due to the implementation of E10 in 2010. The transition to E10 in 2010 is largely expected because of changes in the Predictive Model. However, if ARB finds that the carbon intensity of corn ethanol is less than gasoline (due to justifiable adjustments to LUC and GREET analyses), this change in baseline date is not justified or desired, because increasing ethanol content from E5.7 to E10 would actually reduce overall blend carbon intensity.

Therefore, commensurate with ARB making reasonable changes to the LUC emissions estimate for corn ethanol, we request that the baseline return to 2006 and E5.7. The impetus for this change is further supported by the Governor's Executive Order S-01-07, which suggested the 10% reduction in carbon intensity should be relative to 2006 carbon intensity levels.

Appendix B

Analysis of Current Feeding Practices of Distiller's Grains with Solubles in Livestock and Poultry Feed Relative to Land Use Credits Associated with Determining the Low Carbon Fuel Standard for Ethanol

Dr. Jerry Shurson
Professor
Department of Animal Science
University of Minnesota
March 25, 2009

Analysis of Current Feeding Practices of Distiller's Grains with Solubles in Livestock and Poultry Feed Relative to Land Use Credits Associated with Determining the Low Carbon Fuel Standard for Ethanol

Dr. Jerry Shurson
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Introduction

The purpose of this report is to provide an independent, scientific evaluation of the information contained in two reports being used as references regarding the land use credit associated with the primary co-product, distiller's grains with solubles (DGS), generated from corn ethanol production. The information reviewed in this report was obtained from two sources: "Update of Distillers Grains Displacement Ratios for Corn Ethanol Life-Cycle Analysis" by Arora, Wu and Wang (2008) and Appendix C11 "Co-product Credit Analysis when Using Distiller's Grains Derived from Corn Ethanol Production" by the California Air Resources Board. It is critical that accurate, science-based information be used for government policy decisions. Therefore, the following report is a critique of the scientific validity of the information contained in these two references in order to provide the "current state of knowledge" relative to the use of ethanol co-products in livestock and poultry feeds. The intended use of this report is to provide a third-party evaluation of these issues for the Renewable Fuels Association as it prepares comments that will be submitted to the California Air Resources Board on the Low Carbon Fuel Standard.

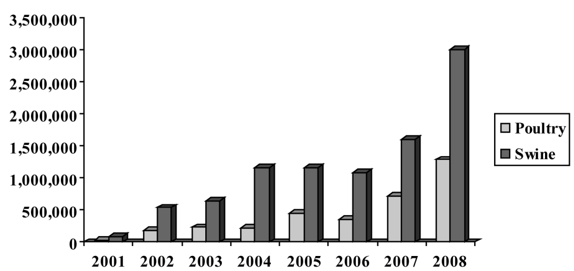
Review of Argonne National Laboratory Analysis (Arora et al., 2008)

The authors of this report correctly acknowledge that the addition of distillers grains with solubles to dairy, beef, and swine feeds has different effects on the amount of corn, soybean meal, and urea (which applies to dairy and beef diets only) that it partially replaces. Although dairy and beef cattle have historically been, and continue to be, the predominant consumers (80%) of DGS in animal agriculture, the amount being used in swine and poultry diets has been increasing over the past several years (Figure 1). In 2001, total annual estimated consumption of DGS was 89,000 MT for swine and 35,000 MT for poultry whereas in 2008, swine and poultry DGS consumption was about 3.0 and 1.3 million MT, respectively. This is a tremendous increase in DGS use over only an 8-year period and represents only 35 and 22% of the potential use in swine and poultry feed in the U.S., respectively (Cooper, 2006).

The percentage estimates of DGS consumed by various livestock and poultry species in 2008 are shown in Table 1. Dairy cattle consumed the greatest amount of DGS (9.0 million MT), followed by beef cattle (8.2 million MT), swine (3.0 million MT), and poultry (1.3 million MT), with the remaining 4.5 million MT being exported. As the amount of DGS production has increased, the estimated quantities of DGS consumed by all livestock and poultry sectors have also increased, and the estimated percentages of distribution of total DGS consumption have changed to include a higher percentage of total production in swine and poultry diets. Three primary factors that will affect further future market penetration in the various food animal sectors, and the percentage use of total DGS production are:

1. The price relationship between DGS and the ingredients it competes with in livestock and poultry diets (e.g. corn and soybean meal [all species], urea [cattle], and inorganic phosphate, fat, and synthetic amino acids [swine and poultry].
2. Availability of supply of the co-product as a feed ingredient.
3. Research focused on developing solutions for overcoming the barriers to increase DGS use in the livestock and poultry industries.

Figure 1. Estimated use of DGS in U.S. poultry and swine diets from 2001- 2008 (Metric Tonnes).



Source: S. Markham, CHS, Inc. (personal communication).

Therefore, when calculating land use credits due to DGS production and consumption, the usage in the swine and poultry sectors needs to be accurately estimated. Although the Arora et al (2008) report was the most comprehensive and objective analysis of the impact of DGS displacement ratios, the results are somewhat biased because it did not provide a thorough and accurate evaluation of the impact of DGS consumption in the swine and poultry industries.

Table 1. Estimated North American DGS usage rate by species (2008).

Species	% of total non-export[1]	Metric Tonnes
Dairy Cattle	42	9,025,800
Beef Cattle	38	8,166,200
Swine	14	3,008,600
Poultry	6	1,289,400
Exports	-	4,510,000[2]
Total	100	26,000,000[3]

[1] Source: S. Markham, CHS, Inc. (personal communication).
[2] Source: D. Keefe, U.S. Grains Council
[3] Source: Renewable Fuels Association www.ethanolrfa.org

In addition, the calculations for displacement ratios for DGS in the Arora et al. (2008) report only accounted for the amount of corn, soybean meal and urea replaced. While this is valid for calculating displacement ratios for cattle feeds, it does not fully account for partial replacement of other common ingredients used in swine and poultry diets such as inorganic phosphate, fat, synthetic amino acids, and salt.

2.1.1.2 DGS Inclusion in Feed and Animal Performance

Beef cattle

Arora et al. (2008) chose an excellent source of data and information for beef cattle using the review and meta-analysis by Klopfenstein et al. (2008) involving nine experiments to measure growth performance at DGS dietary inclusion levels up to 40%. Using these data for calculating feed ingredient displacement ratios for DGS in beef feedlot cattle diets is very appropriate.

Dairy cattle

Data from a recent study by Anderson et al. (2006) were used in the calculation of displacement ratios for DGS in lactating dairy cattle diets. The dietary inclusion rates of DGS in the Anderson et al. (2006) study represent the current range in feeding levels in the dairy industry, and the milk production and composition responses are consistent with other published studies. Although a more thorough review and summary of results from multiple studies should have been done, the data and assumptions used in their calculations are scientifically valid and representative of diet composition changes, as well as milk production levels and composition when feeding DGS diets to lactating dairy cows.

Swine

The analysis of DGS use in swine feeds was inadequately described by Arora et al. (2008) and was based on results from only a few select studies. It is more appropriate to use information from all of the published scientific studies to accurately characterize growth responses of growing swine fed diets containing DGS at levels of 10 to 30% of the diet. Stein and Shurson (2008) recently conducted a comprehensive literature review of results from all published studies and summarized growth performance responses for weanling pigs (Table 2) and grower-finisher pigs (Table 3). The majority of the studies conducted have shown no change in weanling pig and growing-finishing pig performance when DGS is included in the diet at levels up to 30% compared to feeding typical corn-soybean meal based diets. Although feed conversion (G:F) was improved in 50% of the weanling pig studies and 16% of the growing-finishing pig studies, indicating improved utilization of DGS diets compared to conventional corn-soybean meal diets, I chose to be conservative by assuming that feeding DGS diets results in no change in growth rate or efficiency of feed utilization. Therefore, when calculating displacement ratios for DGS, I did not give any credit for improvements in performance but rather focused on the amounts of common feed ingredients that DGS partially replaces (Table 4).

Currently, the industry average dietary inclusion rate of DGS in growing swine diets is 20%, which is double the assumption used in the Argonne report, and it has been as high as 40% for growing-finishing pigs when it has been priced substantially lower than the feeding value of corn, soybean meal, and inorganic phosphate. At a 20% dietary DGS inclusion rate, 400 lbs of DGS plus 6.4 lbs of calcium carbonate, and 2.8 lbs of synthetic amino acids replace 279.6 lbs of corn, 118 lbs of soybean meal, and 11.6 lbs of dicalcium phosphate per ton (2000 lbs) of complete feed (Table 4), resulting in a displacement ratio of 0.699 for corn, 0.295 for soybean meal, and 0.029 for dicalcium phosphate (Table 5). At the 30% dietary DGS inclusion rate the displacement ratios are 0.688 for corn, 0.307 for soybean meal, and 0.027 for dicalcium phosphate (Table 5).

Table 2. Effects of including corn distillers dried grains with solubles (DGS) in diets fed to weanling pigs[1]

Item	N	Response to dietary corn DGS		
		Increased	Reduced	Not changed
ADG	10	0	0	10
ADFI	10	0	2	8
G:F	10	5	0	5

[1]Data calculated from experiments by Whitney and Shurson (2004), Gaines et al. (2006), Linneen et al. (2006), Spencer et al. (2007), Barbosa et al. (2008), and Burkey et al. (2008).

Table 3. Effects of including corn distillers dried grains with solubles (DGS) in diets fed to growing-finishing pigs[1, 2]

Item	N	Response to dietary corn DGS		
		Increased	Reduced	Not changed
ADG	25	1	6	18
ADFI	23	2	6	15
G:F	25	4	5	16

[1] Data based on experiments published after 2000 and where a maximum of 30% DDGS was included in the diets.

[2]Data calculated from experiments by Gralapp et al. (2002), Fu et al. (2004), Cook et al. (2005), DeDecker et al. (2005), Whitney et al. (2006), McEwen (2006, 2008), Gaines et al. (2007ab); Gowans et al.(2007), Hinson et al. (2007), Jenkin et al. (2007), White et al. (2007), Widyaratne and Zijlstra (2007), Xu et al. (2007ab, 2008ab), Augspurger et al. (2008), Drescher et al. (2008), Duttlinger et al. (2008), Hill et al. (2008), Linneen et al. (2008), Stender and Honeyman (2008), Weimer et al. (2008), and Widmer et al. (2008).

Table 4. Partial replacement amounts of common feed ingredients with 20 or 30% DGS in typical swine grower diets.

Ingredient, %	**0% DGS**	**20% DGS**	**Difference**	**30% DGS**	**Difference**
Corn	81.30	67.32	-13.98	60.65	-20.65
Soybean meal, 46% CP	16.50	10.60	-5.90	7.30	-9.20
DGS	0.00	20.00	+20.00	30.00	+30.00
Dicalcium phosphate	0.82	0.24	-0.58	0.00	-0.82
Calcium carbonate	0.68	1.00	+0.32	1.13	+0.45
Salt	0.30	0.30	0.00	0.30	0.00
Synthetic amino acids	0.15	0.29	+0.14	0.37	+0.22
Vitamins and trace minerals	0.25	0.25	0.00	0.25	0.00
Total	100.00	100.00		100.00	

Table 5. Summary of co-product displacement ratios for swine when DGS is added at 20 and 30% dietary inclusion rates.

Dietary DGS Inclusion Rate	**Corn**	**Soybean meal**	**Dicalcium phosphate**
20%	0.699	0.295	0.029
30%	0.688	0.307	0.027

Poultry

Use of DGS in broiler, layer, and turkey diets was omitted from the analysis in the Argonne report (Arora et al., 2008). The authors cited that "poultry consumption was excluded because feed composition and performance data available for poultry were insufficient". While the

NASS-USDA (2007) survey did not include poultry data, other sources could have been used as a reference. Therefore, I elected to provide the following summary of DGS usage in broiler, layer, and turkey diets and calculate displacement ratios for common ingredients partially replaced in these diets, and include this information in the final composite displacement ratios for all food animal species.

Current dietary inclusion rates of DGS in broiler diets range from 3 to 15%, with an average of 5% (Dr. Amy Batal, 2009, personal communication). Commercial layer diets contain between 3 to 12% DGS, with an average dietary inclusion rate of 7% (Dr. Amy Batal, personal communication). For turkeys, typical dietary DGS use levels are 10%, but in 2008, levels of 20 to 30% DGS were used when feed prices were extremely high (Dr. Sally Noll, personal communication). Tables 6, 7, and 8 summarize the partial replacement rates of corn, soybean meal, and inorganic phosphate with DGS in broiler, layer, and turkey diets, respectively. The ranges in dietary DGS inclusion rates for broiler, layer, and turkeys used in this analysis result in no change in growth performance compared to feeding conventional corn-soybean meal based diets.

Table 6. Partial replacement amounts of common feed ingredients with 5 or 10% DGS in typical broiler grower diets.

Ingredient, %	**0% DGS**	**5% DGS**	**Difference**	**10% DGS**	**Difference**
Corn	64.87	61.81	-3.06	58.75	-6.12
Soybean meal, 49% CP	27.19	24.99	-2.20	22.79	-4.40
DGS	0.00	5.00	+5.00	10.00	+10.00
Poultry by-product	3.00	3.00	0.00	3.00	0.00
Defluorinated phos.	1.05	0.95	-0.10	0.85	-0.20
Calcium carbonate	0.59	0.68	+0.09	0.77	+0.18
Salt	0.39	0.38	-0.01	0.37	-0.02
Synthetic amino acids	0.32	0.36	+0.04	0.42	+0.10
Fat A-V Blend	2.26	2.49	+0.23	2.72	+0.46
Vitamins, trace minerals, and additives	0.33	0.34	+0.01	0.33	0.00
Total	100.00	100.00	100.00	100.00	100.00

At a 5% dietary DGS inclusion rate, 100 lbs of DGS plus 1.8 lbs of calcium carbonate, 0.80 lbs of synthetic amino acids, and 4.6 lbs of animal-vegetable blend fat replaces 61.2 lbs of corn, 44 lbs of soybean meal, and 2 lbs of defluorinated phosphate in one ton (2000 lbs) of complete feed, resulting in a displacement ratio of 0.612 for corn, 0.440 for soybean meal, and 0.020 for defluorinated phosphate. At the 10% dietary DGS inclusion rate the displacement ratios for corn, soybean meal, and defluorinated phosphate are the same as those at the 5% dietary inclusion level.

Table 7. Partial replacement amounts of common feed ingredients with 5 or 10% DGS in typical layer diets (peak egg production).

Ingredient, %	0% DGS	5% DGS	Difference	10% DGS	Difference
Corn	58.64	55.60	-3.04	52.56	-6.08
Soybean meal, 49% CP	26.53	24.34	-2.19	22.14	-4.39
DGS	0.00	5.00	+5.00	10.00	+10.00
Defluorinated phos.	2.26	2.16	-0.10	2.06	-0.20
Calcium carbonate	8.92	9.01	+0.09	9.10	+0.18
Salt	0.19	0.18	-0.01	0.17	-0.02
Synthetic amino acids	0.22	0.26	+0.04	0.30	+0.08
Fat A-V Blend	2.90	3.12	+0.22	3.34	+0.44
Vitamins, trace minerals, and additives	0.34	0.33	-0.01	0.33	-0.01
Total	100.00	100.00		100.00	

Similar to broiler diets, at a 5% dietary DDGS inclusion rate in layer diets, 100 lbs of DDGS plus 1.8 lbs of calcium carbonate, 0.80 lbs of synthetic amino acids, and 4.4 lbs of animal-vegetable blend fat replaces 60.8 lbs of corn, 43.8 lbs of soybean meal, and 2 lbs of defluorinated phosphate per ton (2000 lbs) of complete feed, resulting in a displacement ratio of 0.608 for corn, 0.438 for soybean meal, and 0.020 for defluorinated phosphate. At the 10% dietary DDGS inclusion rate, the displacement ratios for corn, soybean meal, and defluorinated phosphate are the same as those for the 5% dietary inclusion level.

Table 8. Partial replacement amounts of common feed ingredients with 10 or 20% DDGS in typical turkey grower diets (11-14 week old tom, or 8-11 week old hen).

Ingredient, %	0% DGS	10% DGS	Difference	20% DGS	Difference
Corn	59.57	54.10	-5.47	48.62	-10.95
Soybean meal, 46% CP	28.68	24.08	-4.60	19.47	-9.21
DGS	0.00	10.00	+10.00	20.00	+20.00
Dicalcium phosphate	0.95	0.69	-0.26	0.43	-0.41
Calcium carbonate	0.72	0.91	+0.19	1.09	+0.37
Salt	0.23	0.19	-0.04	0.15	-0.08
Synthetic amino acids	0.31	0.37	+0.06	0.39	+0.08
Animal fat	5.03	5.22	+0.19	5.41	+0.38
Vitamins, trace minerals, and additives	4.51	4.44		4.44	
Total	100.00	100.00		100.00	

In turkey diets, a 10% dietary DGS inclusion rate results in adding 200 lbs of DGS plus 3.8 lbs of calcium carbonate, 1.20 lbs of synthetic amino acids, and 3.8 lbs of animal fat to replace 109.4 lbs of corn, 92 lbs of soybean meal, 5.2 lbs of defluorinated phosphate, and 0.80 lbs of salt per ton (2000 lbs) of complete feed, resulting in a displacement ratio of 0.547 for corn, 0.460 for

soybean meal, 0.026 for dicalcium phosphate, and 0.004 for salt. At the 20% dietary DGS inclusion rate, the displacement ratios for all of these ingredients are the same as the 10% DGS dietary level.

Table 9 shows a summary of DGS displacement ratios for broilers, layers, and turkeys. Since these values are similar, I chose to average them to obtain a composite ratio for corn, soybean meal, and phosphate for the overall displacement ratio calculations for poultry shown in Table 10. These values are the same at DGS inclusion rates up to 20% which exceeds current average dietary inclusion rates of 5% for broilers, 7% for layers, and 10% for turkeys.

Table 9. Summary of DGS displacement ratios for poultry.

Species	**Corn**	**Soybean meal**	**Phosphate**
Broilers	0.612	0.440	0.020
Layers	0.608	0.438	0.020
Turkeys	0.547	0.460	0.026
Average	**0.589**	**0.446**	**0.022**

2.1.2 Step 2: Characterize U.S. Distillers Grains Consumption by Animal Type

The Argonne report referred to the NASS-USDA survey published in 2007 as a source of DGS consumption data by species. However, this survey was conducted before the record high corn and soybean meal prices occurred in 2008, and therefore, the dietary inclusion rates for various species reported in this survey are conservative, especially for swine based on current diet usage rates in 2008-2009. Usage estimates of DGS in poultry diets was not included in this survey.

2.1.3 Step 3: Characterize Life Cycle of Animals

The information provided in the Argonne report for beef and dairy cattle is valid and adequately accounts for improved growth performance of feedlot beef cattle and improvements in milk production in lactating dairy cattle. Because growth performance of swine, broilers, layers, and turkeys are unchanged with typical dietary inclusion rates of DGS as previously described, no adjustments in displacement ratios for DGS are needed like those for cattle. This was accurately represented for swine in the Argonne report, although the authors used a 10% dietary DGS inclusion rate where I have used displacement ratios assuming a 20% DGS dietary inclusion rate for swine. The Argonne report did not include calculations for displacement ratios for poultry, however, they will be used in the final displacement ratio calculations presented here.

2.1.4 Step 4: Results - Displacement Ratio of Distillers Grains

The final composite DGS ratio results are presented in Table 10. By adding the proportional amounts of each ingredient that is decreased or increased as a result of using DGS in the diets, while accounting for market share for each species, 1 kg or 1 lb of DGS can displace 1.244 kg or lbs of other dietary ingredients to achieve the same level of performance (or improved performance as with cattle). This displacement ratio is slightly lower, but similar to the value of 1.271 kg obtained in the Arora et al. (2008) report which had limited information on swine dietary DGS usage and expected growth performance results, and DGS usage in poultry diets was not included.

In my analysis, the overall displacement ratio for corn and soybean meal was 1.229 compared to the Argonne calculation of 1.28. The reason for this slightly lower value was that the corn displacement value (0.895) was slightly lower in my analysis compared to the value (0.955) calculated in the Arora et al. (2008) report. However, the soybean meal displacement ratio was higher (0.334 vs. 0.291) value in Argonne report. This indicates that 27% of the corn and soybean meal displacement value is soybean meal compared to 24% in the Argonne report. Most of this change can be explained by the greater proportion of soybean meal displaced (and less corn) in swine and poultry diets, with the remaining contribution coming mostly from savings in phosphate supplementation.

Table 10. Summary of DGS displacement ratio by species and overall DGS displacement ratio[1].

Parameter	**Dairy**	**Beef**	**Swine (20%)**	**Poultry**	**Overall Ratio (kg/kg DGS)**
Market share, %	42	38	14	6	100
Corn	0.731	1.196	0.699	0.589	0.895
Soybean meal	0.633	-	0.295	0.446	0.334
Urea	-	0.056	-	-	0.021
Synthetic amino acids	-	-	+0.140	+0.073	(0.024)
Fat	-	-	-	+0.363	(0.022)
Inorganic phosphate	-	-	0.580	0.220	0.094
Calcium carbonate	-	-	+0.320	+0.183	(0.056)
Salt	-	-	-	0.027	0.002
Total	**1.364**	**1.252**	**1.114**	**0.663**	**1.244**

[1]Values designated with + indicate additions to maintain equivalent dietary nutrient levels when DGS is added to diets for swine and poultry and values in ( ) indicate subtractions from the overall composite ratio.

Review and Critique of Appendix C11 Co-product Credit Analysis when Using Distiller's Grains Derived from Corn Ethanol Production (CARB)

The authors of this Appendix acknowledge that when DGS displaces traditional feed ingredients such as corn and soybean meal, it reduces green house gas emissions and becomes a life-cycle carbon intensity credit for corn ethanol. However, they criticize the Argonne National Laboratory report (Arora et al., 2008) as having insufficient justification for adopting the DGS displacement value in this report. I strongly disagree. In the preceding analysis of this report, I have noted the areas of insufficient information and have made calculations to be more reflective of actual DGS use among the major livestock and poultry species that consume it. Although this Appendix of the CARB report attempts to describe some of the challenges of using DGS in livestock and poultry feeds, it does not accurately represent factual information for making informed decisions on the impact of feeding DGS on land use credits. The following is a summary of critical evaluation of the incorrect information and improper context of statements in this Appendix.

In this Appendix, the California Air Resources Board (CARB) indicated that their staff conducted an extensive literature review to determine the likelihood that significant quantities of traditional feed ingredients will be replaced by DGS. The accuracy of this statement is highly questionable because they vaguely reference a limited number of sources of information, and no list of publications or other sources of information are provided at the end of the Appendix. Furthermore, the most striking point of the information in this Appendix is that they question whether the barriers to DGS use will be overcome to allow it to be used in livestock and poultry feeds in a significant way. **The fact is, ALL of the growing supply of DGS has been, and continues to be used in livestock and poultry feeds both domestically and in the export market**. Although the barriers they have identified are realistic, their impact is more on further market penetration and use in the various livestock and poultry sectors than on the ethanol industry's ability to market the quantities of DGS currently being produced. Variability in nutrient content along with handling, storage and transportation are challenges that have, to some degree, limited market penetration of DGS use for some species. However, under competitive market price conditions, DGS will continue to be fully utilized in livestock and poultry feeds.

There are several additional technical errors in the CARB Appendix C11.

1. In Table C-11-1, they do not reference the source of the information in the table, generalize ranges in digestibility and availability across species, and do not define "availability". Data in this table are being used to argue that variability in nutrient content will determine the **feasibility** of displacing traditional feeds with DGS. It is not a

question of feasibility, but rather a question of managing variability and appropriately valuing and determining nutrient loading values of the source of DGS being fed.

2. Livestock **ARE** able to digest a much higher percentage of the protein (amino acid fraction) than the 16.8 to 28.8% that was indicated. Wet and dry DGS contains about 55% ruminally undegradable protein, and the crude protein digestibility of DGS for swine ranges from 58 to 71%. If protein digestibility were as low as indicated in this Appendix, there would be much lower levels of soybean meal or urea replaced in animal feeds by DGS than is currently done.

3. Yes, DGS is low in lysine content relative to the nutrient requirements of pigs and poultry. That is why **diets for swine and poultry** are supplemented with synthetic lysine and other amino acids to make up for low levels of lysine and a few other amino acids. Supplemental synthetic amino acids are generally not used in cattle diets.

4. High sulfur content of DGS can be a concern in cattle diets in geographic areas where sulfur content of water, forages and other feed ingredients are also high, and a high dietary inclusion rate (40%) of DGS with high sulfur content is fed. However, this has not limited DGS use in cattle feeds (38% of total DGS production is fed to beef feedlot cattle). Historically, there have been a few cases of polioencephalamalacia that have occurred in beef feedlots when high amounts of DGS containing high levels of sulfur have been fed along with high sulfur content of other feed ingredients.

5. The phosphorus content and digestibility in DGS is high (65 to 90%) for all species. This provides a significant nutritional advantage for DGS in swine and poultry diets because it allows for a significant reduction in the need for supplemental inorganic phosphate to meet the animals phosphorus requirement while substantially reducing diet cost. Furthermore, using DGS to displace corn and soybean meal, which have much lower phosphorus content and digestibility, can substantially reduce the amount of phosphorus excreted in manure.

6. Hogs do not get urinary calculi, but it can occur in ruminants. It is essential to add supplemental calcium to diets containing DGS because it is very low in calcium compared to phosphorus, and the proper calcium:phosphorus ratio must be maintained to insure optimal health and growth performance of all food animal species.

7. Lactating dairy cow diets high in fat do not cause milk to contain an unacceptably high fat content. Feeding high fat diets to lactating dairy cows actually can depress milk fat content. That is why dairy cattle feeds should not contain more than about 20% DGS to avoid potential milk fat depression.

8. While it is true that fine particle size of complete feeds can increase the incidence of gastric ulcers in swine, particle size of DGS often exceeds 700-800 microns and only represents a maximum of 20 to 30% of the diet. Particle size of corn and soybean meal has a greater effect on overall diet particle size than most sources of DGS.

9. DDGS is a preferred energy and protein source for cattle because the fermentable carbohydrate (fiber) in DDGS reduces the risk of rumen acidosis compared to feeding corn which has a very rapidly fermentable carbohydrate (starch) that can increase the risk of acidosis.

10. Handling of some sources of dried DGS and transportation costs of wet DGS are challenges but they have not prevented widespread use of DGS in livestock and poultry feeds domestically or in the export market.

11. Livestock producers depend on their nutritionists to help them use diets containing DGS to obtain the best performance at the lowest cost. The majority of animal nutritionists in the feed industry have extensive knowledge of the benefits and limitations of feeding DGS to various livestock and poultry species. Lack of knowledge may have limited DGS use several years ago, but not today.

12. Exports of DGS increased 91% in 2008 from 2.36 million MT to 4.51 MT. There is no doubt that the efforts of U.S. Grains Council have been extremely effective in increasing the export market for DGS.

13. The conclusions in this Appendix are not realistic or valid. The staff who compiled and wrote this Appendix have demonstrated great incompetence in their understanding of the use of DGS in animal feeds.

In summary, the Arora et al. (2008) report slightly overestimated the DGS displacement ratio by not accurately accounting for the contributions consumed by swine and poultry. Based on current estimates for market share for each species and a revised composite DGS displacement ratio, 1 kg or 1 lb of DGS can displace 1.244 kg or lbs of other dietary ingredients to achieve the same level of performance (or improved as with cattle), which is slightly lower, but similar to the value of 1.271 kg obtained in the Arora et al. (2008) report. The information contained in the CARB Appendix does not appear to acknowledge that **all** of the 26 million tonnes of DGS produced in 2008 **was** consumed by livestock and poultry, and inaccurately describes the nature of the challenges for increased use of DGS in livestock and poultry feeding in the future. The information contained in the CARB Appendix C11 is misleading and has no value in establishing land use credits for current DGS production and use.

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Appendix C

Memorandum Re: Comments on the Use of the GTAP Model for the California Air Resources Board

Informa Economics, LLC

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an AGRA informa company

Memorandum

To: Tom Darlington, Air Improvement Resource
From: Scott Richman
CC: Geoff Cooper, Renewable Fuels Association; Don Frahm, Informa Economics
Date: April 15, 2009
Re: Comments on the Use of the GTAP Model for the California Air Resources Board

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Informa Economics ("Informa") has had an opportunity to conduct an initial review of the California Air Resources Board ("ARB") *Proposed Regulation to Implement the Low Carbon Fuel Standard*. Specifically, Informa has reviewed sections of the report and the appendices that pertain to the use of the Global Trade Analysis Project ("GTAP") model, as well as a brief summary that was provided to Informa separately regarding the model's results pertaining to crop area. The following are Informa's three key comments regarding the use and results of the model:

1. There is an incorrect assertion in Appendix C10 (pp. C-44 and C-47) that yield increases have been the same across countries and major crops since 2001; therefore, ARB incorrectly assumes a simple adjustment external to the GTAP model is appropriate to account for the significant increase in U.S. corn yields since 2001. Per Table 1 below, growth rates in corn yields have differed between the U.S. and the rest of the world (ROW); moreover, there has been a particularly notable difference in the growth rate of other crop yields versus U.S. corn. From 2001 through 2007, U.S. corn yields increased at an annual average rate of 1.5%, whereas ROW corn yields increased at a 2.0% rate; thus the ROW growth rate was 1.4 times that of the U.S. Including preliminary yield estimates for 2008, ROW corn yields increased 2.2% annually from the 2001 base year to the average for the period 2006-2008, or 1.5 times the increase in U.S. corn yields. As acknowledged by the authors of the appendix, "If U.S. corn yield grows slower than ROW yield, then we will overestimate the net change in cropland due to increase in ethanol production" (C-49).

   The differential in growth rates versus yields of other commodities, specifically soybeans, is of particular importance in determining real-world crop area allocation in response to a demand shock. From 2001 to 2007, soybean yields increased at an average annual rate of 0.9% in the U.S. and 1.2% in the ROW; these rates were only 0.6 and 0.8 times the U.S. corn yield growth rate, respectively. (Data for Table 1 were obtained from the USDA's Production, Supply & Distribution database;

though it is recognized that the GTAP model utilizes data from the U.N. Food and Agriculture Organization, it is doubtful there would be a significant difference.)

Table 1: Annualized Crop Yield Growth Rates

	Growth Rate 2001-2007	Ratio to U.S. Corn Growth	Growth Rate 2001A-2008P	Ratio to U.S. Corn Growth	Growth Rate 2001 to 2006-2008P Avg.	Ratio to U.S. Corn Growth	Growth Rate 1999-2001 Avg. to 2006-2008P Avg.	Ratio to U.S. Corn Growth
U.S. Corn	1.5%		1.6%		1.5%		1.5%	
Non-U.S. Corn	2.0%	1.4	2.3%	1.5	2.2%	1.5	2.0%	1.3
U.S. Soybeans	0.9%	0.6	0.0%	0.0	0.7%	0.5	1.2%	0.8
Non-U.S. Soybeans	1.2%	0.8	-0.1%	-0.1	0.9%	0.6	0.8%	0.5
U.S. Wheat	0.0%	0.0	1.6%	1.0	0.4%	0.3	-0.1%	-0.1
Non-U.S. Wheat	0.6%	0.4	1.6%	1.1	1.1%	0.7	1.0%	0.7

Note: 2008P indicates preliminary non-U.S. and world estimates

In Appendix C10 (p. C-47), the authors provide an example in order to:

> "demonstrate that post GTAP adjustment to the net change in cropland due to increased biofuel production is sufficient and no further adjustments are necessarily to reflect higher current yields.
>
> In 2001, US corn yield is 335 bu/ha and ROW corn yield is 109 bu/ha. In US cultivated area is 36.34 Mha. In the ROW cultivated area is 252.04 Mha …
>
> To produce 13.25 billion gallons of corn ethanol, we would need 5096 Mbu of corn. …
>
> Land required for this production is:
>
> 5096Mbu / 109bu = 47 Mha in the ROW. So, in this simple calculation, the net change in cropland is 47 Mha.
>
> If we compare average corn yield over 2006-2008 and our base year (2001) corn yield for U.S., we find that U.S. corn yield had grown by 9.5%. …
>
> What is the net change in cropland due to increased ethanol production at higher yields? Again, to produce 13.25 billion gallons of corn ethanol, we would need 5096 Mbu of corn. …
>
> Land required for this production is:
>
> 5096 Mbu / 119 bu/ha = 43 Mha in the ROW. At higher yields, the net change in cropland is 43 Mha.

> Now, compare 47 Mha and 43 Mha. One could obtain 43 Mha by simply adjusting 47 Mha to reflect higher current corn yields:
>
> 47/(1+0.095) = 43 Mha.
>
> This idea is behind the post GTAP adjustment applied to the net change in cropland obtained at 2001 yields. So, to know the net change in cropland at higher current yields, it is sufficient to apply factor 1/(1+percent change in corn yield/100) to the GTAP net change in cropland due to increased ethanol expansion obtained at 2001 yields."

In reality, while U.S. corn yields did increase by 9.5% during this time period, ROW corn yields increased by 14.2% (refer again to Table 1). Using the factor 1/(1+percent change in corn yield/100), the amount of land required would be:

47/(1+0.142) = 41 Mha

Thus, the reduction in land required due to yield improvements should have been 6 million hectares (47 Mha - 41 Mha), which is a 50% greater reduction than the 4 million hectares (47 Mha - 43 Mha) from the GTAP authors' example. This indicates that the land use adjustment that was performed outside the GTAP model might have been inadequate; that is, the adjusted results from the model might still have overstated the amount of land use change associated with an increase in ethanol production.

2. The elasticities of crop yields with respect to certain factors as discussed in Appendix C5 are questionable. This is particularly true for the elasticity of crop yields with respect to area expansion. As stated on page C-29, "Although this is a critical input parameter, little empirical evidence exists to guide the modelers in selecting the most appropriate value." This is unfortunate since, depending on the parameters used, there was a "77% variation in the GHG emission estimate." Additionally, "professional judgment" was used to set the parameter; however, the amount of error that could be introduced by this variable suggests that the elasticity should be determined empirically or it should be excluded from the model. The parameter was judgmentally set at a value of 0.5, indicating that yields on new land are far less than those on land previously planted to the crop. A brief examination of the data indicates that the empirical evidence for such a low value is lacking.

   The best example of this can be seen by examining the area and yields of soybeans. As shown in Table 2, soybean area outside the U.S. almost exactly doubled between the 1989-1991 period and the 2006-2008 period, from 33 million hectares to 65 million hectares. (Much of the increase occurred in South America.) During the same timeframe, yields increased by 38%. This was significantly higher than the 23% yield increase that occurred in the U.S. on a 23% increase in soybean area. If

new land were far less productive than previously planted land, the large increase in non-U.S. yields would have been logically suspect, and at a minimum the increase would have been expected to have been lower than that of the U.S., where the percentage area increase was only one-fourth as large.

The results for corn are not as dramatic as those for soybeans, since the expansion in area has not been as large in percentage terms, but area and yield patterns for corn point in the same direction as those for soybeans. Both U.S. and non-U.S. corn area grew by roughly one-fifth between the 1989-1991 period and the 2006-2008 period. Over that timeframe, yields increased by approximately one-third. Additionally, the increases outside the U.S. have been slightly higher than those for the U.S.: non-U.S. yields increased 34% on an area increase of 22%, while U.S. yields rose by 32% on an area expansion of 18%.

Table 2: Long-Term Growth in Crop Area and Yields

	Area (000 Hectares)					Yields (Quintals/Ha)				
	Avg. 1989-1991	Avg. 1999-2001	Avg. 2006-2008P	Change 1989-91 to 2006-08P	% Change 1989-91 to 2006-08P	Avg. 1989-1991	Avg. 1999-2001	Avg. 2006-2008P	Change 1989-91 to 2006-08P	% Change 1989-91 to 2006-08P
U.S. Corn	27,054	28,633	31,809	4,754	18%	72	85	95	23	32%
Non-U.S. Corn	101,971	110,029	124,094	22,123	22%	28	32	37	9	34%
World Corn	129,025	138,662	155,902	26,877	21%	37	43	49	12	32%
U.S. Soybeans	23,480	29,384	28,786	5,305	23%	23	26	28	5	23%
Non-U.S. Soybeans	32,566	46,163	64,784	32,219	99%	16	21	23	6	38%
World Soybeans	56,046	75,547	93,570	37,524	67%	19	23	24	5	28%

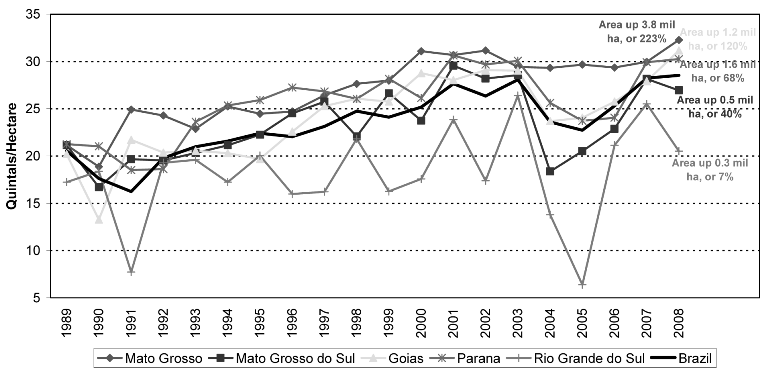
Note: 2008P indicates preliminary non-U.S. and world estimates

In Appendix C-5, the first comment about the elasticity of crop yields with respect to area expansion is, "Because almost all of the land that is well-suited to crop production has already been converted to agricultural uses, yields on newly converted lands are almost always lower than corresponding yields on existing crop lands." (C-29) One of the main areas of the world where a substantial amount of new land has been brought into crop production during the last couple of decades is Brazil. From 1989 to 1998, major crop area in Brazil increased by 9 million hectares, virtually all accounted for by an increase in soybean area. A review of Brazilian soybean yields by state produces results that are contrary to the assertion that "yields on newly converted lands are almost always lower than corresponding yields on existing crop lands."

In fact, as shown in Figure 1, the Brazilian states where soybean area expansion has been the greatest over the last two decades have tended to have higher yields than those where less expansion has taken place. In recent years, yields have been highest in Mato Grosso, where soybean area expanded by 3.8 million hectares between 1989 and 2008, an increase of 223%. The second-highest yield in 2008 among states reflected in Figure 1 (the top five states by soybean area) was in Goias, where soybean area has increased by 1.2 million hectares since 1989, or

120%. Both states experienced yields that were higher than the Brazilian average, and yields in Mato Grosso have been consistently above the national average.

Figure 1: Brazilian Soybean Yields by State



Parana is a more traditional soybean-producing state, and its yields have been consistently above the national average. However, there has been considerable expansion in Parana as well, with 1.6 million hectares more planted in 2008 than 1989, an increase of 68%.

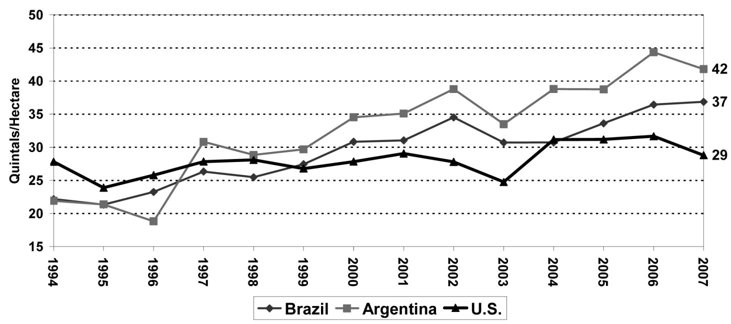
Back in 1989, Rio Grande do Sul was the largest soybean-producing state in Brazil, accounting for 30% of the country's planted area. However, there has been little soybean area expansion in the state, and yields significantly lag the national average and are more variable than in the other major states.

In summary, yields in the "new" soybean states of Mato Grosso, Mato Grosso do Sul and Goias were 31 quintals per hectare (3.1 metric tons per hectare) in 2008, compared to an average 25 quintals per hectare in the more established soybean-growing states of Parana and Rio Grange do Sul. Averaged over the last three years (2006-2008), the yield differential was slightly smaller, with the "new" states averaging 29 quintals per hectare and the established states averaging 25 quintals per hectare.

Looked at another way, the combination of substantial soybean area growth and increasing yields in Brazil and Argentina demonstrate that it is mathematically unlikely that the assignment (based on judgment) of a value of 0.5 to the elasticity of crop yields with respect to area expansion is correct. Given actual national average soybean yields that have occurred in the U.S., Brazil and Argentina since 1994, Figure 2 shows soybean yields that would have had to be achieved on the land on

which soybeans were grown in 1994, if the yield elasticity for new land were 0.5. By 2007, the yield on existing land would need to have been 42 quintals per hectare (62 bushels per acre) in Argentina and 37 quintals per hectare (55 bu/ac) in Brazil, which is far higher than the 29 quintal-per-hectare (43 bu/ac) yield implied for existing land in the U.S. It is also roughly double the 22 quintal-per-hectare (33 bu/ac) yield that occurred on the same land in Brazil in Argentina in 1994. Actual national average yields in 2007 were roughly 28 quintals per hectare (42 bu/ac) in all three countries in 2007 (across all area planted).

Figure 2: Implied Soybean Yields on Previously Existing Land, Assuming an Area Expansion Elasticity of 0.5



In conclusion, regarding the elasticity of crop yields with respect to area expansion, the given the findings provided above, it cannot be determined that yields on new area have been meaningfully different than yields on area previously planted to crops (i.e., that the elasticity is less than 1). It appears that "judgment" was used to set the value for the elasticity parameter at an unrealistically low level; ARB should correct this by obtaining empirical data regarding actual yields on existing crop land versus newly planted land.

3. It is likely problematic that the GTAP model takes cross-commodity effects into account, but the subsequent adjustment outside the model does not. In a manner related to the previous two comments, the assumptions (stated or implicit) in Appendices C5 and C10 that all yield increases have been similar, which allows an adjustment to be made outside the model rather than having all acreage allocation and impact estimates made inside the model, are problematic. In particular, the extent to which corn versus soybean area is assumed to increase in the ROW in response to a shock to U.S. corn demand is important. On average over the last three years, U.S. corn yields have been approximately 2.55 times ROW corn yields, whereas U.S. soybean yields have been a lesser 1.25 times ROW soybean yields (i.e., half the magnitude of the corn differential). Thus, if corn area increases in the

U.S. at the expense of soybean acres, and additional soybean acres in the ROW are needed to make up for a loss of U.S. soybean acres, the land-use impact will be less than if corn were to account for a large share of the ROW area change. Given the comments above regarding the elasticities discussed in Appendix C5, it is not clear that the model "handled" this issue appropriately.

Appendix D

Report by NERA:

Accounting for Differences in the Timing of Emissions in Calculating Carbon Intensity for the California Low Carbon Fuels Standard

April 2009

Accounting for Differences in the Timing of Emissions in Calculating Carbon Intensity for the California Low Carbon Fuels Standard

Prepared for the
Renewable Fuels Association

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Executive Summary

The California Air Resources Board (CARB) has proposed regulations to implement a Low Carbon Fuels Standard (LCFS). In developing the LCFS, CARB must consider indirect emissions (in this case, increases in emissions due to land use changes) as well as direct emissions associated with different fuels. One of the issues addressed by CARB staff in the Initial Statement of Reasons (ISOR) is how to account for the fact that the emission profiles of the various fuels differ widely over time. In particular, the CARB staff estimates that land use changes associated with increased use of corn-based ethanol would generate substantial indirect CO_2 emissions in the early years of a project. In contrast, the reductions in direct emissions due to the use of ethanol rather than gasoline would be spread relatively evenly over many years. What formula is used to aggregate these various streams across time has a major effect on the potential credits given to corn-based ethanol as a substitute for gasoline in meeting a LCFS.

A. CARB Considers Four Alternative Timing Approaches in the Initial Statement of Reasons

In the ISOR, the CARB staff reviews four different methods for comparing uneven streams of emissions over time:

1. The *Annualized* method averages emissions over the life of the project and compares those averages.

2. The *Net Present Value* (NPV) method compares the present value of discounted emissions.

3. The *Fuel Warming Potential* (FWP) projects the impacts of emissions on the stock of CO_2 in the atmosphere over a fixed Impact Horizon and sums those impacts for comparison.

4. *The Economic Fuel Warming Potential* (FWPe) uses the same projections as the FWP, but discounts the stock impacts.

Note that the Annualized method is a special case of the NPV method with a discount rate of zero. Similarly, the FWP method is a special case of the FWPe method, again with a discount rate of zero.

These methods vary significantly in the relative weights they give CO_2 emissions in different years. The Annualized method weights emissions equally for all years in which they occur. At the other extreme, the FWPe gives relatively little weight to emissions in later years both because it discounts their impacts on the stock of CO_2 and because it tracks those emissions' effects on the atmospheric stock for fewer years, as we discuss below.

B. The Two Fuel Warming Potential Approaches are Arbitrary and Should Not be Used to Compute Carbon Intensity for Land Use Changes

The two FWP and FWPe methods, while claiming to provide a proxy measure of relative damages, in fact reflect an arbitrary choice of a fixed Impact Horizon over which effects are evaluated. This fixed Impact Horizon leads to calculating the effects of emissions in later years over fewer years, thus arbitrarily decreasing the relative importance of later-year emissions. With a 30-year Impact Horizon, for example, the atmospheric impacts of a unit emitted in year 1 are tracked over the full 30 years. However, a unit emitted in year 30 is tracked over only 1 year.

This truncation of the analysis for emissions in later years gives undue weight to emissions in the early years, when those for corn-based ethanol are greatest. We show that eliminating this differential truncation, so that the atmospheric effects of all emissions are tracked for the same length of time from the time they are emitted, makes the FWP equivalent to the Annualized method and the FWPe equivalent to the NPV approach. This equivalence holds true regardless of the length of time over which emissions are tracked following their release. In light of the arbitrary nature of the Impact Horizon and its uneven impacts, we recommend that CARB not rely on either of the two FWP approaches.

C. Calculations of Carbon Intensity Should Account for the Expectation that the Social Cost of Carbon Will Increase over Time

Discounting is normally applied to monetary measures of costs and benefits. If it is to be applied to emissions or other physical measures, it is not appropriate to apply the same discount rate used for dollars unless the dollar value per unit of the physical measure is constant over time. In the case of CO_2 emissions, there is a wide consensus among researchers who have studied the issue that the "Social Cost of Carbon" (SCC) is growing over time. This growth reflects several different factors, including growth in populations and income and rising atmospheric concentrations of CO_2 and other greenhouse gases. An IPCC report published in 2007, after reviewing the literature, concluded that "current knowledge suggests a 2.4 percent rate of growth."

In practice, adjusting for value means that whatever discount rate CARB finds is appropriate for monetary measures should be reduced by the estimated growth rate of the SCC. The ISOR provides estimates of carbon intensity using discount rates of 2 percent and 3 percent. Using the IPCC estimate of 2.4 percent, if the monetary discount rate is 2 percent, for example, the discount rate that should be applied is -0.4; i.e., later emissions should receive *more* weight than early emissions because of the greater damage they cause. If the monetary discount rate is 3 percent, the discount rate applied to emissions should be only 0.6 percent.

D. Illustrative Comparisons of Impacts of Alternative Methods on the Estimated Carbon Intensity of Land-Use Changes

For illustrative purposes, we use the various time-accounting methods to compute alternative estimates of ethanol's indirect emissions—the "Land Use Change Carbon Intensity" (LUC CI) for corn-based ethanol—using the ISOR's estimated profile of the LUC emissions. For each of three different general methods we computed the LUC CI's for discount rates in the range 0 to 3 percent—the range that bounds the values provided in the ISOR—as shown in Table E-1:

1. The "Annualized/NPV" method corresponds to the ISOR's Annualized method for a discount rate of 0 and to its NPV method for positive discount rates.

2. The Value-Adjusted method adjusts the discount rate to reflect a 2.4 percent annual growth in the SCC.

3. The FWP(e)-30 method corresponds to the ISOR's FWP method for a discount rate of 0 percent and to its FWPe method for positive discount rates with an Impact Horizon of 30 years.

For any given discount rate, the FWP(e) methods gives the highest estimates and the Value-Adjusted method the lowest.

Table E-1. LUC CIs with Alternative Methods for Accounting for Emission Timing (CO2e/MJ)

Discount Rate	Annualized/NPV	Value-Adjusted	FWP(e)-30
0%	29.9	22.9	47.5
1%	33.3	25.7	49.8
2%	36.9	28.7	52.2
3%	40.7	31.9	54.7

Note: Assumes 30-year project horizon and SCC growth of 2.4 percent for Value-Adjusted method. Annualized/NPV values are ISOR's Annualized Method for r=0 and its NPV method for r>0. FWP(e)-30 values are the FWP method for r=0 and FWPe for r>0, assuming 30-year Impact Horizon
Source: NERA calculations based on CARB (2009) and O'Hare et al. 2009.

Note that the Value-Adjusted approach yields values of 28.7 and 31.0 for discount rates of 2 and 3 percent, respectively. These values are similar to the value of 29.9 achieved using the Annualized/NPV approach with a discount rate of 0 (i.e., no discounting), the approach apparently preferred by CARB staff.

I. Introduction and Overview

The California Air Resources Board (CARB) has proposed regulations to implement a Low Carbon Fuel Standard (LCFS) pursuant to Executive Order S-01-07 and Assembly Bill 32 (AB 32). In developing the LCFS, CARB is required to consider indirect as well as direct emissions associated with different fuels. Estimating the direct and indirect emissions of different fuels is a complex task that depends on numerous assumptions and assessments. The task is made more complicated by the fact that calculating the carbon intensity of various fuels involves comparing emissions profiles that differ in their timing. In this paper we focus on how emission profiles that vary over time can be aggregated to allow meaningful comparisons across fuels.

A. CARB's Estimated Profiles and Aggregation Methods

CARB staff has produced an Initial Statement of Reasons (ISOR) that provides an overview of the regulations and their implementation as well as analyses in support of the proposed rule. A principal component of the ISOR is an analysis of the Carbon Intensity (CI) of "alternative fuel pathways" that might be used in order to comply with the rule. These calculated CI values have implications for the level of credit that will be granted for use of the alternative fuel pathways under the rule, and ultimately how long a given alternative fuel pathway will remain a viable compliance option. For crop-based biofuels, calculations reported in the ISOR include the impact of indirect emissions, based on projections of increased land clearing and conversion (and the consequent release of CO_2 emissions) resulting from increased demand for ethanol. The ISOR refers to these indirect emissions from land clearing as Land Use Change (LUC) emissions.

These emissions have a very different temporal pattern than the reductions in direct emissions from substituting ethanol for gasoline. As estimated by CARB staff, the indirect emissions tend to be significant in early years and gradually fall to zero over about 20 years. In contrast, the direct emissions benefits per unit of fuel are smaller but constant over time. As a result, the calculation of carbon intensity requires a method for comparing emission streams that differ over time.

For any given profile of indirect emissions over time, the ISOR presents four different methods of calculating the indirect CI for comparison with the direct reductions in emissions achieved compared to gasoline:

1. *Annualize*. This approach averages emissions over the project life. It is the CARB staff's currently preferred approach.
2. *NPV* ("net present value"). This approach compares the discounted sums of emissions.
3. *FWP* ("Fuel Warming Potential"). This approach projects how emissions will influence the abundance of CO_2 in the atmosphere over time, based on the Bern model of the carbon cycle. It then sums those values over an "Impact Horizon."
4. *FWPe* ("economic FWP"). This approach uses the projections made with the FWP, but instead of summing the contributions to CO_2 in the atmosphere, it computes their discounted values.

B. Project Objectives and Organization of the Report

The objective of this project is to compare alternative methods for accounting for the different timing of indirect and direct emissions. The remainder of this report is organized into three major sections:

- Section II provides an overview of the methods presented in the ISOR for aggregating emissions over time and shows graphically the implicit weights they give to emissions in different years. It also shows how the FWP methods give disproportionate weight to earlier emissions because they account for their atmospheric impacts over more years than they do for later years. Correcting that imbalance makes the FWP method equivalent to the Annualized method and the FWPe method equivalent to the NPV method.

- Section III shows how taking account of the wide consensus that the marginal damages caused by CO_2 emissions (the "Social Cost of Carbon) will continue to increase for many decades affects the relative weights given to different years. For any given monetary discount rate (including zero), the appropriate discount rate for emissions is reduced substantially and in some cases even becomes negative, increasing the relative weight given to emissions in later years.

- Section IV use the methods developed in the previous two sections to compute alternative estimates of the Land Use Change Carbon Intensity (LUC CI) for corn-based ethanol based on the CARB staff's estimated emissions profile using "representative" parameter values. It also offers brief concluding remarks.

II. Overview of the CARB Staff Analysis

This section provides an overview of the CARB analyses of timing considerations in calculating carbon intensity. We begin by presenting the CARB staff's estimated time profile of emissions from land use changes. Then we explain in more detail the alternative methods for aggregating emissions over time that the ISOR presents.

A. Summary of Indirect Emissions Analysis

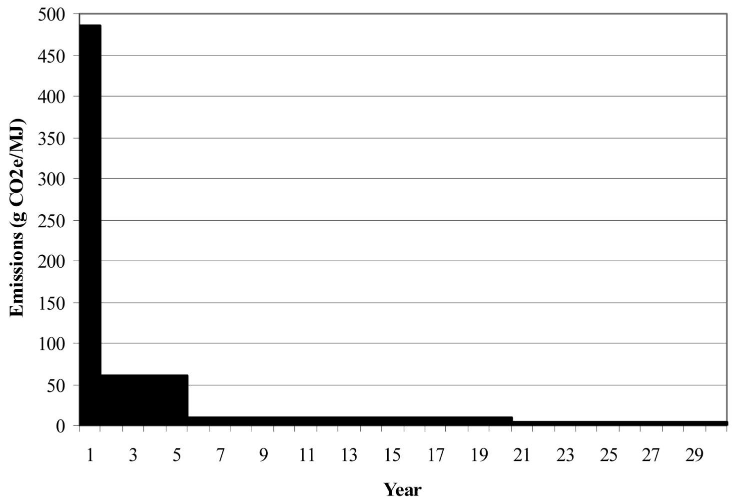
CARB staff use life-cycle analysis to estimate the CI of ethanol and other fuel pathways that might be used under the LCFS. Complete life-cycle analysis requires the development of carbon intensity estimates for both "direct" emissions (resulting from fuel production, transport, storage, and use) and "indirect" emissions (resulting from market interactions associated with changes in fuel demand). CARB staff has developed estimates of indirect emissions only for land use changes for crop-based biofuels, asserting that this is the "one indirect effect that generates significant quantities of GHGs" (p. IV-17). We focus only on CARB staff's assessment of indirect emissions from corn-based ethanol. CARB staff used a computable general equilibrium (CGE) model to estimate the amount and types of land that would be converted as a result of increased ethanol demand, and then estimated the CO_2 emissions that would result.

The profile of emissions from land use changes depends heavily on a large number of assumptions. Because our focus is on alternative methods for weighting emissions over time, not the emissions themselves, we rely on the CARB staff's "representative" emissions profile from land-use changes that may be associated with corn-based ethanol. We understand, however, that the profile is subject to substantial uncertainty and is very sensitive to various assumptions, in particular how much land would be converted per unit of ethanol and the type of land converted.

As shown in Figure 1, the CARB staff's "representative" emission profile has the following characteristics:

- a large initial flux in emissions due to the release of carbon from vegetation cleared from the land and assumed to be burned or left to decay;
- release of carbon sequestered in the soil, with relatively high emissions over the first five years and then a lower rate of emissions over the next 15 years; and
- forgone sequestration occurring over the entire Project Horizon (the period from initial production until corn-based ethanol is assumed to be displaced by other biofuels become more cost-effective).

Throughout this report we refer to "gasoline" and "corn-based ethanol," but the same metrics apply to diesel and other fossil motor fuels and to other biofuels.



Note: Emissions are in gCO2e/MJ
Source: CARB 2009

Figure 1. CARB's Estimates of CO_2 Emissions from Land-Use Changes Associated with the Production of Corn-Based Ethanol

B. Aggregating Emissions Over Time

Because the time profile of indirect emissions is different than that for direct emissions, it is necessary to find a way of aggregating emissions over time so that the different streams associated with different fuels can be compared meaningfully in terms of their CIs. As noted above, the ISOR presents four different methods of aggregation. Application of each accounting method requires the choice of a "Project Horizon." The Project Horizon represents the number of years over which the analyst expects the production of the corn-based ethanol to continue. CARB staff argues that corn-based ethanol will not be competitive with other biofuels in the

long run because of relative costs and direct emissions. The ISOR considers project horizons of 20 and 30 years, with 30 years as the preferred horizon. As discussed above, the ISOR examines four different aggregation methods: (1) Annualized (averaged emissions), (2) NPV (discounted emissions); (3) FWP (carbon-cycle model); and (4) FWPe (FWP with discounting).

In addition to the Project Horizon, the two FWP methods require specifying an Impact Horizon, which is the period of time over which the global warming impacts of ethanol and the gasoline reference fuel are aggregated for comparison. The ISOR evaluates Impact Horizons ranging from 10 to 100 years, but focuses on results from 30 and 50 years. It does not make sense to use an Impact Horizon that is shorter than the Project Horizon and in general the impact horizon should extend well beyond the project horizon in light of the long residence of CO_2 in the atmosphere. The two methods that involve discounting (NPV and FWPe) require specifying a discount rate.

We now discuss the four methods in detail. We focus on the relative weight that each method gives to emissions in different years (w_t = emissions in year t), where the first year's weight is defined as $w_1 = 1.0$.

1. Annualized Method

The Annualized method simply averages LUC emissions over the Project Horizon; i.e., it takes the sum of the indirect emissions and divides them by the length of the Project Horizon. Thus, emissions in all years receive equal weight for any given Project Horizon; $w_t = 1$ for all t. However, annualized indirect emissions fall as the Project Horizon increases and the relatively high early indirect emissions are spread over more years.

2. Net Present Value of Emissions

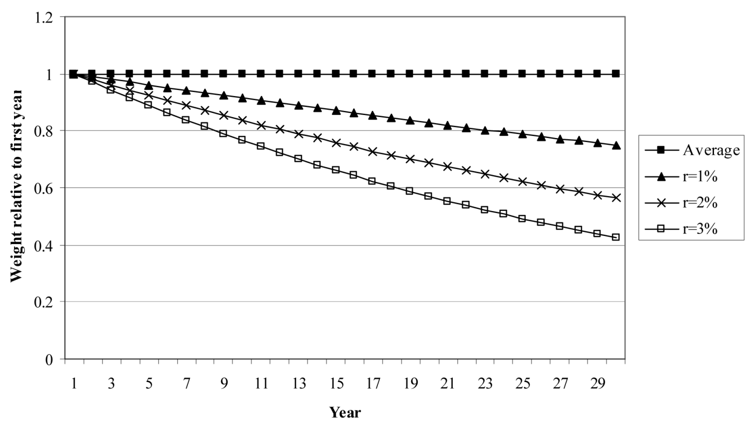
Taking the NPV of emissions assigns declining weights to emissions the farther in the future they occur. The relative weight for emissions in year t is simply $w_t = (1+r)^{-(t-1)}$, where r is the discount rate. Thus, the early sequestration losses assumed from land-use changes get more weight than the net emission reductions achieved in later years. The emissions in year 1, when CARB assumes land would be cleared, receive a weight of 1.0. At the 2 percent discount rate used by CARB in the main body of the ISOR, however, emissions in year 20 receive a relative weight of only 0.69 and those in year 30 receive a weight of 0.56. Thus, to offset each ton of emissions released in year 1, with a discount rate of 2 percent, emissions in year 20 would have to fall by more than 1.4 tons or emissions in year 30 would have to fall by almost 1.8 tons. Higher discount rates would lead to much more rapidly declining weights. With a rate of 3 percent, the discount rate used in Appendix C-4 of the ISOR for illustrative purposes, the weight for year 20 falls to 0.57 and that for year 30 falls to 0.42. The NPV approach also is sensitive to the project horizon, though less so than the averaging method. As with the averaging method, however, it does not vary with the Impact Horizon.[1]

The NPV approach is equivalent to annualizing LUC emissions with a positive interest rate. To calculate the annualized value of an uneven stream, one first takes the NPV of that stream. The annualized value is then the level stream over a specified number of years that yields the NPV of the original uneven stream. Mortgage payments are calculated in this way; monthly payments are set so that their NPV (discounted at the mortgage's interest rate) over the life of the loan is equal to the amount borrowed. If the annualized value is calculated using a discount rate

[1] The NPV approach would vary with the impact horizon only for impact horizons shorter than the project horizon, which, as we noted earlier, generally would not make sense.

of zero, it is the same as the CARB staff's "Annualized" approach, which is a simple average. For positive discount rates, however, the annualized value will be larger than the simple average.

Figure 2 plots the relative weights for the Annualized and the NPV methods, showing values for the NPV for discount rates of 1 and 3 percent in addition to the 2 percent rate used in the ISOR.



Source: NERA Calculations based on CARB (2009).

Figure 2. Relative Weights Given Emissions in Different Years: Averaging and NPV Methods

3. Fuel Warming Potential

The FWP measure, developed by O'Hare et al. (2009) and presented in the ISOR, is substantially more complicated to compute. For a unit of CO_2 emitted in a given year, this model uses the Bern carbon-cycle model to project how much CO_2 will remain in the atmospheric stock over time; the farther one goes into the future from the year in which the emission occurred, the smaller the fraction of the original emission that remains in the atmosphere. The Bern model in

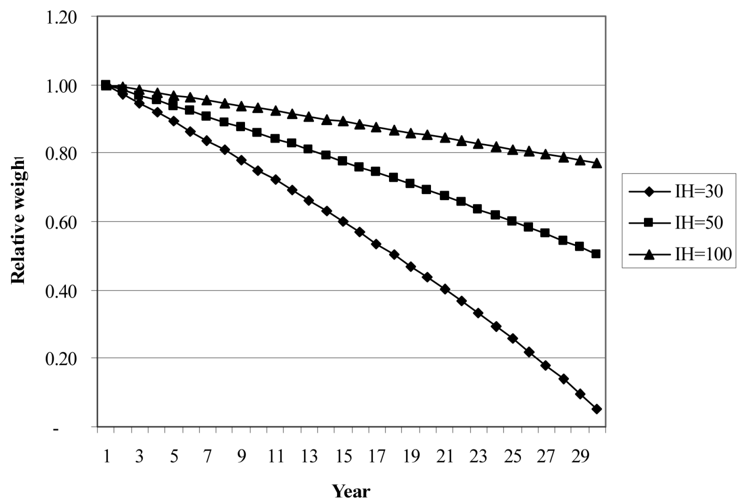
essence yields a decay function, D(i), which is the fraction of a unit of CO_2 remaining in the atmosphere i years after the unit is emitted. The FWP method totals the projected stock impacts from the year in which the emission occurs to the end of the Impact Horizon (H_I). We can then compute the relative weight for a given year by dividing the sum for that year by the sum for the first year:

$$w_t = \frac{\sum_{i=t}^{H_I} D(i-t+1)}{\sum_{i=1}^{H_I} D(i)}. \qquad \textbf{(1)}$$

This expression may be rewritten in the following form:

$$w_t = \frac{\sum_{i=1}^{H_I-t+1} D(i)}{\sum_{i=1}^{H_I} D(i)}. \qquad \textbf{(2)}$$

Note that because the FWP uses a fixed impact horizon, the impacts of later emissions are summed over fewer years. For example, consider Project and Impact horizons that are both equal to 30 years. For emissions that occur in the first year, their impact will be summed over the full 30 years of the Impact Horizon. For emissions that occur in year 30, however, their impact will be summed over only one year. Thus, later tons get less weight than early ones, with especially rapid fall-off as the year of the emission approaches the Impact Horizon. The relative weights are highly sensitive to the Impact Horizon, as shown in Figure 4, which plots the relative weights given to emissions in different years for alternative Impact Horizons ranging from 30 to 100 years and a Project Horizon of 30 years. The shorter the Impact Horizon, the less relative weight emissions in later years receive. As the Impact Horizon grows longer, all of the weights approach 1.0; with an infinite impact horizon, the FWP would be the same as the averaging method.



Source: NERA calculations based on CARB (2009).

Figure 3. Relative Weights under FWP Measure with Alternative Impact Horizons

4. "Economic" Fuel Warming Potential

Appendix C of the ISOR also presents a measure that it calls the "Economic Fuel Warming Potential," which it abbreviates as FWPe. It is simply the FWP with contributions discounted back to a common starting year:

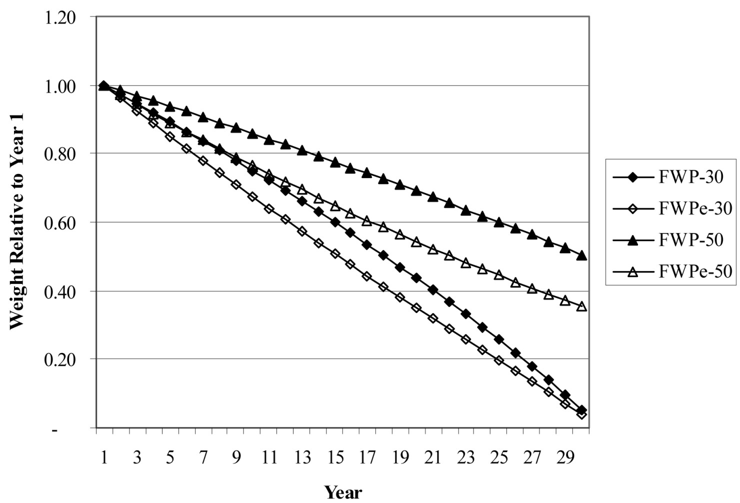
$$w_t = \frac{\sum_{i=t}^{H_I} D(i-t+1)(1+r)^{-i}}{\sum_{i=1}^{H_I} D(i)(1+r)^{-i}} = (1+r)^{-(t-1)} \frac{\sum_{i=1}^{H_I-t+1} D(i)(1+r)^{-i}}{\sum_{i=1}^{H_I} D(i)(1+r)^{-i}}. \qquad \textbf{(3)}$$

On the right-hand side, the term $(1+r)^{-(t-1)}$ is the discount factor reflecting the fact that a unit emitted in year t does not start affecting atmospheric concentrations until t-1 years after a unit

emitted in year 1 does. The ratio of the sums is similar to the ratio with the FWP, but with discounting applied.

With the FWPe approach, emissions in later years receive less weight relative to those in early years both because their implicit impacts are summed over fewer years (as with the FWP) and because they are discounted more heavily. As with the pure FWP, the FWPe is sensitive to the Impact Horizon, although the effect of the Impact Horizon is smaller on a proportional basis than with the FWP.[2] Figure 4 compares the weights assigned by the FWP and FWPe (with a discount rate of 2 percent) approaches for two different Impact Horizons, 30 and 50 years. The longer the Impact Horizon, the more slowly the weights decline over time. Conversely, the higher the discount rate, the more rapidly they decline. As we show in Appendix A, for any given discount rate, the longer the impact horizon, the closer the weights come to those obtained with the NPV method; in the limit, as the impact horizon approaches infinity, the FWP method approaches the Annualized method and the FWPe approaches the NPV method.

[2] That is because the H_I -t+1 extra years counted for year 1 but not year t are discounted and thus receive less weight.



Note: FWPe weights reflect a 2 percent discount rate.
"-n" in legend means an Impact Horizon of n years.
Source: NERA computations based on methods in O'Hare et al. (2009)

Figure 4. Comparison of Relative Weights for FWP and for FWPe with Impact Horizons of 30 and 50 Years and a Discount Rate of 2 Percent for FWPe

C. Modified Fuel Warming Potential and "Economic" Fuel Warming Potential

As discussed above, the FWP and FWPe give lesser weight to emissions in later years simply because those methods evaluate the effects of those emissions in the atmosphere for fewer years. Here we consider a modified version of the FWP(e), one that does not require using a very long Impact Horizon. We propose that instead of using a fixed Impact Horizon, the number of years over which emissions are evaluated after they occur should be constant, to avoid uneven truncation effects. We call this period the Evaluation Horizon. That is, if the evaluation

horizon is 25 years, impacts of year 1 emissions are tracked (using the Bern equation) over 25 years, from year 1 through year 25 and the impacts of year 21 emissions also are tracked over 25 years, from year 21 through year 45. Similarly, if the Evaluation Horizon is 100 years, year 1 emissions are tracked over years 1-100 and year 21 emissions are tracked over years 21-120.

If one evaluates the FWP in this way, using a consistent evaluation period after a given emission occurs, it turns out that the length of the evaluation horizon does not affect the relative weights given emissions in different years; i.e., it does not matter whether one follows emissions in the atmosphere for 1 year after they are emitted or for 1000 years, so long as the Evaluation Horizon is the same for emissions in all years. Appendix A provides a formal proof of this fact.

With the modified FWP, all years receive equal weight: $w_t = 1$ for all t. Thus, if the FWP is modified to evaluate each unit of emissions for the same number of years following its release, the FWP is no different than the Annualized approach. Similarly, if one modifies the FWP_e in the same manner, applying a uniform Evaluation Horizon after emissions occur, it yields the same weights as the NPV method, regardless of how long the Evaluation Horizon is. Thus, although the FWP and FWPe approaches may *appear* to be more sophisticated approaches than their emission-based counterparts, in fact they are no different once one equalizes the times over which the impacts of emissions are tracked after they occur. The temporal patterns of weights given by the original FWP and FWPe approaches are distorted by the uneven evaluation periods applied to emissions in different years because of an arbitrarily chosen Impact Horizon.

III. Accounting for Changing Marginal Damages

The methods presented in the previous section implicitly assume that the marginal value of controlling a unit of emissions is constant over time; i.e., they assume a ton emitted in 2029 causes the same marginal climate change damage as a ton emitted today, when those damages are valued at the time of the emissions. Discounting emissions accounts for the fact that we value a dollar received today more than one received in 20 years. However, as O'Hare et al. (2009) point out, discounting emissions (or other physical measures) using an economic discount rate intended for monetized costs and benefits is not appropriate if the dollar value of emissions is changing. In this section we analyze the impact on relative weights of accounting for projected changes in the marginal damages caused by emissions at different times. Although there is considerable uncertainty about the dollar value of damages caused by CO_2 emissions, commonly called the Social Cost of Carbon (SCC), there is a broad consensus in the literature that the SCC is growing and that the growth rate is significant relative to the discount rates commonly applied to long-term effects of climate change. As a result, taking account of these changes in the value of controlling a ton of CO_2 emissions can have a substantial effect on weights given to emissions over time.

A. Social Cost of Carbon is Likely to Rise over Time

Estimating the marginal damages caused by a ton of emissions in any year is a difficult task subject to many uncertainties. Integrated assessment modeling studies, however, have consistently found that the SCC will rise over time for decades to come. These models take account of the residence time of carbon in the atmosphere, as the FWP and FWPe do, but they also account for the fact that the underlying atmospheric concentrations to which emissions contribute at the margin will change, thus affecting marginal impacts on climate change, and that

the impacts of climate change will vary over time with changes in population, income, and other factors.

The SCC in year *t* is the present value of the stream of marginal damages caused by a ton of emissions in that year during the period it resides in the atmosphere. This SCC reflects many factors: how that ton of emissions will affect the atmospheric stock of GHGs in subsequent years, how those changes in the stock will translate into changes in climate, and finally the marginal damages caused by those changes in climate. Finally, the present value in year *t* of that stream of marginal damages resulting from a ton of emissions must be computed. That present value represents the SCC for year *t*.

There are several reasons why one would expect the SCC to increase over time. First, even with substantial cuts in emissions—especially if they are limited to a subset of developed nations—the atmospheric concentration is likely to continue to grow for many decades, if not a century or more, before a steady-state concentration is reached.[3] This will be the case regardless of what LCFS regulation CARB imposes. Second, within broad limits, the later a ton is emitted, the more it will contribute to higher concentrations because a smaller fraction will have been removed from the atmosphere. Third marginal damages from climate change are likely to increase with the level of climate change. Fourth, marginal damages are likely to increase over time due to growth in population and income (Pearce 2003). As population increases, more individuals are exposed to any negative ecological, health, or economic effects associated with climate change. Similarly, as average worldwide incomes increase, the costs associated with economic disruptions become larger. Thus, it seems likely that the SCC will increase for many decades, well beyond the project horizons assumed in the analyses presented in the ISOR.

3 See, for example, Webster et al. (2003).

B. Estimates of the Social Cost of Carbon from the Literature

Numerous studies report estimates of the SCC, but relatively few address the rate at which the SCC will grow over time. In addition, to the extent to which studies report an expected growth rate over time (or point estimates of the SCC in multiple years), the varied assumptions and methodologies used in different studies make it challenging to reconcile estimates made by different groups. Studies vary in the emissions scenarios assumed (generally either business as usual or optimal control of emissions), the time horizon evaluated, the discount rate, whether equity weights are used (which give greater weight to impacts in less-developed regions), and the scope of damages considered, among other factors.

For all of their differences, however, those studies that have estimated the SCC for different years consistently have produced estimates of the SCC that increase over time. Clarkson and Deyes (2002) provide a survey of studies that develop point estimates for the SCC, including five that estimate the SCC in multiple time periods and find that it increases over time.[4] Pearce (2003) builds upon the research in Clarkson and Deyes, focusing on estimates developed without equity weights and incorporating three additional studies that also find that point estimates of the SCC increase over time.[5] Finally, the Final Report of the UK Government's *Social Costs of Carbon Review* (Watkiss et al. 2006) commissioned additional analyses of the SCC over time using two different integrated assessment models, and likewise

[4] The time periods range from 1991-2000 to 2021-2030. The relevant studies are Cline (1992), Maddison (1994), Nordhaus (1994), Fankhauser (1995), and Tol (1999).

[5] Pearce considers the same time periods and many of the same studies as Clarkson and Deyes. The additional studies considered include Peck and Teisberg (1992), Roughgarden and Schneider (1999) and Nordhaus and Boyer (2000).

finds that the SCC increases over time, though the rate at which this occurs varies over time and between models.[6]

In interpreting the wide range of findings outlined above, the IPCC Fourth Assessment Report notes that "current knowledge suggests a 2.4% rate of growth." (Yohe et al. 2007, p. 822). We use this number for illustrative purposes.

C. Applying the Growth Rate of the Social Cost of Carbon

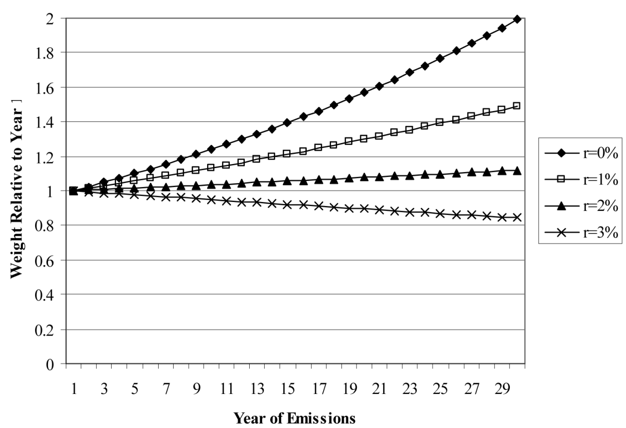
Discounting normally is applied to monetized costs and benefits (or damages), and it is not appropriate to apply a monetary discount rate to physical quantities unless the economic marginal value of the physical measure remains the same over time. If the marginal value of the physical unit is growing at a constant rate over time, however, there is a simple relationship between the financial discount rate and the rate that should be applied to the underlying physical measure.

Let SCC_t be the marginal damages from a unit emitted in year t, reflecting the discounted sum of its damages over its residence in the atmosphere. The present value of one unit of emissions in year t is then $SCC_t/(1+r)^t$. If SCC_t is growing at the rate s, then we can rewrite its present value as $SCC_0 \cdot (1+s)^t/(1+r)^t$, or $SCC_0[(1+s)/(1+r)]^t$. In computing relative weights for different years, the SCC_0 term drops out because it appears in all years; i.e., in developing relative weights, the absolute value of SCC_0 is not needed. The weight given to a unit emitted in year t relative to a unit emitted in year 0 is $[(1+s)/(1+r)]^t$. We obtain the same result if we use a discount rate for emissions that is equal to $(r-s)/(1+s)$, which is approximately the same as $r-s$ for small values of s. Thus, for example, if the monetary discount rate is 3 percent and the growth rate of the SCC is s = 2.4 percent, the equivalent discount rate for emissions is about 0.6

[6] The analyses commissioned by the UK DEFRA evaluate SCC estimates over a time horizon of 60 years.

percent.[7] If the monetary discount rate is 2 percent, the rate used in the ISOR, the equivalent discount rate for emissions is -0.4 percent; i.e., later emissions receive *more* weight than current emissions because the SCC is rising faster than the discount rate.

Figure 5 plots relative weights for a range of monetary discount rates assuming 2.4 percent annual growth in the SCC. If the growth rate exceeds the discount rate, the weights rise over time. If the discount rate exceeds the growth rate of the SCC, the weights fall with time, but at a significantly slower rate than if the growth in the SCC was not incorporated in the calculation.



Note: Assumes that the SCC is growing at 2.4% per year, so the effective discount rate applied to emissions is (r-2.4%)/(1.024).
Source: NERA calculations

Figure 5. Relative Weights for Value-Adjusted Emissions and Alternative Monetary Discount Rates

[7] More precisely, it is $(r-s)/(1+s)$, or (0.03-0.024)/(1.024) = 5.86 percent for r=3 percent and s=2.4 percent.

IV. Illustrative Comparisons of Land Use Change Carbon Intensity Values and Concluding Comments

In this section we compute LUC CIs based on the CARB staff "representative" LUC emissions using the alternative methods of accounting for the timing of emissions discussed in Sections II and III. We also offer some brief concluding remarks.

A. Comparison of Land Use Change Carbon Intensity Values Using CARB Staff's Emission Estimates and Different Methods for Accounting for the Timing of Emissions

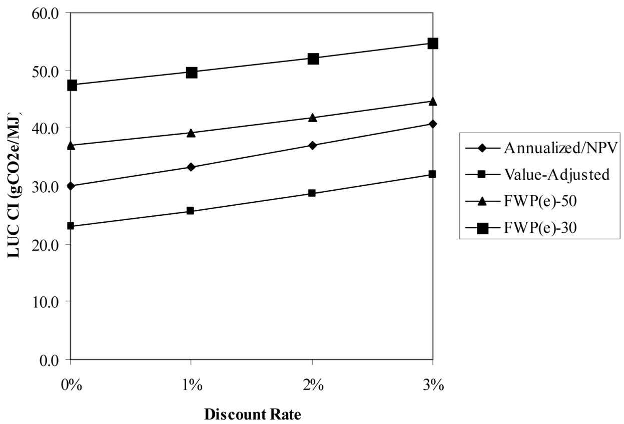
In computing the LUC CIs for the CARB staff's LUC emission estimates, we consider three general methods of accounting for the timing of emissions:

1. Annualized/NPV: Weights based on the discounted sum of emissions. This is the ISOR's Annualized method for r=0 percent and its NPV method for r>0 percent.

2. FWP(e): Weights based on FWP method (when r=0 percent) or FWPe method (when r>0 percent). We consider two Impact Horizons, 30 (FWP(e)-30) and 50 (FWP(e)-50) years.

3. Value-adjusted method: Weights based on discounted sums of emissions with discount rate adjusted for growth rate of SCC (2.4 percent for illustrative purposes).

Figure 6 plots the results, varying the discount rate over the range considered in the ISOR, from 0 to 3 percent. As the figure shows, for any given discount rate, the FWPe yields the highest LUC CI and the Value-adjusted method yields the lowest value. The emissions-only method yields intermediate values. For any given method, the LUC CI is lowest with a discount rate of zero and rises as the discount rate increases. The FWP(e) values are substantially higher with a shorter Impact Horizon.



Note: Assumes 30-year project horizon and SCC growth of 2.4% for Value-Adjusted method.
Annualized/NPV line is ISOR's Annualized Method for r=0 and its NPV method for r>0.
FWP(e) lines are FWP method for r=0 and FWPe for r>0.
Line labeled FWP(e)-50 assumes a 50-year impact horizon and FWP(e)-30 assumes a 30-year impact horizon

Source: NERA calculations based on CARB (2009) and O'Hare et al. 2009.

Figure 6. Impact of Discount Rate on Alternative Methods of Computing LUC CI

Table 1 reports the same information as Figure 6, but in tabular form.

Table 1. LUC CIs with Alternative Methods for Accounting for Emission Timing

Discount Rate	Annualized/NPV	Value-Adjusted	FWP(e)-50	FWP(e)-30
0%	29.9	22.9	37.0	47.5
1%	33.3	25.7	39.3	49.8
2%	36.9	28.7	41.8	52.2
3%	40.7	31.9	44.7	54.7

Note: Assumes 30-year project horizon and SCC growth of 2.4% for Value-Adjusted method.
Annualized/NPV line is ISOR's Annualized Method for r=0 and its NPV method for r>0.
FWP(e) lines are FWP method for r=0 and FWPe for r>0.
FWP(e)-50 assumes a 50-year impact horizon and FWP(e)-30 assumes a 30-year impact horizon

Source: NERA calculations based on CARB (2009) and O'Hare et al. 2009..

B. Concluding Remarks

The method used to aggregate emissions across time can have a large impact on the estimated indirect emissions due to land use changes associated with corn-based ethanol. We recommend that CARB staff reject the use of the FWP and the FWPe methods because they reflect an arbitrary truncation effect. Early emissions can receive dramatically more weight than later ones because their impacts in the atmosphere are tracked and accumulated by the method for more years after they are released. The magnitude of this effect depends on the arbitrarily chosen length of an Impact Horizon. Correcting for the truncation effect with the FWP and FWPe makes them equivalent to the simpler Annualized and NPV approaches, respectively, that are based on emissions.

The Annualized and NPV approaches are superior to the FWP and FWPe, respectively, but like those methods they fail to account for the fact that there is a broad consensus that the marginal damages caused by a ton of CO_2 emissions will grow over time, so that, for example, it will be worth more in 20 years to reduce emissions by a ton in that year than it is worth to control a ton today. This means that in aggregating emissions that occur in different future years, the weights should reflect those higher relative values, as well as whatever discount rate CARB determines is appropriate for monetized benefits.

The practical effect of accounting for changes over time in the SCC is to reduce the monetary discount rate by the growth rate in marginal damages to arrive at a discount rate appropriate for physical emissions. If one uses either of the two discount rates for benefits highlighted in the ISOR (2 or 3 percent) and the growth rate in the SCC suggested in a recent IPPC report (2.4 percent), this approach yields emission discount rates of between -0.6 percent (with r=2 percent) and +0.4 percent (with r=3 percent), bracketing the emission discount rate of

zero implicit in the CARB staff's preferred Annualized or averaging approach. This means that the indirect emissions values for ethanol calculated taking into account increasing marginal damages and the ISOR discount rates of 2 and 3 percent bracket the value obtained using the CARB staff's preferred Annualized (averaging) approach.

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Appendix A. Impact of Constant Evaluation Horizon on FWP(e)

This appendix shows how the FWP(e) approach is affected by the Impact Horizon and how the approach would be modified through use of a common Evaluation Horizon.

A. The FWP(e) Weights and the Impact Horizon

The FWP and FWPe methods defined by CARB have a fixed Impact Horizon. The FWP is simply a special case of the FWPe with a discount rate of zero. Under the FWPe, the weight given emissions in year t relative to year 1 is given by:

$$w_t = \frac{\sum_{i=t}^{H_I} D(i-t+1)(1+r)^{-(i-1)}}{\sum_{i=1}^{H_I} D(i)(1+r)^{-(i-1)}},$$

where D(i) is the fraction of CO_2 remaining in the atmosphere t years after it is emitted and H_I is the Impact Horizon. Note that D(i) depends only on the number of years since an emission occurred, and not when the emission occurred within the Project Horizon. Rearranging terms yields:

$$w_t = (1+r)^{-(t-1)} \frac{\sum_{i=1}^{H_I-t+1} D(i)(1+r)^{-i}}{\sum_{i=1}^{H_I} D(i)(1+r)^{-i}}.$$

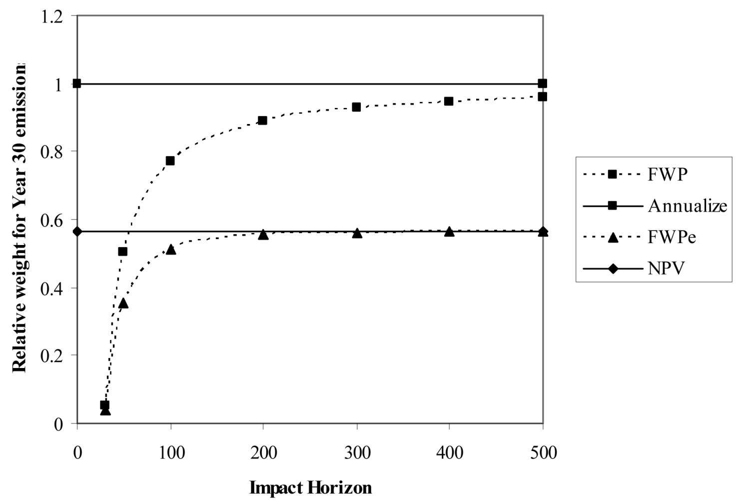
Note that in addition to the discount factor, the two summations in the ratio have the same first ($H_I - t$+1) terms, the numerator lacks the last t terms that are in the denominator. This difference reflects the fact the method tracks the fate of emissions in the atmosphere for a longer time with early emissions than later ones.

To see how w_t changes as the Impact Horizon lengthens, we can rewrite w_t in the following form:

$$w_t = (1+r)^{-(t-1)} \left\{ 1 - (1+r)^{-(H_I - t)} \left[\frac{\sum_{i=1}^{t-1} D(H_I + i - t)(1+r)^{-i}}{\sum_{i=1}^{H_I} D(i)(1+r)^{-i}} \right] \right\}$$

As H_I approaches infinity, the term in square brackets approaches 0, because the number of terms in the summation in the numerator remains constant at t-1, but each terms gets smaller because the t-1 years of atmospheric concentrations not included in the FWPe are increasingly far away from the time of emissions, and hence will have decayed more. In contrast, the sum in the denominator continues to grow with H_I. Moreover, if the discount rate is positive, the ratio shrinks even faster and it is multiplied by a discount factor, $(1+r)^{-(H_I - t)}$, that approaches zero as H_I grows. As a result, as H_I approaches infinity, w_t approaches $(1+r)^{-(t-1)}$, which is the same weight given by the NPV method. If r=0 (i.e., with the FWP), w_t approaches 1 as H_I approaches infinity, the same as the Annualized method.

Figure A-1 compares the relative weights for emissions in year 30 for alternative Impact Horizons. The FWP weight converges slowly to the Annualized weight. With an Impact Horizon of 100 years, it is 77 percent as large as the Annualized weight. With an impact horizon of 500 years, it is 96 percent as large. The FWPe converges more rapidly to the NPV weight as the Impact Horizon lengthens, reaching 91 percent of the NPV value with a horizon of 100 years and 99 percent of the NPV value with a horizon of 200 years or more.



Note: FWPe and NPV weights computed using a discount rate of 2 percent.
Source: NERA calculations

Figure A-1. Weights for Year-30 Emissions with Alternative Impact Horizons

B. Applying a Constant Evaluation Horizon to the FWP(e) Method

If we modify the method to evaluate CO_2 in the atmosphere for a constant number of years (H_E) after they occur, the ratio is:

$$w_t = \frac{\sum_{i=t}^{t+H_E-1} D(i-t+1)(1+r)^{-(i-1)}}{\sum_{i=1}^{H_E} D(i)(1+r)^{-(i-1)}}$$

Rearranging terms yields:

$$w_t = \frac{(1+r)^{-(t-1)} \sum_{i=1}^{H_E} D(i)(1+r)^{-i}}{\sum_{i=1}^{H_E} D(i)(1+r)^{-i}} = (1+r)^{-(t-1)} .$$

Note that this weight does not vary with the length of the Evaluation Horizon (H_E) and that it is the same as the NPV method.

SUBMITTED QUESTIONS

Responses from Joseph Glauber, Ph.D., Chief Economist, U.S. Department of Agriculture

Questions Submitted By Hon. Tim Holden, a Representative in Congress from Pennsylvania

Question 1. Have you discussed who's going to determine questions like whether land was "cleared" prior to passage of EISA (energy bill from 2007)?

Answer. USDA discussed many issues with EPA including analysis, assumptions, land types, record-keeping, where biomass would be produced, and who/what entity should be responsible for validating or verifying that biomass was produced from planted crops and crop residue harvested from agricultural land cleared or cultivated at any time prior to the enactment of the EISA that is either actively managed or fallow, and non-forested. Discussions also included history of land use and potential data available to verify management and usage.

Question 2. Are you familiar with the recent International Energy Agency report? Do you concur with their assessment that "As governments around the world try to establish the greenhouse gas emission benefits of various biofuels, the use of methodologies such as default emission factors could lead to a significant underestimation of the benefits unless the factors are updated on a frequent basis."?

Answer. I am not sure to which report of the International Energy Agency (IEA) that you refer; however, I do agree with the statement that it will be necessary to update greenhouse gas (GHG) emission factors as new information becomes available. Updating the models with more precise information will increase the ability of the models to accurately estimate the effects of expanding biofuels production on GHG emissions. I have no basis to conclude whether such updates will increase or reduce the estimates of GHG emissions from biofuels.

Question 3. The estimates for the indirect emissions as measured by the Searchinger study and the Global Trade and Analysis Project (GTAP) are vastly different. How sensitive are these models to assumptions made? What uncertainty does this mean for the biofuel industry, or investors concerned with compliance issues under the renewable fuel standard?

Answer. The summary below compares the Searchinger study and the GTAP analysis (*Land Use Change Carbon Emissions Due To Ethanol Production,* by Wallace E. Tyner, Farzad Taheripour, and Uris Baldos, January 2009). The comparison focuses on the 30 year ethanol case with no restriction on U.S. exports to be consistent with Searchinger's assumption on the duration of ethanol production. As indicated by the following discussion, the results are very sensitive to the models used in the analysis and the assumptions made by the researchers.

The Searchinger study estimates that each gallon of ethanol generates 8,577 grams of GHG emissions through land use changes. This figure is roughly four times the estimate from the GTAP analysis. The difference is due to three factors. The first factor is how much land use change would occur in response to the increase in ethanol production. The Searchinger study suggests that land use would change by 0.73 hectares of land per 1,000 gallons of ethanol, while the GTAP analysis estimates the change in land use would amount to 0.27 hectares per 1,000 gallons of ethanol.

The second factor is related to the location of changes in land use. The Searchinger study suggests that land use changes would occur mainly in areas where carbon emissions factors from land use changes are relatively high; while the GTAP predictions indicate that land use changes would take place in areas where carbon emissions from land use changes are much more modest. Lastly, the GTAP analysis assumes that 75 percent of carbon stored in forest type vegetation would be released into the atmosphere at the time of land conversion, while Searchinger assumes that 100 percent of the carbon would be released. GTAP analysts argue that it is reasonable to assume that some of the carbon currently stored in trees on converted forestland would be sequestered in lumber for furniture, houses, and other wood products.

Question 4. EPA is required to formulate and update assessments of the lifecycle emissions for biofuels. In general, how might carbon reduction legislation or renewable energy standards affect this lifecycle analysis? Would competition for feedstocks from another legislative standard, say a renewable electricity standard, change the emissions lifecycle for existing plants or practices? Likewise if Brazil cracked down on illegal logging, could that change a lifecycle analysis for a biofuel produced in the U.S.?

Answer. A renewable electricity standard could create new markets for biomass feedstocks, altering land competition and land use dynamics. Additionally, changes

in policies in other countries, such as Brazil cracking down on illegal land conversion, would significantly alter how land markets in these countries respond to the changes in commodity prices. It will be important to incorporate changes in policies, including carbon reduction legislation, and programs into the coefficients researchers use to calculate emissions from international indirect land use changes. At this time, USDA has not determined how the carbon reduction legislation being considered by Congress would affect the lifecycle analysis for biofuels. However, we believe that EPA should include the effects of carbon reduction legislation in the lifecycle analysis of biofuels—if these effects are significant—and if such legislation is passed by Congress prior to EPA's issuance of a final rule implementing the renewable fuel standard in the EISA.

Question 5. During the interagency process it is my understanding that USTR was involved in the discussions. What was their concern? Do you think that the inclusion of indirect land use will impact the international climate dialogue?

Answer. I am unaware of specific concerns. I do not believe the inclusion of indirect land use in the lifecycle analysis of biofuels will affect the international climate dialogue.

Question 6. U.S. corn acres are projected to fall for the second year in a row in 2009, despite projected record levels of grain ethanol production. At the same time, U.S. soybean planted acres are expected to achieve a new record. This trend appears to run counter to the theory that increases in corn ethanol production would cause a "gobbling up" of soybean acres and force that soy production elsewhere in the world. How do you account for this?

Answer. Over the past couple of years, soybean prices have been running relatively strong compared to corn and other major crop prices. Major factors contributing to the strength in soybean prices include a short 2008 crop in Argentina and continued strong demand by China for soybeans. As a consequence, even though the demand for corn for ethanol production is projected to rise about nine percent in the coming marketing year, the profitability outlook for soybeans is enticing U.S. farmers to plant more beans and less corn and other crops.

Question 7. Without a doubt, crop yield improvements play a significant role in mitigating the need to expand agricultural lands. Can you elaborate on the remarkable increases in productivity witnessed not only in the U.S., but in other nations, over the last 25 years and comment on how that impacts land use decisions?

Answer. As you note, crop yields in the United States have increased significantly over the last 25 years. Globally, crop productivity has expanded as well. Since the early 1980s, U.S. corn yields have increased from about 110 bushels per acre to 153.9 bushels per acre in 2008, a 40 percent increase. World corn yields expanded by 62 percent between 1980 and 2008, with Brazil's, China's, and the European Union's corn yields increasing by a total of 103, 83, and 53 percent, respectively. As yields increase over time, less land would be needed for the production of energy crops to fulfill the renewable fuel standard in the EISA.

Question 8. What are your thoughts in regard to what's been taking place in Brazil? What type of agricultural production was expanding where?

Answer. The Amazon rainforest covers more than 500 million hectares or over ⅖ of the South American continent. Over 20 percent of the Amazon rainforest has been converted to roads, farms, ranches, and dams. It is estimated that 2.7 million acres each year are being cleared for logging timber, large-scale cattle ranching, mining operations, government road building and hydroelectric plants, military operations, and subsistence farming by peasants and landless settlers. In many places, the rainforest is being burnt to provide charcoal to industrial plants that have been built on converted rainforest lands.

Brazilian crop and livestock agriculture has been expanding. Major field crop acreage (barley, corn, cotton, oats, soybeans, cottonseed, peanuts, sunflower seed, milled rice, rye, and wheat) rose from 33.4 million hectares in 2000 to a peak in 2004 of 43.8 million hectares. Since 2004, major crop acreage has fluctuated from a low of 41.9 million hectares to an estimated high for 2009 of 43.7 million hectares.

The soybean area harvested peaked in 2004 at 22.9 million hectares. Since 2004, soybean area harvested in Brazil has declined to a recent low of 20.7 million hectares in 2006. In 2008, 21.4 million hectares of soybeans were harvested in Brazil. While the soybean harvested area in Brazil declined from 2004 to 2008, ethanol production in the United States increased from 3.4 billion gallons in 2004 to 9.2 billion gallons in 2008.

Brazilian animal agriculture has shown robust growth with total cattle numbers, measured by inventory, rising steadily from 146.2 million head in 2000 to more than 179.5 million head in 2009. Similarly for swine inventory, stock has grown from 31.9 million head to 33.3 million head in 2009. Unlike cattle, the swine industry does

exhibit some contraction on a year over year basis, but has clearly expanded since 2000.

Question 9. You don't specifically mention it in your written testimony's discussion of the uncertainty of determining yields on recently converted land, but isn't that one of the points of the Searchinger, *et al.* paper? That recently converted land will have much lower yields?

Answer. The yield on recently converted land is a source of great uncertainty, Land productivity depends on a number of factors such as climate, slope, soil type, salinity, and water availability (natural precipitation or availability of irrigation water). In addition, farming practices, such as fertilizer application rates and use of biotech seeds, vary greatly around the world. Thus, assumptions on the location of converted land and the productivity of that land are very important parameters in the Searchinger study and in other studies that provide estimates of the effects of biofuels production on GHG emissions.

Question 10. In your testimony you stated that the definition of renewable biomass in the RFS will limit the opportunity for biofuels to replace fossil fuels. Can you elaborate why? And do you think that definition of renewable biomass could be expanded to be more exclusive and also be environmentally responsible?

Answer. The term renewable biomass is defined differently in various pieces of legislation. The definition of "renewable biomass" in the Food, Conservation, and Energy Act of 2008 includes all materials that are byproducts of preventative treatments on National Forest System lands. Preventative treatments include the removal of trees and other materials to reduce hazardous fuels, reduce or contain disease or insect infestation, or restore ecosystem heath. In contrast, the definition of "renewable biomass" in the EISA excludes these materials. I believe this is one instance in which the definition of "renewable biomass" in the EISA could be expanded without causing environmental harm. There are possibly other examples in which the definition of "renewable biomass" could be broadened without causing environmental damage.

Question 11. Why do you think the European Union has not used indirect emissions as part of their programs?

Answer. While I have not spoken with representative from the European Union on this topic, my understanding is that they have decided not to include indirect land use in their current regulations but will review the issue over the next 2 years.

Question 12. Specifically, what parts of the EPA rule on the RFS did you discuss with the EPA? (Indirect emissions, international land use changes, the definition of agricultural land, agricultural production outlooks . . .)?

Answer. USDA discussed several aspects of the RFS2 EPA rule related to agriculture, including international land use changes, the definition of agricultural land, outlook for agricultural production and exports, fertilizer application rates, fertilizer requirements when removing corn stover, and forest management. In addition, we discussed the current conversion technology used by the U.S. corn ethanol industry, including ethanol yield, the production of Distillers Dried Grains (DDGS), and the feed nutritional benefits of DDGS, industry capacity, and production costs. We also discussed the supply potential of using other feedstocks for ethanol, such as sugarcane, sorghum, and wheat.

In addition, we discussed the economic and technical feasibility of producing ethanol from biomass. A considerable amount of time was spent discussing the potential supply of biomass, the most economical sources of biomass, and the logistics of shipping and storing biomass.

Question 13. Do you agree with the research done in the 2008 Searchinger paper published in *Science?*

Answer. There is little question that increased biofuel production will have effects on land use in the United States and the rest of the world. The more interesting question concerns magnitude. To the degree to which the supply response to increased biofuel production is met through increased yields, cropland expansion will be less. Land use change is more likely to occur where producers are more responsive to price changes. How much pasture and forest is converted to cropland will ultimately depend on the region, national and local land use policies and the degree to which competing uses (grazing, forest products) impose constraints for expansion.

Question 14. In the last few weeks the California Air Resources Board adopted a rule that uses indirect emissions as part of their low carbon fuel standard. What affect do you think this will have on the market for biofuels in California, and on biofuel producers nationwide?

Answer. The California low carbon fuel standard (LCFS) could potentially reduce the use of corn ethanol in California. Under the rule adopted by the California Air

Resources Board, Midwest corn ethanol has higher GHG emissions than reformulated gasoline. This would make Midwest corn ethanol an unattractive source for California fuel blenders. However, the California Air Resources Board has indicated that it will review the parameters and models used to develop the emissions estimates for corn-based ethanol and other biofuels. Thus, at this point, it is very hard to say how the market for biofuels will ultimately be affected by the rule adopted by the California Air Resources Board.

Question 15. In your testimony you stated that the literature on biofuel production and international land use has developed largely over the past 5 years, with most of the research on this being done for the domestic market, how can we build models that incorporate the international changes when there isn't adequate data?

Answer. Acquiring international data to help model the effects of land use change is a major issue. There are three primary factors that affect international land use change: economic, political, and cultural. Most U.S. models that estimate the effects of increasing biofuels on land use change rely on economic data, but some economic data simply does not exist in many of the countries where land use change is occurring or expected to occur as biofuel production expands. While we have some experience with international agricultural models, we have far more limited understanding of international land use of pasture, rangeland and forests. For example, USDA and the Food and Agriculture Policy Research Institute (FAPRI) both prepare 10 year baselines of projected cropland use. We have not developed similar baselines for pasture and forestland.

Question 16. Furthermore you stated in your testimony that "the empirical literature on land use and greenhouse gas emissions is relatively young with most studies appearing in the last 2 or 3 years." Is it responsible for expansive Federal policy such as the RFS to be dependent on such nascent science? Do you believe there will be a time when we will have a scientific consensus for this issue?

Answer. Lifecycle analysis (LCA) has historically been used to make comparisons at a point in time, *e.g.,* comparing the environmental benefits of a biofuel *versus* a petroleum fuel. Previous LCA of biofuels has not considered significant indirect impacts so EPA and others have combined LCA models with economic models to help estimate the effects of the RFS2 on land use change. While there is little doubt that increased biofuel production will have effects on land use in the United States and the rest of the world, there are uncertainties in the magnitude. Data on production, input use, historical and current land use, and distribution of land by type, for most developing and emerging economies is poor to non-existent. The empirical literature on land use and GHG emissions is relatively young, with most studies appearing in the last 2 or 3 years. Sensitivity analysis suggests wide variation in results. Key sources of uncertainties in these analyses include:

- The amount of change in land use;
- Differences in the sources of land being converted and the part of the world the where the change in land use occurs; and
- Differing assumptions regarding the percent of carbon stored in forest vegetation that is emitted when forest is converted into cropland.

In addition to the analytic uncertainties, there are also questions about the policy response of governments to land conversion. To the degree to which the supply response to increased biofuel production is met through increased yields, cropland expansion will be less. How much pasture and forest is converted to cropland will ultimately depend on the region, national and local land use policies, and the degree to which competing uses (grazing, forest products) impose constraints for expansion.

Question 17. Can you explain the role Distillers Dried Grains (DDGS) and other co-products play in a lifecycle emission analysis?

Answer. For every bushel of corn converted to ethanol in a dry mill plant, about 17.5 pounds (⅓ of a bushel equivalent) of DDGS (27 percent protein) is produced. DDGS have feeding value and may be used to replace corn and soybean meal in feed cattle and dairy feed rations. Small amounts of DDGS can also be used in hog and poultry feed rations. On a feed value basis, 1 pound of DDGS could replace up to 1.27 pounds corn and soybean meal in livestock rations, though for nutritional reasons, DDGS can only replace a portion of the corn and soy fed to livestock (Argonne National Lab). Since DDGS has value as a livestock feed, researchers have generally agreed that the lifecycle analysis should at least allocate a portion of the emissions produced in ethanol production process to DDGS.

In a lifecycle emission analysis (LCA), GHG emissions need to be allocated to all end products not just ethanol. There are a number of ways various researchers have allocated GHG emissions, such as energy content of ethanol *versus* DDGS, mass basis (weight of ethanol *versus* weight of co-products), displacement/replacement ap-

proach, and the ASPEN Plus Model which estimates the energy used in every stage of the production process (*i.e.,* energy used to dry DDGS assigned to DDGS). Each of these different approaches for allocating emissions between ethanol and DDGS yield different estimates of lifecycle emissions attributed to ethanol.

Question 18. Your testimony highlighted timeframe assumptions in emission models as an area of uncertainly. How does the timeframe a model uses affect the results? Why are these assumptions important?

Answer. GHG emissions associated with land use change result from releases of much of the carbon into the atmosphere that was previously stored in the soil. These emissions can be viewed as one-time events that typically occur when lands shift from pasture, grassland, or forest into crop production. Hence, emissions related to bringing new land into production are generally concentrated in the year of conversion and the first couple years thereafter, creating what is referred to in the literature as a "carbon debt". In contrast, growing biofuel feed stocks offsets the use of fossil fuels and removes carbon dioxide from the atmosphere which overtime can offset the upfront "carbon debt" associated with land use change.

Using a shorter timeframe for the lifecycle analysis makes it less likely that the "carbon debt" created for keeping newly converted land in crop production will be offset by the annual carbon emission benefits of growing crops for biofuel production. Thus, the shorter the timeframe the more likely ethanol and other biofuels will not achieve the GHG emissions reduction targets contained in the EISA.

Questions Submitted By Hon. Stephanie Herseth Sandlin, a Representative in Congress from South Dakota

Question 1. Would you agree that even the best available methodologies and models have proven to be significantly imprecise in predicting indirect land use changes?

Answer. Models are representations of reality and will not replicate reality with 100 percent certainty. Second, it is important to recognize that the questions being asked of these models may not be the types of questions that the models were originally intended to answer. Third, a number of factors are driving land use change not only in the United States, but around the world: factors such as population growth and urban encroachment; economic development; agriculture and forestry production; and policy to mention a few. In reality, we do not know at this point in time how precise or imprecise these model forecasts or projections are to predict direct and indirect land use changes, land conversion, and GHG emissions on a global scale, though we know some of the major sources of uncertainty.

Question 2. Would you also agree that we will need the most current economic and agricultural data available to arrive at a level of consensus on approaches to determining indirect effects?

Answer. The more current the data, the better the analysis should be. For example, a snap shot of satellite images for two points in time 2001 and 2004 was used by Winrock International to determine what types of land (*e.g.,* forest or grassland) are cleared when agricultural production expands. These data show crop expansion by type of land due to political, economic, social and a variety of other factors. The factors driving land use change from 2001 to 2004 are not necessarily the same factors driving land use change between 2005 and 2008.

Question 3. Do you believe that USDA has available to it the resources necessary to initiate a research effort that fairly determines such indirect effects?

Answer. USDA has a limited number of models that can partially address some of the issues dealing with land use change. We believe the best path for moving forward is to continue to work collaboratively with EPA, DOE and the academic community to further refine existing models to address land use changes. This would be the most expedient process for developing a consensus on the effects of biofuels on land use.

Question 4. Is there additional support that Congress can provide, and specifically, we on the Agriculture Committee? For instance, would some additional appropriations for USDA for this purpose in Fiscal Year 2010 be needed in order to accurately resolve these issues as quickly as possible?

Answer. We believe the best path for moving forward is to continue to work collaboratively with EPA, DOE and the academic community to further refine existing models to address land use changes. In addition, the Administration's FY 2010 budget proposal would provide an additional $5 million to the Office of the Chief Economist for climate work. Some of this funding would be used to address land use issues.

Questions Submitted By Hon. Deborah L. Halvorson, a Representative in Congress from Illinois

Question 1. Dr. Glauber, do you feel that U.S. policy on renewable fuels are the sole influencer of land use change in other countries such as the deforestation occurring in Brazil? What do you believe are the other variables that need to be analyzed? Do you feel we have models today that can accurately do this? Do you feel that crude oil prices have an effect? How large?

Answer. U.S. renewable fuels policy is not the sole influence of land use change in Brazil and other countries in the world. There are many factors that influence land use change in other countries besides U.S. policy on renewable fuels. The rainforest in Brazil is being destroyed and fragile lands elsewhere are being converted to cropland due to political, social, and economic reasons. In Brazil, the rainforest is being cleared for logging timber, large-scale cattle ranching, mining operations, government road building and hydroelectric plants, and subsistence agriculture.

It is clear from the analyses that land conversion is sensitive to many variables—some of which can be influenced by government policies or actions. To the degree to which the supply response to increased biofuel production is met through increased yields, cropland expansion will be less. How much pasture and forest is converted to cropland will ultimately depend on the region, national and local land use policies and the degree to which competing uses (grazing, forest products) impose constraints for expansion.

The models that we currently have are limited in their ability to estimate direct and indirect land use change associated with biofuels production. This assessment is based on the lack of data and definitive analysis of the factors affecting global land use changes. This lack of data and analysis leads to widely varying differences on the effects of U.S. biofuels policy on land use. However, the analysis does focus exclusively on the changes in land use caused by U.S. renewable fuels policy; projections about other economic, political, and cultural trends that might affect future land use are reflected in the model baselines.

Oil prices do have some affect on land use. Higher oil prices lead to higher prices for gasoline, diesel fuel, and other energy related production inputs. Generally, we would expect producers to respond to higher production costs by reducing acreage planted but when oil prices are high, the demand for alternative energy sources rises pushing up the price of crops used to produce biofuels. Due to the offsetting effects of higher oil prices on production costs and the prices of crops used to produce biofuels, the effects of crude oil prices on land use are expected to be relatively small.

Question 2. Dr. Glauber, USDA has a wealth of global data to predict future trends in agriculture. Does USDA have the computer models sophisticated enough that you would be willing to build regulations on their predicted results around the indirect land use changes of renewable fuels?

Answer. While USDA has developed numerous models over the years to examine specific issues that are germane to these topics, we do not have an integrated, interdisciplinary model(s) or modeling system to address *global* land use changes issues of the sort addressed in the proposed RFS2 rule. We have drawn heavily on the work of other researchers. EPA's analysis uses a suite of models to address the issue of indirect land use change.

Question 3. Dr. Glauber, do you believe that through technology improvements that crop yields in not only the U.S. but the world will continue to increase?

Answer. We continue to see remarkable gains in crop productivity both in the United States and globally through the application of biotechnology and conventional plant breeding. For most crops, yields in the United States are well above those in the rest of the world. Nevertheless, foreign crop producers are continuing to adopt new seeds and improved farming methods that will allow them to boost yields over the coming years. Higher commodity prices and returns to farming will support these advances.

Question 4. How will USDA address the lack of scientific understanding of how to measure the sustainability of biofuels, including indirect land use change? How can USDA help advance scientific analysis to address the scientific uncertainties that are inherent in trying to evaluate international land use issues related to biofuels production?

Answer. We do need to develop better models for measuring the sustainability of biofuels, include indirect land use change. USDA will continue to work on these issues in conjunction with the academic community, the U.S. Department of Energy, the U.S. Environmental Protection Agency, and other stakeholders interested in advancing the science of measuring the sustainability of biofuels. In recent years,

USDA economists and scientists have participated in a number of workshops and have been involved in research projects to evaluate the current state of knowledge and identify the research needed to more accurately measure the effects of biofuels on indirect land use change and GHG emissions.

Question 5. From a rural development and agricultural management point of view, how can USDA help maximize the sustainability of biofuels?

Answer. USDA can maximize the sustainability of biofuels by continuing to put emphasis on research programs that boost agricultural productivity, increase energy efficiency, and lead to advances in agricultural management practices that promote sustainable resource use. In addition, we must continue to develop partnerships with the Department of Energy and other stakeholders to ensure that we are all working together to accelerate the commercialization of more efficient biofuel conversion technologies and next-generation biofuels.

Question 6. The biotechnology industry has played a key role in increasing crop yields, developing enzymes for advanced biofuels, ethanologens for sugar conversion, algal systems, and new processes to make biobutanol and green gasoline. How will you further incorporate modern biotechnology into the USDA mission?

Answer. USDA research programs have been very successful in increasing crop yields, developing new farming methods that are more sustainable, and creating more efficient processes for converting crops, crop residues, and other feed stocks into biofuels. The Obama Administration is committed to continuing this important research that is essential to reducing our dependence on foreign oil sources, reducing GHG emissions, and mitigating the effects of climate change. USDA scientists, in coordination with researchers from the private sector, will continue their commitment to developing new seed varieties and sustainable management practices that will enable the agriculture sector to produce food to feed a growing population and energy that is less polluting and less dependent on foreign sources.

Question 7. At least for the last 30 years world crop acreage has been steadily going up while the U.S. crop acreage for the most part has been flat. In this past year U.S. acreage went up 7 million acres and the world went up 57 million acres. How could a 7 million rise in crop acreage in the U.S. cause a 57 million acre rise in the world? For 2009 U.S. crop acreage actually went down, did the world crop acreage fall?

Answer. The rise in world crop acreage in 2008 was driven by the very same forces that drove acreage higher in the United States. Producers throughout the world responded to sharply higher prices for most commodities in the fall of 2007 and spring of 2008 by planting more acreage. Our estimates of 2008 harvested area for grains, oilseeds, and cotton, suggest that the relative increase for the United States, at 2.5 percent, was actually larger than that for the rest of the world, at 0.9 percent. USDA's world crop area numbers for 2009 are still relatively tentative with planting of summer crops still ongoing in the Northern Hemisphere and planting for 2009 crops in the Southern Hemisphere still months away. Again, based on our projections of harvested area for grains, oilseeds, and cotton, world crop area is expected to increase in 2009, but by less than half of one percent. Offsetting increases in the rest of the world, area in the United States is expected to fall by about four percent, primarily reflecting reduced plantings of winter wheat last fall.

Responses from Margo T. Oge, Director, Office of Transportation and Air Quality, Office of Air and Radiation, U.S. Environmental Protection Agency

Questions Submitted By Hon. Tim Holden, a Representative in Congress from Pennsylvania

Question 1. Have you discussed who's going to determine questions like whether land was "cleared" prior to passage of EISA (energy bill from 2007)

Answer. We have crafted the RFS2 proposal in such a way as to implicitly address the issue of whether agricultural land or land on which tree plantations are situated had been cleared prior to passage of EISA. We have proposed to define the term "existing agricultural land" as cropland, pastureland, or Conservation Reserve Program land that existed as of December 2007 (and continuously thereafter). As long as land was being used as cropland, pastureland, or CRP land on December 2007, we would presume it to have been cleared (or cultivated) prior to December 2007. Likewise, we have proposed to define the term "actively managed tree plantation" to mean tree plantations that existed as of December 2007 (and continuously thereafter). Again, we would presume that a tree plantation that can satisfy our proposed definition for "actively managed tree plantation" would automatically satisfy the requirement that it have been cleared prior to passage of EISA.

We have proposed that the responsibility for verifying that feedstocks come from "existing agricultural land" or "actively managed tree plantations" falls on the renewable fuel producer and that they acquire and maintain documentation from their feedstock producers to support their claims. This documentation would be reviewed as part of the producer's annual audit ("attest engagement"), and EPA would conduct any supplemental oversight or auditing if inconsistencies were reported based on that audit.

Question 2. Are you familiar with the recent International Energy Agency report? Do you concur with their assessment that "As governments around the world try to establish the greenhouse gas emission benefits of various biofuels, the use of methodologies such as default emission factors could lead to a significant underestimation of the benefits unless the factors are updated on a frequent basis."?

Answer. EPA is familiar with the recent International Energy Agency report "An Examination of the Potential for Improving Carbon/Energy Balance of Bioethanol" under IEA Task 39 Commercializing 1st and 2nd Generation Liquid Biofuels from Biomass.

The paragraph to which the question refers suggests that lifecycle greenhouse gas assessments should consider future developments in addition to historical data. EPA has worked with the U.S. Department of Agriculture, the U.S. Department of Energy, and industry experts to incorporate technology improvement projections (*e.g.,* biorefinery efficiency improvements, agricultural yield improvements) and socioeconomic trend projections (*e.g.,* food consumption, GDP, population growth) into the lifecycle in order to account for expected future developments. EPA will continue to refine data and assumptions in coordination with other Federal departments and other experts as we progress to the final rulemaking. Additionally, following publication of the final rule we will continue to update our methodology to incorporate new information and advancements.

Question 3. The estimates for the indirect emissions as measured by the Searchinger study and the Global Trade and Analysis Project (GTAP) are vastly different. How sensitive are these models to assumptions made? What uncertainty does this mean for the biofuel industry, or investors concerned with compliance issues under the renewable fuel standard?

Answer. It is true that models are sensitive to certain key inputs, like crop yields. This is one reason why EPA's proposal identifies and conducts sensitivity analyses around these key inputs. In addition, we are working with numerous scientists and stakeholders and conducting peer reviews to ensure that we use the best available data in our modeling through an open transparent process. The intent of this process is to ensure a final rulemaking that provides clarity and stability for the biofuels industry.

It is also important to note that regardless of the models and assumptions used in the many studies that have been conducted to date on lifecycle analysis, a number of studies have shown that indirect land use emissions comprise a significant portion of the total lifecycle emissions of some biofuel pathways. Therefore, these impacts should be accounted for in order to ensure an accurate and scientifically credible assessment of the GHG impact of renewable fuels.

Question 4. EPA is required to formulate and update assessments of the lifecycle emissions for biofuels. In general, how might carbon reduction legislation or renewable energy standards affect this lifecycle analysis? Would competition for feedstocks from another legislative standard, say a renewable electricity standard, change the emissions lifecycle for existing plants or practices? Likewise if Brazil cracked down on illegal logging, could that change a lifecycle analysis for a biofuel produced in the U.S.?

Answer. Policy developments such as those described above are important to consider. The Agency has incorporated current policy regimes into the proposed lifecycle analysis. For example, we are working closely with experts in Brazil to ensure that Brazil's land use and enforcement policies are appropriately incorporated into the lifecycle models. EPA has met with experts and representatives from other countries (*e.g.,* EU countries, Argentina) regarding their current biofuel and agricultural policies to accurately inform our models and have consistently invited countries and foreign companies inquiring about renewable fuels to share data and policy information with us for analytical refinement.

Moreover, should significant policy developments occur in the future that would impact the lifecycle analysis, we will update our lifecycle analysis accordingly. However, we feel it is not appropriate to attempt to predict and incorporate future policy passed by Congress or other countries into the lifecycle analysis.

Question 5. During the interagency process it is my understanding that USTR was involved in the discussions. What was their concern? Do you think that the inclusion of indirect land use will impact the international climate dialog?

Answer. EPA continues to work with USTR and other agencies to ensure that the RFS rule will comply with all trade obligations.

Question 6. While the focus of this hearing is mostly on ILUC, can you elaborate on the findings of EPA's **DIRECT** emissions lifecycle analysis for ethanol? I understand your agency's analysis showed that most ethanol offers an approximate 50% reduction in direct GHG emissions relative to petroleum than previously believed. Can you elaborate on the reasons for this reduction being greater than previous EPA estimates?

Answer. If indirect land use change is excluded from the analysis, most corn ethanol offers an approximately 50% reduction in GHG compared to petroleum gasoline. However, this is not an indication of direct impacts. Our methodology includes both direct and indirect impacts together. The indirect impact modeling accounts for land use change, as well as other "positive" indirect impacts in terms of biofuels GHG emissions, such as reductions in livestock emissions and shifting of crop production to regions with lower GHG impacts. Therefore it is important to consider the results with all indirect impacts, including indirect land use change. Inclusion of these "positive" indirect impacts was not done in our previous analyses. We also project advancements in ethanol energy efficiency that result in lower estimates of emissions than previously considered.

Question 7. I understand EPA relied on satellite data and imagery from 2001–2004 to estimate the types of lands that might be converted as a result of U.S. biofuels expansion. While this data might be helpful in determining what types of land were converted to other uses during a brief period at the beginning of this decade, I'm assuming this data does not provide any insight into the CAUSE of the land conversion. Is that correct?

Answer. The satellite data is not used to attribute unique causes to each instance of land conversion, but rather, it allows us to project the type of land converted into cropland for a variety of reasons. Our modeling assumes that the same mix of land types will be converted to cropland in the future if demand for cropland increases. We use economic modeling to predict how changes in demand for crops determine the amount of new cropland that will result. Thus, in our analysis, the causes of crop expansion are captured with economic modeling. We rely on well-established economic models to project the amount of crop expansion in each country resulting from increased biofuel production. We then use satellite data to determine not the amount of land that might be converted, but what types of land will be used in a particular country if additional land is needed for crop production as a result of U.S. biofuels expansion, based on land use change patterns determined from satellite imagery from 2001 to 2004.

That being said, we recognize that this is an area of potential uncertainty. Therefore, the use of satellite data is one of the components of the lifecycle analysis that we are having peer-reviewed and have specifically asked for comment on throughout the rulemaking process. We also have sought input from our Agency partners, including USDA, on this issue.

Question 8. The International Energy Agency report also challenged the biofuels industry to keep better track of its performance. Are you working with the biofuels industry on that front?

Answer. EPA has an extensive history of working with the biofuels industry and other stakeholders. These interactions have helped us craft approaches in our regulations to help keep better track of performance. For example, our RFS2 proposal includes new registration and reporting requirements for biofuel producers which will help us to better quantify and track individual producers' performance and the industry's performance overall. The registration requirement will help us understand the feedstocks, processes, energy sources, and products that existing facilities are capable of utilizing or producing. In addition, we also are proposing that producers submit an annual production outlook report. This report will help us gauge the overall direction of the industry, including anticipated biofuel production volumes and facility expansions or other changes being planned or underway. This information will help us set the annual RFS standards for each of the four categories of renewable fuel, as well as feed into any future analyses of the industry as well as supporting our future lifecycle modeling efforts.

Furthermore, EPA is currently undergoing a separate rulemaking that would require industrial sources that emit above a certain threshold of GHGs per year to report these emissions to EPA. Biofuel production facilities that meet or exceed the

threshold would be required to report their emissions, providing EPA with additional, facility-specific data that will help us track the industry's performance.

Question 9. In your testimony you discussed the statutory emission reduction thresholds for each of the four different renewable fuel categories. Also in statute are explicit provisions that give the authority for EPA to reduce the emission reduction thresholds. Under what circumstances would you consider using this authority?

Answer. EISA stipulates the conditions under which EPA may make an adjustment to the GHG emission reduction thresholds. All such adjustments must be the "minimum possible adjustment" and result in the "maximum achievable level" of GHG reduction, taking cost into consideration. There are additional criteria for the fuel-specific thresholds. For the 20 percent threshold applicable to all renewable fuel, the adjusted level must be that achievable by "natural gas fired corn-based ethanol plants, allowing for the use of a variety of technologies and processes." For the 50 percent thresholds applicable to advanced biofuel and biomass-based diesel, and the 60 percent threshold applicable to cellulosic biofuel, an adjustment must allow for the "use a variety of feedstocks, technologies, and processes." Finally, adjusted thresholds can be no lower than ten percent below the thresholds specified in EISA.

In our Notice of Proposed Rulemaking for the RFS2 program, we have proposed that the GHG threshold for advanced biofuel be lowered to 44 percent, or potentially as low as 40 percent. This proposal is based on our projection that imported sugarcane ethanol is the only renewable fuel available in sufficient volumes over the next several years to allow the statutory volume requirements for advanced biofuel to be met. Based on the preliminary lifecycle analysis conducted for the proposal, sugarcane ethanol would achieve a 44 percent reduction in GHGs. The final adjustment would depend upon the updated lifecycle analyses conducted for the final rule.

Similarly, due to the projected insufficiency of waste grease feedstocks that could be used to produce biodiesel or renewable diesel meeting the 50 percent GHG threshold for biomass-based diesel, we take comments on reducing this threshold to 40 percent in combination with an allowance for biodiesel producers to average the GHG reduction profile of their soy oil and waste fats and greases feedstocks. These adjustments would allow biodiesel producers to utilize sufficient volumes of feedstocks to meet or exceed the 1.0 billion gallon volume mandate established by EISA for biomass-based diesel in 2012.

Question 10. In your written testimony you said that the EPA has developed a "robust and scientifically supported methodology that identifies direct AND indirect emissions, including those resulting from international land use changes." When you say you have developed a scientifically supported methodology, are you including the 125 scientists who submitted a letter to the California Air Resources Board during the public comment period who wrote that the science for indirect emissions from land use changes is NOT ready for implementation in the California Low Carbon Fuel Standard?

Answer. EPA has consulted with dozens of noted experts in developing our lifecycle assessment for biofuels including those from industry, academic researchers and experts from USDA and DOE. These experts have presented a range of viewpoints and information that enabled the Agency to prepare a technically and scientifically sound analysis of the full lifecycle GHG emission impacts of biofuels, using well-accepted, peer-reviewed models. We also anticipate that the feedback we receive through the lifecycle workshop and peer review will further improve our analysis.

We also have coordinated with California's Air Resources Board. We note that California's Air Resources Board received numerous comments, including those from a large number of scientists who supported their proposed assessment of both direct and indirect land use impacts. After considering all comments received, the Board voted almost unanimously to adopt the rules which included land use impacts.

Question 11. Given the uncertainty of the science and lack of confidence for methodologies surrounding indirect emissions from land use changes how do you think the decisions to use indirect land use changes as part of the RFS proposed rule is reconciled with the March 9, 2009 the White House memo calling for "science and the scientific process must inform and guide decisions" for the Administration?

Answer. EPA's work is using science and the scientific process to inform and guide decisions. For example, dozens of scientists and EPA experts have established that indirect emissions comprise a significant portion of the total lifecycle emissions of biofuels. In creating our lifecycle methodology we turned to use of well-established models, tools, and data. We also recognize that lifecycle analysis is a new part of the RFS program and that much of our methodology represents groundbreaking science. Therefore we have proceeded in a manner consistent with the President's call to guide decisions on science in a transparent process. EPA's proposal describes

in depth the lifecycle analysis methodology and highlights the assumptions and model inputs that particularly influence our assessment. We have conducted a sensitivity analyses on key parameters and demonstrate how our assessments might change under alternative assumptions. Additionally, EPA is conducting formal peer reviews of several key components of the lifecycle methodology. Lastly, the Administrator recently extended the comment period on the proposed rule by 60 days in order to provide additional time for review of EPA's work.

Question 12. Please describe in detail the work you have done to develop methodologies to measure the indirect emissions from conventional fuels in general? Specifically, what work have you done in this area regarding the production of gas and oil from tar sands and oil shale?

Answer. Based on the EISA requirements, we compare the lifecycle emissions of biofuels to the average 2005 emissions of producing either petroleum gasoline or diesel fuel depending on what fuel the biofuels replace. We use the same lifecycle boundaries for biofuels and petroleum-based fuels when addressing both domestic and international greenhouse gas impacts, including extraction emissions from crude oil. In 2005, five percent of crude was Canadian tar sand, one percent was Venezuela extra heavy, and 23 percent was heavy crude.

The direct emission factors for Canadian tar sand production were based on the GREET model Version 1.8b, and emission factors for other non-conventional sources of heavy crude were based on analysis done by EPA for the proposed rulemaking. We plan to update these factors for our final rulemaking analysis with, for example, work done by the U.S. Department of Energy's National Energy Technology Laboratory (NETL) that estimates the average lifecycle GHG emissions from petroleum-based fuels sold or distributed in 2005.

With regard to analyzing the direct and indirect emission impacts of petroleum fuel production, our work to date has found that the indirect land use change emissions are insignificant because, unlike biofuels, there is not the same opportunity cost of land. This is because the land needed for petroleum extraction is not replacing land that would otherwise be used to provide resources for an existing market (*i.e.,* crop based biofuels displacing crops used for feed). However, for the final rule we are evaluating other indirect impacts associated with petroleum fuel production, such as petroleum product supply and demand changes associated with a marginal change in transportation fuel use. This will need to be evaluated in the context of the Act requirements of using a 2005 average baseline for petroleum fuels.

In the proposed rule we are seeking comment on EPA's work on this topic and on the best approach for analyzing each aspect of the petroleum lifecycle.

Question 13. In your testimony you stated that the burden for ensuring feedstock eligiblity for the RFS program will rest on the biofuel producer. What is the expected cost of compliance for a biofuel producer? Does this rule expose biofuel producers to citizen or environmental lawsuits if non-eligible feedstocks are used? Under any enforcement mechanism, do you expect the EPA to go onto a farm to verify land or feedstock eligibility for the RFS?

Answer. In the analysis that accompanies the RFS2 proposal, we have estimated the cost of compliance for renewable fuel producers to be roughly $2,000 annually per producer; however, we realize that this sum may actually be higher or lower depending on a producer's business practices. We are seeking comment from industry on this estimate for the final rule. We do not believe that our proposal exposes biofuel producers to lawsuits to a higher degree than their current exposure under the existing RFS program.

As for whether or not EPA would have to visit a farm to verify feedstock production, our main proposal would not envision having EPA visit farms. The proposal seeks comment on a variety of alternatives that could help inform our enforcement efforts while limiting any visits to or audits of feedstock producers' records, including using aerial photography or satellite imagery to identify general land use trends. We also investigated several options besides our proposed option, including use of data already collected by USDA to help us ensure compliance with the renewable biomass provision. However, due to USDA policy and new data-sharing restrictions contained in the 2008 Farm Bill, this option does not appear to be available to us. We are continuing to work with USDA on this issue.

Question 14. Have you made available the specifics of your modeling on land use changes? So that people can see what your assumptions were.

Answer. Yes. All of the information supporting EPA's analysis is now available in the public docket for the rule. This information includes a full description of each of the models we used, all of our assumptions, and all of the empirical data used (*e.g.,* input and output files). In addition to this availability, during the development of our assessment, we shared our plans and assumptions with USDA and other Fed-

eral agencies and with a wide variety of stakeholders including those from the biofuel industry as well as the agricultural industry. Important assumptions such as growth in crop yields were coordinated prior to our finalizing our assessments to make sure we benefited from full industry input. Then, after completing our analyses, we shared the results again with our Federal partners, the affected industry members and other experts as part of our open rulemaking process, all before processing the rule for public release.

Question 15. EPA says their modeling shows that ethanol reduces greenhouse gases by 16% compared to gasoline, however that is after you penalize corn based ethanol by 40% for the indirect international land use. This is a significant reduction. Will you provide the modeling that you have used to determine this reduction to the public and to this Committee? Knowing full well that farmers in Brazil and other countries base a number of factors, exports, weather, local needs, have been changing their practices for decades—how did you arrive at this penalty based on one use—corn ethanol?

Answer. We have made all of our modeling (including all of the assumptions and key variables) available to the public. EPA has both shared this information with our stakeholders via numerous meetings and presentations and provided it in the public docket.

In determining indirect impacts, the methodology we have developed isolates the impacts of biofuels production, which allows us to differentiate and assign just the land use change directly caused by increases in renewable fuels. This approach considers the impacts of increased biofuels production *versus* a baseline that incorporates the number of other factors you mention. Therefore the only change we measure is from biofuels production, keeping all other factors constant. As noted above, this approach is described in detail in the proposed rule.

Question 16. Yesterday's Presidential Directive directed EPA to solicit peer reviewed, scientific data on the indirect land use component, and this is the issue that all the media seems to have focused on—yet, your testimony seems to gloss over it. Do you not think it is important?

Answer. As I described in my oral and written testimony, EPA considers peer review a critical component of our lifecycle methodology and the scientific process. This is why we made conducting these reviews during the public comment period a top priority. The reviews are focused on four areas of our lifecycle assessment that in particular charted new ground: use of satellite data to project future the type of land use changes; land conversion GHG emissions factors estimates used for different types of land use; estimates of GHG emissions from foreign crop production; methods to account for the variable timing of GHG emissions; and how the models are used together to provide overall lifecycle GHG estimates. The reviews are being conducted following OMB's peer review guidance that ensures consistent government-wide implementation of peer review and according to EPA's longstanding and rigorous peer review policies.

Question 17. Can you describe to me the process whereby EPA determined how it would measure indirect effects associated with biofuel production? What is the scientific basis? What data does the EPA possess that demonstrates indirect effects associated with biofuels production?

Answer. Measuring the indirect effects of biofuels is based on the fact that in any given year, the use of biofuel production requires land that would have been used for other uses absent use for biofuels. Therefore, there is an opportunity cost associated with using feedstocks or land for biofuels that would have otherwise been used for an alternate use absent the biofuel production. EPA has relied on peer-reviewed agricultural sector models to conduct this work. These models are used (and have been used historically) to predict how the market will respond to these type of changes. This work has established that indirect emissions comprise a significant portion of the total lifecycle emissions of biofuels.

In developing a lifecycle methodology that incorporated indirect effects we focused on maximizing transparency and utilizing the many noted experts in this field, including those from industry, academic researchers and other Federal agencies. For example, we met regularly with the USDA and turned to their experts for key data points (*e.g.,* crop yield assumptions). The range of viewpoints and information we have received through this process has enabled the Agency to prepare a technically sound and scientifically robust analysis of the full lifecycle GHG emission impacts of biofuels. We then built on this process by holding a 2 day public workshop on the lifecycle methodology and conducting a formal, scientific peer review of key elements of the methodology.

Question 18. Will the EPA make all of its analysis and the models it used to determine indirect land change available to the public? If so when? If not, why not?

Answer. All models, data, spreadsheet calculations, and results input and generated in the lifecycle analysis are publicly available. Please see the NPRM docket at *www.epa.gov/otaq/renewablefuels/index.htm.* In addition, EPA recently held a 2 day public workshop on our lifecycle analysis during which each major element of the methodology was presented and discussed.

Question 19. It is clear that there is no scientific consensus that indirect land use change is the result of increased biofuels production (cite the 111 Ph.D. letter among others). Indirect land use is not a parameter for Life Cycle Analysis as set forth by the International Standards Organization in ISO 14040 and 14044. The EU decided to postpone the inclusion of indirect effects in its assessment of GHG emissions. The State of California recognizes that there are problems with quantification of indirect effects as part of their low carbon fuel standard and decided to study this theory over the next 20 months—why does the EPA persist in including indirect land use change in its analysis?

Answer. EISA mandates that significant indirect effects such as land use change be incorporated into the RFS lifecycle assessment. The International Organization for Standardization (ISO) sets out guidelines for development of lifecycle analysis and advises that lifecycle boundaries should include all components with significant effects on the environmental impact (*i.e.,* greenhouse gas emissions) and expanded to take into account additional functions related to co-products. EPA follows this guidance by incorporating indirect land use change into the lifecycle analysis in a manner that appropriately takes into account co-products.

The State of California and the many independent studies on this topic have reached the same conclusion regarding indirect land use—and that is that indirect land use change in response to biofuel production can significantly impact associated lifecycle GHG emissions and therefore it must be considered. In fact, we understand that California has finalized their rulemaking including indirect land use change. EPA continues to communicate closely with the California Air Resources Board and with the European Commission and EU countries in regards to our respective work on greenhouse lifecycle assessment for biofuels and on land use change.

EPA recognizes there is uncertainty in these analyses, which is why we are pursuing formal peer reviews of key components of the methodology, soliciting comments before finalizing the rule, and incorporating a process that recognizes that the science in this area will continue to evolve even after a final rule.

Question 20. Indirect land use has deeply divided the scientific community and consensus does not exist. Before indirect effects apply to one sector of the U.S. economy and the only sector currently displacing foreign oil this needs to get figured out, and only then, should it be applied at all. It certainly cannot be applied to only biofuels. Please describe for this Committee—in detail and timeline—your thoughts on "indirect land use effects" from tar sands, coal, and foreign oil?

Answer. Our work to date has found that petroleum fuel production does not have the same indirect land use change emissions associated with biofuels because, unlike biofuels, there is not the same opportunity cost of land needed for petroleum extraction in the sense it is not replacing land that would otherwise be used to provide resources for an existing market (*i.e.,* crop based biofuels displacing crops used for feed). There is potentially direct land use change emissions associated with extraction but these are estimated to be insignificant due to the relatively small amount of land required and the large amount of energy produced over the life of a crude oil well.

For the final rule, we are also evaluating other indirect impacts associated with petroleum fuel production, such as petroleum product supply and demand changes associated with a marginal change in transportation fuel use. This will need to be evaluated in the context of the Act requirements of using a 2005 average baseline for petroleum fuels. EPA also is continuing to evaluate direct emission estimates for the final rule, including, for example, land needed in the surface mining of tar sands.

Question 21. From a scientific and economic standpoint—does the disparity in application of this theory—bother the agency responsible for regulation?

Answer. EPA's responsibility is to follow the law and, on this point, the law is clear. We are required to assess renewable fuel lifecycle greenhouse gas emissions, including direct emissions and significant indirect emissions, such as significant emissions from land use change. We are required to use a 2005 average petroleum baseline fuel. From a scientific standpoint, we use the same lifecycle boundaries for biofuels and petroleum-based fuels when addressing both domestic and international greenhouse gas impacts, in that we are including international extraction emissions from crude oil.

As mentioned above, for the final rule, we are also evaluating indirect impacts associated with petroleum fuel production, such as petroleum product supply and demand changes associated with a marginal change in transportation fuel use. This will need to be evaluated in the context of the Act requirements of using a 2005 average baseline for petroleum fuels.

Question 22. During the week of April 22, 2009—a study looking at one indirect effect from petroleum was published in the academic journal *Biofuels, Bioproducts and Biorefining*. The authors from the University of Nebraska found that the indirect emissions from safeguarding oil supplies in the Middle East **double** the carbon intensity of our gasoline imports from that part of world. Have you given any thought to the indirect emissions of foreign oil due to overseas military operations and expenditures? Have you seen the study? Has EPA considered this?

Answer. We are aware of this particular report and have studied and considered how to measure the indirect emissions of foreign oil due to overseas military operations. EPA has explored this issue in a peer reviewed study of the energy security benefits of reducing U.S. oil imports. The review concluded that attribution of military costs to particular missions or activities is difficult. So while there may be a link between military expenditures and petroleum production, there is no methodology for allocating a portion of military expenditures to oil production and specifically an incremental change in oil imports. The same would be true from a lifecycle GHG emission context in that there is no methodology for allocating these emissions to petroleum production. However, this is an area we are continuing to study and one we specifically seek comment on in the proposed rule. In particular, we have asked for comment on how we can estimate the emissions associated with maintaining a U.S. military presence to help secure stable oil supply from potentially vulnerable regions of the world given the difficulty of attributing these emissions to particular missions or activities. Another consideration is that we must apply the same lifecycle boundaries for biofuels and petroleum-based fuels when addressing both domestic and international greenhouse gas impacts and therefore should also then consider emissions from military expenditures to protect domestic agriculture interests.

Question 23. Did EPA work with other Federal agencies and CARB on your modeling? Did CARB use a different set of models than EPA? If so, why? Did you find fault with the CARB modeling?

Answer. EPA worked very closely with other Federal agencies, in particular the Departments of Agriculture and Energy. Early in the process, we coordinated our analytical plan, receiving their concurrence. This was followed by numerous consultations and briefings along the way. We relied heavily on the technical inputs of USDA and DOE as we developed the best assumptions to use and then modeled the impacts of the rule. We similarly coordinated with CARB, sharing assumptions, results, and methods. Both EPA and CARB agreed that important assumptions used in running these models should be consistent and we worked closely to assure that was the case. We continue to work with CARB to improve the lifecycle GHG assessment of biofuels. In addition, we discuss and ask for comment in the NPRM on the approach that CARB has taken in their program.

Question 24. I order to meet the requirements of the RFS2 for corn ethanol it is 15 billion gallons by 2022—I assume that if no new virgin acres came into production to meet that requirement, then by definition your ILUC number for corn ethanol would be zero, correct? If yes, then the reduction of GHG for corn ethanol should be 60%, not the 16% in the rule? Can you please clarify?

Answer. No, that is not correct. Our methodology compares land use changes occurring under two scenarios—one with the RFS volume mandates in place and one without. So we are considering for a given year, the opportunity cost of using feedstocks and land for biofuels production as opposed to what the land would be used for absent biofuels production. Therefore, even if corn ethanol production increased from current levels to 15 Bgal in 2022 without any observable land use change in the U.S., there would still be an indirect land use change associated with the corn ethanol production in 2022. What we are comparing is how much land would be required to meet worldwide demand for food and feed in 2022 assuming the RFS2 in place *versus* no RFS2. So even if yields are increasing to help meet increasing demand over time, the increased demand for land associated will biofuels will have an indirect impact from what would have happened otherwise.

Questions Submitted By Hon. Stephanie Herseth Sandlin, a Representative in Congress from South Dakota

Question 1. At the hearing on May 6, 2009, you testified in response to my questioning that the indirect emissions were broken out to show the difference between

international and domestic sources. For corn ethanol, for example, EPA has provided a table (Table VI.C.1–1) which appears to outline various elements of the lifecycle analysis for a natural gas dry mill that dries its distiller grains (p. 315). Table VI.C.1–2 then provides two columns of EPA's estimate of reductions under two options for each of the corn ethanol pathways identified by EPA (p. 317). EPA does not explain how these tables reflect the fuel's lifecycle stage being considered as outlined in the remainder of the preamble or how Table VI.C.1–1 relates to the additional pathways in Table VI.C.1–2. I request that EPA provide the following information as requested in the tables listed below.

For Table VI.C.1–1 (and similar tables for other fuels), identify the fuel lifecycle stage being addressed by the emissions, a list of source of emissions for that stage, and whether such emissions are direct or indirect, and identify the total net emissions without international land use change and with international land use change. Where there are no emissions references for the petroleum baseline, please provide an explanation as to why there are no such numbers:

Answer.

Modified Table VI.C.1–1—Absolute GHG Emissions for Corn Ethanol and the 2005 Petroleum Baseline (CO_2-eq/mmBtu)

With and Without International Land Use Changes

	2005 Gasoline Baseline	Natural Gas Dry Mill with dry DGs	2005 Gasoline Baseline	Natural Gas Dry Mill with dry DGs
Lifecycle Stage	100 yr 2%		30 yr 0%	
Feedstock/Fuel Production	823,262	1,436,720	573,058	1,037,279
—Direct Emissions (list sources of emissions)	—Crude oil extraction —Transport of crude oil to refinery —Upstream and onsite energy use and emissions at refinery to produce gasoline —Distribution of gasoline	—Agricultural inputs and emissions from growing corn used in ethanol production —Land use change to grow corn used in ethanol production —Upstream and onsite energy use at ethanol production plant	Same as 100 yr 2%	Same as 100 yr 2%
—Indirect Emissions (list sources of emissions, excluding international land use changes)	—EISA requires that lifecycle GHG emissions of renewable fuels be compared to a 2005 average petroleum baseline. Determining indirect impacts would require EPA to estimate, for example, petroleum displaced by renewable fuel. This analysis seems inconsistent with the statute's 2005 baseline requirement. However, the NPRM seeks comment on this.	—Agricultural inputs and emissions from growing crops indirectly impacted by use of corn for ethanol production (domestically and internationally) —Indirect domestic land use changes including changes in soil management practices —Changes in livestock production	Same as 100 yr 2%	Same as 100 yr 2%
Fuel and Feedstock Distribution and Delivery	Included in Feedstock/Fuel Production	174,327	Included in Feedstock/Fuel Production	121,346
Use of Finished Fuel (Tailpipe Emissions)	3,417,411	37,927	2,378,800	26,400
Net Total Emissions (w/o indirect emissions from international land use changes)	4,240,674	1,648,974	2,951,858	1,185,025

Indirect emissions from international land use changes	—EISA requires that lifecycle GHG emissions of renewable fuels be compared to a 2005 average petroleum baseline. Determining indirect impacts would require EPA to estimate, for example, petroleum displaced by renewable fuel. This analysis seems inconsistent with the statute's 2005 baseline requirement. However, the NPRM seeks comment on this	1,911,391	Same as 100 yr 2%	1,910,822
Net Total Emissions	4,240,674	3,560,365	2,951,858	3,095,846

Question 2. For Table VI.C.1–2 (and similar tables for other fuels), identify the percent reductions without consideration of international land use changes, as follows:

Answer.

Modified Table VI.C.1–2—Lifecycle GHG Emissions Changes for Various Corn Ethanol Pathways in 2022 Relative to the 2005 Petroleum Baseline

Corn Ethanol Production Plant Type	Percent Change from 2005 Petroleum Baseline (100 yr 2%, without international land use changes)	Percent Change from 2005 Petroleum Baseline (100 yr 2%, with international land use changes)	Percent Change from 2005 Baseline (30 yr 0%, without international land use changes)	Percent Change from 2005 Baseline (30 yr 0%, with international land use changes)
Note: EPA's approach to lifecycle modeling considers all significant direct and indirect sources of emissions. It is invalid to present results that only omit emissions from international land use change. Lifecycle modeling accounts for land use change as well as other "positive" indirect impacts in terms of biofuels GHG emissions, such as reductions in livestock emissions and shifting of crop production to regions with lower GHG impacts. The lifecycle modeling and results are internally inconsistent when only one of the indirect impacts is omitted. The results without international land use change presented below are for illustrative purposes only.				
Natural Gas Dry Mill with dry DGs	−61%	−16%	−60%	+5%
Natural Gas Dry Mill with dry DGs and CHP	−64%	−19%	−63%	+2%
Natural Gas Dry Mill with dry DGs, CHP, and Corn Oil Fractionation	−72%	−27%	−71%	−6%
Natural Gas Dry Mill with dry DGs, CHP, Corn Oil Fractionation, and Membrane Separation	−76%	−30%	−74%	−10%
Natural Gas Dry Mill with dry DGs, CHP, Corn Oil Fractionation, and Membrane Separation, and Raw Starch Hydrolysis	−80%	−35%	−79%	−14%
Natural Gas Dry Mill with wet DGs	−72%	−27%	−70%	−6%
Natural Gas Dry Mill with wet DGs and CHP	−75%	−30%	−74%	−9%
Natural Gas Dry Mill with wet DGs, CHP, and Corn Oil Fractionation	−78%	−33%	−76%	−12%
Natural Gas Dry Mill with wet DGs, CHP, Corn Oil Fractionation, and Membrane Separation	−81%	−36%	−80%	−15%
Natural Gas Dry Mill with wet DGs, CHP, Corn Oil Fractionation, and Membrane Separation, and Raw Starch Hydrolysis	−84%	−39%	−83%	−18%
Coal Fired Dry Mill with dry DGs	−32%	+13%	−31%	+34%
Coal Fired Dry Mill with dry DGs and CHP	−35%	+10%	−33%	+31%
Coal Fired Dry Mill with dry DGs, CHP, and Corn Oil Fractionation	−51%	−5%	−49%	+15%
Coal Fired Dry Mill with dry DGs, CHP, Corn Oil Fractionation, and Membrane Separation	−58%	−13%	−57%	+8%
Coal Fired Dry Mill with dry DGs, CHP, Corn Oil Fractionation, and Membrane Separation, and Raw Starch Hydrolysis	−67%	−21%	−65%	−1%
Coal Fired Dry Mill with wet DGs	−54%	−9%	−53%	+12%
Coal Fired Dry Mill with wet DGs and CHP	−56%	−11%	−55%	+10%
Coal Fired Dry Mill with wet DGs, CHP, and Corn Oil Fractionation	−63%	−17%	−61%	+3%
Coal Fired Dry Mill with wet DGs, CHP, Corn Oil Fractionation, and Membrane Separation	−70%	−25%	−69%	−4%
Coal Fired Dry Mill with wet DGs, CHP, Corn Oil Fractionation, and Membrane Separation, and Raw Starch Hydrolysis	−75%	−30%	−74%	−9%
Biomass Fired Dry Mill with dry DGs	−84%	−39%	−83%	−18%
Biomass Fired Dry Mill with wet DGs	−85%	−40%	−84%	−19%
Natural Gas Fired Wet Mill	−52%	−7%	−51%	+14%

Modified Table VI.C.1–2—Lifecycle GHG Emissions Changes for Various Corn Ethanol Pathways in 2022 Relative to the 2005 Petroleum Baseline—Continued

Corn Ethanol Production Plant Type	Percent Change from 2005 Petroleum Baseline (100 yr 2%, without international land use changes)	Percent Change from 2005 Petroleum Baseline (100 yr 2%, with international land use changes)	Percent Change from 2005 Baseline (30 yr 0%, without international land use changes)	Percent Change from 2005 Baseline (30 yr 0%, with international land use changes)
Coal Fired Wet Mill	−25%	+20%	−24%	+41%
Biomass Fired Wet Mill	−92%	−47%	−91%	−26%

Question 3. As requested above, please provide a similar analysis for Table VI.C.1–3 (Corn Ethanol Lifecycle GHG Emissions Changes in 2012, 2017, and 2022).

Answer.

Modified Table VI.C.1–3—Corn Ethanol Lifecycle GHG Emissions Changes in 2012, 2017, and 2022

Scenario Description	Percent Change from 2005 Petroleum Baseline (100 yr 2%)	Percent Change from 2005 Petroleum Baseline (100 yr 2%, without international land use changes)	Percent Change from 2005 Petroleum Baseline (30 yr 0%)	Percent Change from 2005 Petroleum Baseline (30 yr 0%, without international land use changes)
Note: EPA's approach to lifecycle modeling considers all significant direct and indirect sources of emissions. It is invalid to present results that only omit emissions from international land use change. Lifecycle modeling accounts for land use change as well as other "positive" indirect impacts in terms of biofuels GHG emissions, such as reductions in livestock emissions and shifting of crop production to regions with lower GHG impacts. The lifecycle modeling and results are internally inconsistent when only one of the indirect impacts is omitted. The results without international land use change presented below are for illustrative purposes only.				
Corn Ethanol Natural Gas Dry Mill in 2012 with dry DGs	−16%	−61%	−3%	−60%
Corn Ethanol Natural Gas Dry Mill in 2017 with dry DGs	−13%	−61%	+9%	−60%
Corn Ethanol Natural Gas Dry Mill in 2022 with dry DGs	−16%	−61%	+5%	−60%

Question 4. As requested above, please provide a similar analysis for Table VI.C.1–4 (Corn Ethanol Lifecycle GHG Emissions Changes Associated with Different Volume Changes).

Answer.

Modified Table VI.C.1–4—Corn Ethanol Lifecycle GHG Emissions Changes Associated with Different Volume Changes

Scenario Description	Percent Change from 2005 Petroleum Baseline (100 yr 2%)	Percent Change from 2005 Petroleum Baseline (100 yr 2%, without international land use changes)	Percent Change from 2005 Petroleum Baseline (30 yr 0%)	Percent Change from 2005 Petroleum Baseline (30 yr 0%, without international land use changes)
Note: EPA's approach to lifecycle modeling considers all significant direct and indirect sources of emissions. It is invalid to present results that only omit emissions from international land use change. Lifecycle modeling accounts for land use change as well as other "positive" indirect impacts in terms of biofuels GHG emissions, such as reductions in livestock emissions and shifting of crop production to regions with lower GHG impacts. The lifecycle modeling and results are internally inconsistent when only one of the indirect impacts is omitted. The results without international land use change presented below are for illustrative purposes only.				
Corn Ethanol Natural Gas Dry Mill in 2022 with dry DGs; 2.7 Bgal change in corn ethanol volumes	−16%	−61%	+5%	−60%
Corn Ethanol Natural Gas Dry Mill in 2022 with dry DGs; 6.3 Bgal change in corn ethanol volumes	−6%	−52%	+14%	−51%

Question 5. How does EPA (or the models EPA used) determine what factor(s) cause specific land use change?

Answer. The methodology EPA has developed isolates the impacts of biofuels production, which allows us to differentiate and assign just the land use change directly caused by increases in renewable fuels. This approach considers the impacts of increased biofuels production *versus* a baseline that incorporates the number of other factors you mention. Therefore the only change we measure is from biofuels production, keeping all other factors constant.

To do this work, we combine a suite of peer-reviewed process models and peer-reviewed economic models of the domestic and international agricultural sectors to determine direct and significant indirect emissions, respectively. These agricultural sector models allow us to estimate the total additional cropland needed internationally and where (by country) expansion would occur for the specific factor of increased biofuels production. To determine what types of land are converted to meet this additional cropland demand, we use recent land use trends based on satellite data. These trends take into account a number of drivers, but for the purposes we are using them for (*i.e.,* to determine what type of land is converted with increased cropland expansion) they apply for any driver of cropland expansion, including biofuels.

Questions Relating to Biodiesel:

Question 6. Is it correct that you took 2001to 2004 land conversion rates and extrapolated those into the future to come up with the calculation of land use change you expect?

Answer. No, this is not the case. In our analysis, the causes of crop expansion are captured with economic modeling. We rely on well-established economic models to project the amount of crop expansion in each country resulting from increased biofuel production. We then use satellite data to determine not the amount of land that might be converted but what types of land will be used in a particular country if additional land is needed for crop production as a result of U.S. biofuels expansion.

We recognize that this is an area of potential uncertainty. Therefore, the use of satellite data is one of the components of the lifecycle analysis that we are having peer-reviewed and have specifically asked for comment on throughout the rulemaking process.

Question 7. If U.S. biodiesel production from 2001 to 2004 grew from 5 million gallons in 2001 to 25 million gallons in 2004, is it unreasonable to conclude that biodiesel was not a significant cause of land use change that occurred from 2001 to 2004? Why or why not?

Answer. No, this is not a correct conclusion. Our methodology compares land use changes occurring under two scenarios—one with the RFS volume mandates in place and one without. We are not comparing changes in emissions or land use over time but comparing the opportunity cost of using a feedstock or land for biofuel production in a given year. So a more appropriate comparison is what land use would have been in 2004 without the increase in biodiesel production.

Questions Submitted By Hon. Deborah L. Halvorson, a Representative in Congress from Illinois

Question 1. As you know, in the 2007 energy bill EPA was tasked with determining the lifecycle greenhouse gas emissions of current and future transportation fuels as part of the new renewable fuels standards. EPA has released published for comment a proposed rulemaking on this issue, but has had difficulty in finding consensus on the methodology, especially with respect to the issue of emissions from indirect land use change.

My understanding is that the issue of greenhouse gas emissions from indirect land use change is a highly controversial one in the scientific community, and that there is still a very limited understanding of how biofuels production—or petroleum production and other economic activities, for that matter—impact land use change around the world. What will EPA do to resolve this uncertainty, and how will it implement the renewable fuels standards in a timely fashion while continuing to develop a greater understanding of this complex problem?

Answer. As mandated by EISA, EPA's greenhouse gas emission assessments must evaluate the full lifecycle emission impacts of fuel production including both direct and indirect emissions, including significant emissions from land use changes. There is no question that this task was a challenge and required groundbreaking work. This is why we have taken every opportunity to test our assumptions, minimize uncertainties and maximize transparency.

Question 1a. Will EPA re-examine the indirect land use issue in light of new research showing that initial estimates may have been overstated?

Answer. EPA has spent the last year and half developing a technically and scientifically sound analysis of the full lifecycle GHG emission impacts of biofuels that incorporates indirect land use changes, using well-accepted, peer-reviewed models. This process has included reviewing the research in this field and, in many cases, consulting with the authors of this research. Through this effort, EPA has determined that indirect emissions comprise a significant portion of the total lifecycle emissions of biofuels. Many studies in the peer-reviewed literature also show that indirect land use emissions comprise a significant portion of the total lifecycle emissions of some biofuel pathways.

We also recognize the significance of using lifecycle greenhouse gas emission assessments that include indirect impacts such as emission impacts of indirect land use changes and acknowledge the varying degrees of uncertainty in the different aspects of our analysis. As described above, we have taken a number of steps to address this uncertainty. However, EPA recognizes that the science in this area will continue to evolve even after a final rule. Thus, we are committed to revising and updating our analysis on an ongoing basis as new data and information comes available.

Question 2. The issue of lifecycle analysis for biofuels is just one example of why scientists are critical to the mission at EPA. What will you do to ensure that scientists play a bigger role at EPA?

Answer. EPA is committed to using scientific expertise housed both within and outside the Agency. EPA's scientists, other Federal scientists (*e.g.,* USDA, DOE) and scientists at U.S. universities have and will continue to directly contribute to the development of the data and models for the lifecycle analysis. In addition, EPA is conducting formal peer review processes for several key components of the lifecycle analysis. During this process, external scientists will extend their expertise to provide third-party feedback on EPA's methodologies. EPA will continue to use research and knowledge developed by the nation and the world's scientific community as we proceed in refining the lifecycle analysis proposed in the NPRM.

Throughout this work, EPA has remained committed to fostering sound science, consistent with the President's March 9, 2009 memorandum on scientific integrity. Our analyses are based upon the best science available, with every step of the process building upon our extensive collaboration with both Federal and independent scientific experts.

Question 3. We are supposed to have 500 million gallons of biodiesel in 2009. My district lost a biodiesel plant this year. How is EPA insuring 500 million gallons are used this year?

Answer. Although the RFS2 program will not be in place in 2009, after coordinating with our stakeholders, we are proposing a means of still implementing the statutory requirement for 500 million gallons of biomass-based diesel for 2009. While the RFS1 regulations do not provide a mechanism for putting this requirement in place in 2009, in our Notice of Proposed Rulemaking we are proposing that the 2009 requirement of 500 million gallons and the 2010 requirement of 650 million gallons be added together, with the total volume of 1.15 billion gallons applicable in 2010 under RFS2. Obligated parties could then use credits (RINs) from both 2009 and 2010 to comply, and would have a strong incentive to blend biodiesel in 2009 in addition to 2010.

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